MP-1454

Salt River Project Diversion and Conveyance System Historic District
Name of Property

Maricopa, AZ
County and State

United States Department of the Interior
National Park Service

National Register of Historic Places Registration Form

This form is for use in nominating or requesting determinations for individual properties and districts. See instructions in National Register Bulletin, *How to Complete the National Register of Historic Places Registration Form*. If any item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, architectural classification, materials, and areas of significance, enter only categories and subcategories from the instructions. **Place additional certification comments, entries, and narrative items on continuation sheets (NPS Form 10-900a).**

1. Name of Property

Historic name: Salt River Project Diversion and Conveyance System Historic District

Other names/site number: Granite Reef Diversion Dam, Arizona Canal, New Crosscut Canal, Crosscut Hydro Plant (sometimes called Crosscut Powerplant), Grand Canal, South Canal, Consolidated Canal, Eastern Canal, Tempe Canal, Western Canal, Highline Canal (sometimes called Highline Laterals, North and South Branch)

2. Location

Street & number: Greater Phoenix metropolitan region ☐ not for publication

Cities or towns: Greater Phoenix metropolitan area, including the cities of Phoenix, Mesa, Gilbert, Chandler, Scottsdale, Tempe, Glendale, Peoria, and any section of rural Maricopa County served by this system

☒ vicinity

State: Arizona code: AZ county: Maricopa code: 013 zip code:

3. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act, as amended,

I hereby certify that this X nomination __ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60.

In my opinion, the property X meets __ does not meet the National Register Criteria. I recommend that this property be considered significant at the following level(s) of significance:

__ national X statewide __ local

George A Hartsoe — 11/22/2016
Signature of certifying official — Date

Federal Preservation Officer — Bureau of Reclamation, DOI
Title — State or Federal agency and bureau

In my opinion, the property X meets __ does not meet the National Register criteria.

Kathleen Kilpatrick — 17 Feb 2017
Signature of commenting official — Date

SHPO — Arizona State Parks
Title — State or Federal agency and bureau

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__ **national** X **statewide** __ **local**

George Hartfield — Signature of certifying official

11/22/2016 — Date

Federal Preservation Officer — Title

BOR, LO1 — State or Federal agency and bureau

In my opinion, the property __ meets __ does not meet the National Register criteria.

Signature of commenting official

Date

Title

State or Federal agency and bureau

Salt River Project Diversion and Conveyance System Historic District
Name of Property

Maricopa, AZ
County and State

4. National Park Service Certification

I, hereby, certify that this property is:

Signature of the Keeper — Date of Action

[X] entered in the National Register — 3/7/2017

[ ] determined eligible for the National Register

[ ] determined not eligible for the National Register

[ ] removed from the National Register

[ ] other (explain:)

5. Classification

Ownership of Property
(Check as many boxes as apply)

[ ]	public - Local
[ ]	public - State
[X]	public - Federal
[ ]	private

Category of Property
(Check only one box)

[X]	district
[ ]	site
[ ]	structure
[ ]	building(s)
[ ]	object

Number of Resources within Property
(Do not include previously listed resources in the count.)

Contributing	Noncontributing	
		sites
10		structures
		objects
2		buildings
12		**Total**

Name of related multiple property listing

Salt River Project, Arizona

Number of contributing resources previously listed in the National Register

0

6. Function or Use

Historic Functions
(Enter categories from instructions)

GOVERNMENT/*public works*
AGRICULTURE/*irrigation facility*
INDUSTRY/PROCESSING – *Water works*

Current Functions
(Enter categories from instructions)

GOVERNMENT/*public works*
AGRICULTURE/*irrigation facility*
INDUSTRY/PROCESSING – *Water works*

7. Description

Architectural Classification
(Enter categories from instructions)

N/A

Other/concrete ogee weir dam

Materials
(Enter categories from instructions)

Foundation N/A

walls: N/A

roof: N/A

other Concrete, Earth

Narrative Description

Summary Paragraph

The Salt River Project (Project) is a Federal reclamation project authorized in 1903 under the National Reclamation Act. Originally envisioned to provide irrigation water and incidental electrical power to support agricultural growth in the Salt River Valley, the Project evolved over the course of the twentieth century to provide water and electricity for urban and agricultural purposes. Project water and power have been essential to the transformation of the valley and its small agricultural communities into the Phoenix metropolitan area. This nomination for the Salt River Project Water Diversion and Conveyance System Historic District is submitted under the Salt River Project multiple property document (MPD). The Historic District consists of nine main Salt River Project canals, the diversion dam that feeds water to those canals, and one hydropower plant situated on one of those canals. The contributing properties are: Granite Reef Diversion Dam (a structure); the Southside Gatekeeper's house at the dam (a building); three canals serving land on the north side of the Salt River (the Arizona, Grand, and New Crosscut canals, all structures); six canals serving land on the south side of the Salt River (the South, Eastern, Consolidated, Tempe, Western, and Highline canals, all structures); and the Crosscut Hydro Plant (a building), situated at the downstream end of the New Crosscut Canal. All are part of an operationally interconnected system of 1,300 miles of canals, laterals, ditches, and drains, with appurtenant sub-structures, that supply water to farms and communities within an approximately 375 square mile water service area. The Crosscut Hydro Plant is one component of the larger Project power generation system that, collectively, provides electric service to a three county area of central Arizona that encompasses Phoenix and its satellite communities and area farms. The associated system of secondary laterals, ditches, and drains are not included in the present district nomination. Only a few of the laterals and drains remain as the original structures. In the future, some of these features may be determined to be contributing, as data on their historic association and integrity becomes available, but it is anticipated that most secondary features will not be included under this nomination. The Salt River Project Diversion and Conveyance District meets the Registration Requirements set forth in the Salt River Project MPD for Property Type II: Diversion-Conveyance System and Type III: Powerplants.

Narrative Description

Granite Reef Diversion Dam, (GRDD) (contributing structure) is located on the Salt River four miles downstream of the confluence of the Verde River with the Salt and about 22 miles east (upstream) of Phoenix. Constructed by the U.S. Reclamation Service (called the Bureau of Reclamation after 1923, both herein referred to as Reclamation, USRS, or USBR) between 1906 and 1908, it is operated by the Salt River Project Water Users' Association (Association and later SRP) for the purpose of diverting water into north and south-bank canal headworks. As constructed, the dam is a cyclopean rubble and concrete ogee weir with embankment wings, and a stone and concrete apron along the downstream toe. The dam has a structural height of 29 feet, with a total crest length of 1,128 feet, and can pass a volume of 35,000 cubic yards of water. A sluiceway and a canal headworks are located at each end of the dam, each controlled by slide gates; the north side headworks contain eighteen seven by five feet slide gates while the south side has nine of these gates. The dam's downstream apron was repaired and reinforced in 1916. All project water is diverted through either the north or southside canal headworks into a canal that each feeds a system of canals that convey water to lands and towns throughout the service area. The sluice gates on the southside were located 1,600 feet below the headgates of the dam and served as a combination waste gate, check, and bridge. The structure was made from reinforced concrete with three five by seven feet cast-iron waste gates. The six massive timbered check gates were each 9.5 by nine feet and swing on hinges at the upper edges. Zanjeros originally raised the gates by means of copper cables and a windlass operated by hand. The original northside slide gates at the sluiceway were replaced in the 1950s with radial gates. The operation of

diversion gates switched from manual to electrical means in the 1950s. The Southside Gatekeeper's house (contributing building) was constructed at the same time as the dam, less than 200 feet from the southside headgates. The house is a two-story cement block building with a steeply sloping shingled roof. An open concrete porch was on the front of the house and the porch on the back was screened.

Canal System. Typical features along a canal include sluiceways or drain gates, turnout structures to laterals or headgates to other canals, culverts or siphons, flumes, pipes, intake structures, drop structures, grates and trask racks, weirs and other measuring devices, and checks. Taintor (or tainter) gates are on several of the Project canals and dams to control water flow. The taintor gate is a sement of a cylinder mounted on radial arms that rotate. It is considered to be economical and simple in design. Bridges, both for foot and vehicular traffice, cross the canals. Since the 1920s, most of the Project canals have been lined and they are periodically repaired. Modern canals have safety steps, ladders, and ramps for maintainence equipment. Project canals are equipped with an automated system that controls the gates from a central dispatch center. Like the Hohokam canal system, the Project main water transmission system travels along topographic contours, so that gravity supplies the necessary force to move water from the river or source to the irrigated lands. Portions of the Project canal system, primarily the distribution system of laterals and ditches, follows artificial survey lines to deliver water to farm land. Most of the main Project canals follow their original alignment with only minor modifications, such as the Tempe Canal, which was piped to accommodate transportation improvements.

North-side Conveyance System

On the north side of the river, the Arizona Canal (contributing structure) runs generally west 38.5 miles from the canal headworks at the GRDD to the tail drain gates near the Arizona Canal Diversion Channel (ACDC) and Skunk Creek. It was originally constructed by private interests from 1883 to 1885, and enlarged by the USRS between 1907 and 1912. The headworks, built by the USRS in 1908, has a diversion capacity of 2,000 cubic feet per second (cfs), and is controlled by 18 seven by five feet slide gates. Major features along the Arizona Canal are the Indian Bend Wash siphon, the newly rebuilt Arizona Falls Hydropower Plant, and Cave Creek Wash. A typical maximum section of the concrete lined portion of the canal has a bottom width of 80 feet, 0.75:1 side slopes, and a water depth of 6.8 feet, while a typical maximum earthen section has a 70-foot base width and 1:1 side slopes, with a 5.2-foot water depth.

The New Crosscut Canal (contributing structure) runs south 3.5 miles through Scottsdate from the Arizona Canal to connect with the Grand Canal at the Crosscut Hydro Plant in Tempe (its termination point), and was constructed by the USRS from 1912 to 1913. The intake structure from the Arizona Canal contained two double screw-stem steel lift gates measuring 17 by seven feet, which were operated by a hand crank and electric motor. A typical maximum concrete lined section has a bottom width of 16 feet, 1:1 side slopes, and a water depth of sixfeet, while the typical maximum earthen section has a 38-foot bottom width, 1:1 slope, and 4.1-foot water depth. Several major features include delivering water to the Tempe North Filter Plant, the concrete flume, the forebay for the Crosscut Hydro Plant, and a turnout for water deivered to Tempe Town Lake. The New Crosscut Canal replaced the Old Crosscut Canal (non-contributing structure), which was built in 1889 to connect the Arizona and Grand canals.

The Crosscut Hydro Plant (contributing building) is located in Tempe, at the terminus of the New Crosscut Canal. The Hydro Plant was constructed by the USRS from 1913 to 1914. The Crosscut Canal connects two parallel penstocks, 2,240 feet long and drops 116 feet into the plant. The outside dimensions of the generator room are 176 by 42 feet while the transformer and switch house was approximately 89 by 43 feet. The cast-in-place concrete structure has a maximum height of 63 feet with the main generator floor 22 feet above the tailrace. The plant was first extensively retrofitted from 1937 to 1939. The retrofit included adding diesel and steam powered generators (non-contributing) in adjacent buildings. In the mid-1950s the original hydro units at the Crosscut Hydro Plant were decommissioned and removed, but the 60 cycle unit, installed in the 1930s, continued to be used for peak load. The plant was again renovated in 1976, new equipment installed in the original 1913 building, and the plant returned to service. The contributing component of the hydro plant facility is the 1913 building, but does not include the equipment it houses.

The Grand Canal (contributing structure) now runs from the Crosscut Hydro Plant facility in Tempe, north and west 22.3 miles through Phoenix to terminate at the New River near 107th Avenue. It was constructed by private interests in 1878, and enlarged by the USRS from 1907 to 1912. Originally it had a headworks on the Salt River, which was abandoned when the Old Crosscut Canal was constructed in 1889. It now receives water from the Arizona Canal by way of the New Crosscut Canal. A typical maximum concrete lined section has a bottom width of 28 feet, 0.75:1 side slopes, and a water depth of five feet, while the typical maximum earthen section has a 35-foot base width, 1:1 side slopes, and a five foot water depth.

Southside Conveyance System

On the south side of the river, the South Canal (contributing structure) is considered today to run from the GRDD 10.1 miles southwest to the north boundary of the City of Mesa, where it divides into the Consolidated and the Tempe canals along Brown Road near Mesa Drive. However, originally only the uppermost two miles of this 10.1-mile length was considered to be the South Canal, with the remainder considered the upper end of the Consolidated Canal. This two-mile-long upper section of the South Canal was built by the USRS in 1908, and linked the new canal heading at the GRDD with the Consolidated Canal. The intake structures at the headworks consisted of nine seven by five feet regulator gates with a total width of 145.5 feet and a flow capacity of 1,600 cfs. A typical maximum concrete lined section of the present-day South Canal has a bottom width of 63 feet, 1:1 side slopes, and a water depth of eight feet. The diversion capacity for the canal is 1,700 cfs. Among the major features on the South Canal are a small hydropower plant, the Hennessy Drain, and the Roosevelt Water Conservation District (RWCD) Pumping Plant.

The Consolidated Canal (contributing structure) today runs generally south 18.4 miles from the South Canal division gates through the Cities of Mesa, Gilbert, and Chandler. It originally extended about 10 miles further upstream in a run of canal now incorporated into the South Canal. The Consolidated Canal initially had its own headworks, which became obsolete with the construction of the GRDD, and now no longer exist. The Consolidated Canal was built by private interests from 1892 to 1893. In order to unify the south-side system, it was purchased by the USRS in 1908, and enlarged and lined from 1925 to 1927. The Consolidated Canal provides water to adjoining treatment plants from neighboring communities. Today, a typical maximum concrete lined section has a bottom width of 60 feet, 0.75:1 side slopes, and a water depth of eight feet. A typical earthen section has a 40-foot bottom width,1:1 side slopes, and a 5-foot water depth. The canal has a diversion capacity of 525 cfs and ends at U.S. Highway 87 by Arizona Avenue, although the flow of water continues off-project into a different irrigation system.

The Eastern Canal (contributing structure) runs 14.5 miles south, and parallel to the Consolidated Canal, from a heading in the South Canal. The turnout structure for the modern Eastern Canal is at the third South Consolidated Power Plant. Because the USRS lacked funding to build this canal, it was built in 1909 by the canal users under USRS' engineering oversight and approval. It replaced the old Highland Canal, located about 0.25 miles to the west. Between 1920 and 1923, the USRS widened the Eastern Canal to increase its carrying capacity, and it was concrete lined in 1925 to 1927. Today, a typical maximum section has a bottom width of 31 feet, 0.75:1 side slopes, and a water depth of 4.2 feet. The canal has a diversion capacity of 360 cfs and ends south of Pecos Road by Lindsay Road.

The Tempe Canal (contributing structure) runs generally west and southwest 9.3 miles from its present-day heading at the South Canal diversion gates to its terminus at its juncture with the Western Canal at the Tempe Water Treatment Plant. Private interests began construction of the Tempe Canal in 1871, and it grew as a series of interconnected laterals and divisions over the next several decades. The Tempe Canal today consists of a south extension constructed in the early 1880s, while the upper-most section of the current canal (once called the Tempe Crosscut Canal) was constructed by the Consolidated Canal Company in 1892. Reclamation purchased the Tempe Canal system in 1923, and enlarged it from 1926 to 1927. It is the oldest continuously operating canal in the Project. A typical maximum concrete lined section has a bottom width of 34 feet, 0.75:1 side slopes, and a water depth of 4 feet, while the typical maximum earthen section has a 45-foot bottom width, 1:1 side slope, and four foot water depth. It has a diversion capacity of 600 cfs. Today the Tempe Canal flows into the Western Canal below Guadalupe Road along Price Road.

The Western Canal (contributing structure), originates at the terminus of the Tempe Canal, runs due west for 9.5 miles before turning north to run about 14 miles around the north side of South Mountain to 23rd Avenue and Dobbins Road in South Phoenix. Using force account, the USRS constructed the eastern section of the canal in 1911, and after a hiatus due to lack of funding, completed that work late in 1912. Farmers, organized as the Western Canal Company, completed the remainder of the canal running west from Section 32, Township 1 North, Range 4 East, between 1912 and January 1915. Their contractor worked under the supervision USRS engineers and in accordance with USRS design specifications, and then turned the canal over to the agency. The USRS reimbursed their construction expenses with credits that could be applied against their water and other Project assessements. A typical maximum concrete lined section has a bottom width of 35 feet, 0.75:1 side slopes, and a water depth of four feet, with a typical maximum earthen section with a 35-foot bottom width, 1:1 slope, and 4.5 foot water depth. The open canal has a diversion capacity of 500 cfs. The Western Canal ends at Dobbins Road near 18th Avenue, while a lateral continues to deliver water farther west.

The Highline Canal laterals (contributing structure) are fed by the Western Canal, and wind north and south through Tempe, Guadalupe, Awahtukee, and southwest Phoenix. Following a process established for the Western Canal, the Highline system was constructed in 1913 by the Highline Canal Company, formed by the canal's future water users specifically to fund the construction of the facilities with the intention of turning them over to the USRS in exchange for

credits on assessments. They built the system under the supervision of USRS engineers using government specifications, and they also had the USRS select or directly hire contractors for the more complex work. The system consisted of a 54-inch diameter pressure pipe about one mile long, extending west from the Western Canal; the pressure pipe raised the water up 40 feet to the head of the Highline Canal. The 1952 Highline Pumping Plant (non-contributing) pumps the water up along the Highline Canal. The canal was in reality two laterals that carried water around the base of South Mountain. The open North Branch Lateral extended about 10 miles north and then west until 10th Avenue south of Guadalupe Road, and the primarily open South Branch Lateral traveled about 4.5 miles south and then west ending near 44th Street, south of Chandler Blvd. A pumping plant (non-contributing) was constructed at the east end of the pipe section to pump water through the pressure pipe. The 1913 pumping plant was decommissioned and replaced by a new plant constructed on the west side of the Western Canal in 1952.

The GRDD and Project canals and pumping plants have been repaired and modified over the years. Irrigation facilities require maintenance that can necessitate replacing original materials. Furthermore, funding constraints during initial construction often caused builders to use wood for operating structures within canals, which deteriorated more rapidly. Although some replacement of wooden structures or lining installations/repairs occurred in the early years, systematic programs to replace aging structures or inferior materials began in the 1930s. From 1935 through 1938, Reclamation and the Association used the Civilian Conservation Corps to replace wooden turnouts and structures with concrete structures, repair damaged concrete lining, install lining in selected earthen canal sections, construct floodways, and perform other minor modifications. These kinds of minor modifications continued after 1949 under the Rehabilitation and Betterment Act programs. Most of these changes have been made to the downstream apron, except for the new flashgates added in 2000. The Crosscut Hydro Plant structure has not changed; however, the generating equipment has been modernized. See the historic context statements provided in Section 8 for additional detail on the nature and extent of modifications made to the facilities over time. In large part the diversion and conveyance system has sustained remakably limited change, except where urbanization has required modifications to the canals, such as the Waterfront on the Arizona Canal, bridges and street widenings, and safety features such as steps and ramps. Except in limited instances, the conveyance system follows the original canal alignments and still delivers water to shareholder lands.

8. Statement of Significance

Applicable National Register Criteria

(Mark "x" in one or more boxes for the criteria qualifying the property for National Register listing)

- [x] A Property is associated with events that have made a significant contribution to the broad patterns of our history.
- [ ] B Property is associated with the lives of persons significant in our past.
- [ ] C Property embodies the distinctive characteristics of a type, period, or method of construction or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.
- [ ] D Property has yielded, or is likely to yield, information important in prehistory or history.

Criteria Considerations

(Mark "x" in all the boxes that apply)

Property is:

- [ ] A owned by a religious institution or used for religious purposes.
- [ ] B removed from its original location.
- [ ] C a birthplace or grave.
- [ ] D a cemetery.
- [ ] E a reconstructed building, object, or structure.
- [ ] F a commemorative property.
- [ ] G less than 50 years old or achieving significance within the past 50 years.

Areas of Significance

(Enter categories from instructions)

Politics/Government

Agriculture

Community Planning and Development

Period of Significance

1906–1938

Significant Dates

1906–1923: Federal purchase of Pioneer canals

1908: Granite Reef Diversion Dam completed

1927: Project conveyance system completed

1938: CCC canal improvements completed

Significant Person

(Complete only if Criterion B is marked above)

Cultural Affiliation

Architect/Builder

Numerous Private Interests (before 1903)

U.S. Reclamation Service/Bureau of Reclamation (after 1903)

Salt River Project Water Users' Association

Period of Significance (justification)

In 1868, Jack Swilling completed a small canal on the north side of the Salt River, and in 1871 settlers started using a small canal system they had built on the south side of the river, which became the earliest component of the Tempe Canal. In 1908, Reclamation completed the purchase of the existing "Pioneer" canal system on the north side of the river and began to operate it as part of the Salt River Project. That same year, Granite Reef Diversion Dam was completed, providing a permanent diversion point for all Salt River Valley canals and without which the Project conveyance system could not operate. Between 1908 and 1924, Reclamation purchased the south side Pioneer canal systems. By 1927, all construction of new canals and renovation of existing main canals that make up the Salt River Project's conveyance system serving the Phoenix Metropolitan area were completed; however, the conveyance system required renovations to

replace old gates and maintain linings. The Association made use of the Civilian Conservation Corps to repair and maintain portions of the conveyance system until 1938.

Statement of Significance Summary Paragraph

The Salt River Project Diversion and Conveyance System (diversion-conveyance system) is eligible for nomination as a historic district to the National Register of Historic Places under Criterion A. Working in concert with the Project's six storage-regulation dams, the diversion-conveyance system diverts water stored and released by the other facilities into an extensive carriage system that consists of 131 miles of canals and approximately 1,000 miles of laterals. As one of the first five federal reclamation projects authorized by the Secretary of the Interior under the National Reclamation Act of 1902, and with many features constructed by the USRS, the Project has not only been instrumental in the explosive physical and economic growth of the Phoenix metropolitan area in the twentieth century, but it is associated with the beginnings of federal intervention in the planning and building of large-scale water storage and irrigation delivery systems in the arid regions of the western United States. Additionally, it is the only federal reclamation project out of the original five that created an expansive urban environment, to the extent that the greater Phoenix metropolitan area is now one of the largest in America. Because of the sustained water supply created by the Project storage system, central Arizona was able to bolster the mining and agricultural industries during World War II and that economic growth continued into the second half of the twentieth century with the development of high technology industries. The Project diversion-conveyance system was pivotal to this economic growth, initially providing water to support the agricultural industry that was the economic foundation of local communities, and later delivering water for urban and industrial uses as the Valley transformed and its economic base changed. The water running through the conveyance system also was used to generate hydroelectric power, an essential component of the Valley's growth and economic transformation.

Narrative Statement of Significance

Under Politics and Government and Community Planning and Development, the Salt River Project and its diversion-conveyance system is significant because it illustrates the change in the federal government's policies and roles in the development of the West, its resources, and communities. Until passage of the National Reclamation Act, the federal government played a limited role in these processes, expecting private enterprise to fund and implement development, including construction of land reclamation projects. With passage of the Reclamation Act, the USRS was authorized to directly fund and construct large irrigation projects. This significantly influenced the patterns of settlement and economic growth in the arid areas of the West. Before passage of the National Reclamation Act, cooperative groups and private enterprise had struggled to fund construction of small irrigation systems, essentially all of which were dependent upon flood flows. They rarely could fund construction of a storage reservoir or large conveyance systems. Much of the West's arable land remained undeveloped and those that were developed remained highly vulnerable to drought or flood. Federal involvement meant funding was available for constructing storage reservoirs, the water from which could support much larger agricultural development. The Salt River Project was one of the first five projects selected for construction under the National Reclamation Act, indicating that it was considered to be one of the projects most likely to show the greatest success, and therefore illustrate to Congress and the public the wisdom of this new federal irrigation program. Subsequent significant changes in federal policy are also illustrated by the Salt River Project and the conveyance system, such as the decision in 1906, codified in the Town Sites and Power Development Act, to allow development of hydropower capability on irrigation works and sell excess power to communities and businesses. This change in policy led to construction of the Crosscut Hydro Plant on the north-side conveyance system, the first in a series of electrical generation works constructed on Project canals after 1910. Implementation of the programs authorized under these two federal laws radically altered the patterns of development of the Salt River Valley.

Under Agriculture, the Salt River Project and its diversion-conveyance system is significant because it provides a reliable source of irrigation and municiple water, which allowed full development of the agricultural potential of the Salt River Valley, and brought stability to the farming community by means of a reliable water supply. This in turn established a strong economy that supported the growth of communities and other businesses to sustain those communities. The Project ultimately triggered a social and economic transformation of the Valley and its communities, both agricultural and urban. Prior to 1903, Salt River Valley irrigation systems were developed by cooperative canal companies and private enterprises. They lacked the resources to build storage reservoirs or even well-constructed diversion dams. Canal systems extended to a relatively small area typically near the Salt River, and canals and diversions suffered from poor maintenance and inefficient operation. Under the Project, water storage was created, a reliable diversion dam constructed, canals were improved and the system expanded to reach more than 200,000 acres of agricultural land. Consolidation of the system increased efficiency and conserved water. Drainage systems were built to address the chronic problem of water-logging, which could poison land with alkalai, and the recovered water was used to supplement

the water supply and further expand the irrigation capability of the Project. In accordance with USRS requirements, a central water users' oganization operated and maintained the system, equally distributing water and assessing fees. These factors combined to transform the Salt River Valley's agricultural processes and economy, as well as the lives of those living on the farms and the farming communities. In part due to the water and electrical power provided by the Project, and in response to broader social changes occurring after World War II, the Valley began to move away from a primarily agricultural base to a more urban focus, and in post-1950 years has exploded into one of America's most dynamic urban centers. The Project remains an essential component to the sustanance of the Valley and its economy.

Developmental history/additional historic context information

Please see Section E of the Salt River Project MPD for an overview of the evolution and development of irrigated agriculture in the Salt River Valley, and role the Project played in the creation of the modern greater Phoenix metropolitan area. Also see the Section 8 Continuation Sheet attached to this Salt River Project Diversion and Conveyance System nomination for detailed information about the construction, modification, and historic operations of individual contributing properties to the historic district.

9. Major Bibliographical References

Bibliography

Please see SRP MPL Cover Document, Section I, for a comprehensive bibliography.

Previous documentation on file (NPS):

- ____ preliminary determination of individual listing (36 CFR 67 has been requested
- ____ previously listed in the National Register
- ____ previously determined eligible by the National Register
- ____ designated a National Historic Landmark
- ____ recorded by Historic American Buildings Survey #_____
- ____ recorded by Historic American Engineering Record: # AZ-51 (Granite Reef), AZ-21 (Old Crosscut), AZ-22 (Western), AZ-52 (South), AZ-55 (Consolidated-DRAFT), AZ-60 (New Crosscut), AZ-16 (Tempe), AZ-56 (Eastern), AZ-17
- X (Grand), AZ-19 (Arizona), AZ-23 (Highline), AZ-6 (San Francisco)

Primary location of additional data:

- ____ State Historic Preservation Office
- ____ Other State agency
- x Federal agency
- ____ Local government
- ____ University
- x Other

Name of repository: Salt River Project Archives

Historic Resources Survey Number (if assigned): _____

10. Geographical Data

Acreage of Property Approx. 1,048 acres

UTM References

Please refer to Section 10 (UTM list) and Section 11 (site maps with UTMs) Continuation Sheets

Verbal Boundary Description

The boundaries for the historic district encompass the contributing properties, which are Granite Reef Diversion Dam and the Gatekeeper's house approximately 200 feet south of the dam, located a few miles northeast of Mesa; the alignments of the contributing canals (on the north side of the Salt River, the Arizona, Grand, and New Crosscut canals, and on the south side of the Salt River, the South, Eastern, Tempe, Consolidated, Western, and Highline canals); and the Crosscut Hydro Plant which lies within 100 feet of the Crosscut Canal, just north of the start of the Grand Canal. See attached USGS topographic sheets that show these linear features and indicates the beginning and end points for contributing portions of canals.

Boundary Justification

Boundaries for this district were selected to provide a historic and thematic connection to the diversion dam and the canals it serves. As per consultation with the Arizona State Historic Preservation Office and the Office of the Keeper of the National Register, the nomination of canals is limited to main canals that retain historic integrity. No laterals, sub-laterals, drains, or other minor water conveyance features are presently included in this district. It should be noted that canal property boundaries include only the canal's structure and immediate right-of-way, encompassing the canal prism proper and extending laterally to the toe of the canal berms or banks, plus those attached features central to canal operation, such as headworks, diversion gates, turnouts, checks, weirs, flumes, siphons, horse steps, etc., that were constructed during the period of significance. Features that are not included are road or highway bridges, utility and other crossings, signs, or any other features *not* central to canal operations. Dam and canal boundaries are also kept tight to allow SRP and Reclamation personnel to perform routine operation and maintenance work to fences, roads, or any other ancillary feature adjacent to or near the diversion dam and canals. The Southside gatekeeper's house at GRDD is included because it is the original building used by the dam tender and retains almost all of its initial integrity. The Crosscut Hydro Plant maintains it original structure and still provides hydropower to the Project.

11. Form Prepared By

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Additional Documentation

Submit the following items with the completed form:

- **Maps:** An aerial map indicating the property's location.
- **Continuation Sheets:** 8 (context, historic photos), 10 (UTM listings), 11 (individual site maps with UTMs)
- **Additional items**: *2010 Salt River Project Water Transmission Book*. All photographs are keyed within this book.

Photographs:

Photo Log (See Section 8 Continuation Sheet)

Current Photographs

Name of Property: Salt River Project Water Diversion and Conveyance System Historic District
City or Vicinity: Phoenix Metropolitan Area
County: Maricopa
State: AZ
Photographer: Jim Bailey, Bureau of Reclamation; Salt River Project
Date Photographed: March 2010; Salt River Project 2009
Location of Original Digital Files: Bureau of Reclamation, Denver, CO; Salt River Project, Phoenix, AZ
Number of Photographs: 57

Photo 1 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Granite Reef Diversion Dam_0001)
Granite Reef Diversion Dam aerial, 2009. Photo courtesy of the SRP.

[i] All contact information is for the Phoenix Area Office Archaeologist.

Photo 2 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Granite Reef Diversion Dam_0002)
Granite Reef Diversion Dam crest looking north.

Photo 3 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Granite Reef Diversion Dam_0003)
Granite Reef Diversion Dam north side turnout looking north.

Photo 4 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Granite Reef Diversion Dam_0004)
Granite Reef Diversion Dam north side turnout structures looking east. Photo courtesy of the SRP.

Photo 5 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Granite Reef Diversion Dam_0005)
Granite Reef Diversion Dam south side gate structure looking west.

Photo 6 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Granite Reef Diversion Dam_0006)
Granite Reef Diversion Dam south gate structure and South Canal turnout looking northeast.

Photo 7 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Granite Reef Diversion Dam_0007)
Granite Reef Diversion Dam dam tenders house looking east.

Photo 8 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Granite Reef Diversion Dam_0008)
Granite Reef Diversion Dam dam tenders house looking south.

Photo 9 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Arizona Canal_0001)
Arizona Canal at Arizona State Route (Loop) 101 looking east.

Photo 10 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Arizona Canal_0002)
Arizona Canal at Scottsdale Road and Camelback Road looking north.

Photo 11 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Arizona Canal_0003)
Arizona Canal at Old Arizona Falls power plant looking east.

Photo 12 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Arizona Canal_0004)
Arizona Canal at Central Avenue looking northwest.

Photo 13 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Arizona Canal_0005)
Arizona Canal west of Metrocenter looking east.

Photo 14 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Arizona Canal_0006)
Arizona Canal west of Metrocenter looking west.

Photo 15 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Arizona Canal_0007)
Arizona Canal toe looking northwest.

Photo 16 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Crosscut Canal_0001)
Crosscut Canal turnout at Arizona Canal looking west.

Photo 17 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Crosscut Canal_0002)
Crosscut Canal at Arizona Canal looking south.

Photo 18 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Crosscut Canal_0003)
Crosscut Canal check at 64th Street and Thomas Road looking north.

Photo 19 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Crosscut Canal Hydro Plant_0004)
Crosscut Hydro Plant looking north (see site drawing).

Photo 20 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Crosscut Canal Hydro Plant_0005)
Crosscut Hydro Plant looking northeast.

Photo 21 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Crosscut Canal Hydro Plant_0006)
Crosscut Hydro Plant looking southwest.

Photo 22 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Crosscut Canal Hydro Plant_0007)
Crosscut Hydro Plant roof detail.

Photo 23 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Grand Canal_0001)
Grand Canal (foreground) at Old Crosscut Canal toe looking north.

Photo 24 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Grand Canal_0002)
Grand Canal at Hohokam Expressway looking west.

Photo 25 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Grand Canal_0003)
Grand Canal at 40th Street and Van Buren looking southeast.

Photo 26 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Grand Canal_0004)
Grand Canal at Central Avenue looking east.

Photo 27 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Grand Canal_0005)
Grand Canal check at 75th Avenue and Camelback Road looking southeast.

Photo 28 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Grand Canal_0006)
Grand Canal west of University of Phoenix (Cardinals) Stadium looking northeast.

Photo 29 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Grand Canal_0007)
Grand Canal toe drain looking northwest.

Photo 30 of 57 (AZ_Maricopa County_Salt River ProjectMPS_South Canal_0001)
South Canal turnout at Granite Reef Diversion Dam.

Photo 31 of 57 (AZ_Maricopa County_Salt River ProjectMPS_South Canal_0002)
South Canal at Thomas Road in Mesa, looking northeast.

Photo 32 of 57 (AZ_Maricopa County_Salt River ProjectMPS_South Canal_0003)
South Canal “horsesteps” detail (same location as Photo 33).

Photo 33 of 57 (AZ_Maricopa County_Salt River ProjectMPS_South Canal_0004)
South Canal near McDowell Road looking northeast.

Photo 34 of 57 (AZ_Maricopa County_Salt River ProjectMPS_South Canal_0005)
South Canal at Tempe/Consolidated/South canals juncture looking north.

Photo 35 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Consolidated Canal_0001)
Consolidated Canal at 8th Street, Mesa looking northwest.

Photo 36 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Consolidated Canal_0002)
Consolidated Canal at Lindsey Trail, looking north.

Photo 37 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Consolidated Canal_0003)
Consolidated Canal at Arizona State Route (Loop) 202 looking north.

Photo 38 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Consolidated Canal_0004)
Consolidated Canal at Ocotillo Road looking south.

Photo 39 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Consolidated Canal_0005)
Consolidated Canal check at Ocotillo Road looking north.

Photo 40 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Consolidated Canal_0006)
Consolidated Canal toe at Arizona State Route 87 looking north.

Photo 41 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Eastern Canal_0001)
Eastern Canal at turnout from South Canal looking northeast.

Photo 42 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Eastern Canal_0002)
Eastern Canal at Val Vista Road looking north.

Photo 43 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Eastern Canal_0003)
Eastern Canal check at Williams Field Road, looking south.

Photo 44 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Eastern Canal_0004)
Eastern Canal at Williams Field Road looking north.

Photo 45 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Eastern Canal_0005)
Eastern Canal toe at Pecos Road looking north.

Photo 46 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Tempe Canal_0001)
Tempe Canal at Tempe Draw gates looking northwest.

Photo 47 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Tempe Canal_0002)
Tempe Canal at Dobson Road looking northeast.

Photo 48 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Tempe Canal_0003)
Tempe Canal at Broadway Road looking northwest.

Photo 49 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Tempe Canal_0004)
Tempe Canal just north of piped section looking north.

Photo 50 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Tempe Canal_0005)
Tempe Canal piped section intake looking south.

Photo 51 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Western Canal_0001)
Western Canal at Tempe water treatment plant looking east.

Photo 52 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Western Canal_0002)
Western Canal at Tempe water treatment plant looking west.

Photo 53 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Western Canal_0003)
Western Canal at Guadalupe Road looking north.

Photo 54 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Western Canal_0004)
Western Canal check at 16th Street, Phoenix, looking east.

Photo 55 of 57 (AZ_Maricopa County_Salt River ProjectMPS_Western Canal_0005)
Western Canal toe at 23rd Avenue and Dobbins Road, Phoenix looking north.

Photo 56 of 57 (AZ_Maricopa County_Salt River ProjectMPS_North Highline Canal_0001)
North Highline at Central Avenue looking west.

Photo 57 of 57 (AZ_Maricopa County_Salt River ProjectMPS_South Highline Canal_0002)
South Highline at Grove Parkway looking north.

Historic Photographs

Name of Property: Salt River Project Water Diversion and Conveyance System Historic District
City or Vicinity: Phoenix Metropolitan Area
County: Maricopa
State: AZ
Photographers: Salt River Project
Date Photographed: unknown, 1901, 1902, 1913, 1916, 1928, 1937, 1938, 1943, 1960
Location of Original Digital Files: Salt River Project, Phoenix, AZ
Number of Photographs:

Historic Photo 1. Granite Reef Diversion Dam facing north, March 1928. Photo courtesy of the SRP.

Historic Photo 2. Arizona Falls on the Arizona Canal, facing east, prior to power plant construction in 1901. Photo courtesy of the SRP.

Historic Photo 3. Arizona Canal excavation, eight miles northeast of Phoenix. Undated photo by Walter J. Lubken.

Historic Photo 4. Workers lining the Arizona Canal with concrete, December 1943**.** Photo courtesy of the SRP.

Historic Photo 5. Italian prisoners of war working on the Arizona Canal, December 1943. Photo courtesy of the SRP.

Historic Photo 6. Arizona Dam facing east, circa 1902. Photo courtesy of the SRP.

Historic Photo 7. Crosscut Hydro Plant under construction, 1913. Photo courtesy of the SRP.

Historic Photo 8. CCC rubble paving in the Grand Canal near 83rd Avenue and Bethany Home Road, January 18, 1938. Photo courtesy of the SRP.

Historic Photo 9. Taintor gates on the Grand Canal at 7th Avenue, 1937. Photo courtesy of the SRP.

Historic Photo 10. Grand Canal reconstruction looking east toward Tempe Butte, circa 1916. Photo courtesy of the SRP.

Historic Photo 11. Grand Canal facing north on Central Avenue, circa 1960. Photo courtesy of the SRP.

Historic Photo 12. Children playing in the Grand Canal lateral near 7th Avenue. Photo courtesy of the SRP.

The Salt River Project Diversion and Conveyance System

The discussions provided below consist of summaries and excerpts from reports that document the history of Salt River Project (Project) facilities, most of which come from Historic American Engineering Records (HAER). They are provided here, in whole or in part, to provide additional contextual information about Project diversion and conveyance system facilities included in this nomination. Passages have been revised to correct typographical or editorial errors and to establish consistent nomenclature. Some inconsistencies occur between sections, as is normal for materials prepared by different authors with varying levels of expertise and using a wide array of source materials. Factual errors that could cause confusion within the context of this nomination have been corrected, and additional information has been inserted for clarification and comprehension. While reading these discussions, note that after 1949 the organization that operates and maintains the Project is also called Salt River Project (SRP). To avoid confusion, in this document the name "Salt River Project" or "Project" is used only to refer to the Bureau of Reclamation's (Reclamation) irrigation project, while the acronym "SRP" is used only to refer to the business entity comprised of the Association and the Salt River Agricultural Improvement and Power District.

Granite Reef Diversion Dam

Source: *Granite Reef Diversion Dam, Salt River, Mesa Vicinity, Maricopa County, Arizona*. HAER No. AZ-51. Tanya Woods Horton, 1998. Additional material on the Gatekeeper's House, July 2012.

Located approximately 22 miles east-northeast of Phoenix, adjacent to the City of Mesa, and four miles downstream from the Salt and Verde River confluence, Granite Reef Diversion Dam (GRDD or Granite Reef) is the diversion structure that supplies water to the Salt River Project irrigation canals on both sides of the Salt River. While overshadowed in size and scope by the higher-profile Theodore Roosevelt Dam, the first major flagship structure proposed by the newly-formed Department of the Interior's (Interior) U.S. Reclamation Service (USRS), the construction of Granite Reef Diversion Dam was, in fact, a crucial element in the overall scheme of water storage, diversion, and delivery.

Granite Reef's origins lie in the perceived need for a dependable, well-built structure that could divert water into the north and south-side canal system, some of which was already in place when the Project was authorized in 1903. While engineer Arthur P. Davis realized that the potential for settlement and growth in the Salt River Valley depended on harnessing the erratic flows from the Salt River, his original studies of the region focused on a water storage dam in the Tonto Basin. His assessments did not consider a permanent diversion dam downstream, because one already existed (Arizona Dam), with its own canal systems in place (the Arizona Canal on the north side and the Consolidated Canal on the south side).

Yet the crudely constructed Arizona Dam proved no match for Salt River floods. It was initially constructed in 1885 by the Arizona Water Company as a timber crib filled with rock on an excavated foundation. It was replaced at least twice, the last time after the 1891 flood. However permanent Davis considered Arizona Dam, it was apparent to U.S. Geological Survey (USGS) Director Charles Walcott

that it could not withstand a heavy Salt River flood. In 1903 he recommended to Davis that any plans for a dependable water supply to the Salt River Valley needed to consider a permanent diversion facility, one that could work in concert with the proposed storage dam. The Salt River Valley Water Users' Association (Association) concurred. In April 1905, Mother Nature proved Walcott correct. A horrendous Salt River flood destroyed Arizona Dam. While the loss of this diversion structure caused serious problems for farmers served by the Arizona Canal, it led the federal government to purchase the north side canal system and construct what would be known as Granite Reef Diversion Dam.

The 1905 destruction of Arizona Dam heightened anxieties regarding the future of irrigation on the north side of the river. Efforts to repair the Arizona Canal's headgates and weirs were only seen as temporary measures subject to persistent failures from rising river waters during intermittent periods of flooding. It was apparent that if the Project system was to succeed, a permanent diversion structure was necessary. After extensive legal and political wrangling over issues such as water rights, on January 13, 1906, the Secretary of the Interior (Secretary) allotted $375,000 "for the construction of a diversion dam, headworks, and a new canal on the system's upper two miles…." After additional issues of ownership and water rights were resolved, the government purchased the "Arizona main canal system and the appurtenances" for $235,168 on February 17, 1906. Included in this sale contract for $78,993 were the "Arizona Cross Cut canal, the Grand canal, the joint head of the Maricopa and Salt River Valley canals, the Maricopa canal, and the Salt River Valley canal and the appurtenances thereof." This government purchase set the stage for the comprehensive management of a system of irrigation encompassing the Salt River Valley. Actual federal operation of the newly acquired canal systems did not begin until May 1907.

Embedded in the controversy over the reconstruction of the Arizona Canal headworks was the ongoing search for a site suitable for a permanent diversion dam. Exploratory borings prior to January 1906 were unsuccessful in locating an area without deep bedrock that would require considerable excavation. However, the drilling team did find a site a few miles downriver from the first test site, one known as "granite ripple or riffle." A little more than two miles downstream from the Arizona Canal headworks, crews tested the ripple site for a good rock foundation at a shallow depth. Evidently, the massive expense of maintaining the upper reaches of the Arizona Canal led engineers to conclude that the priority lay in the dam site selection regardless of its proximity to the original dam and headworks; the proposed "granite riffle" dam location was only a few yards away from a section of the Arizona canal alignment.

A series of borings revealed a bedrock foundation at depths between 17 to 20 feet, with one fissure that could be stabilized by filling it with cement. The "granite riffle" site proved the most satisfactory in terms of the dam's general site requirements because it had a more narrow river channel (some 200 feet wide), with bedrock for a foundation at a depth requiring less excavation than other locations. On February 6, 1906, USRS chief engineer Louis C. Hill filed a notice of intent to divert water and build a "canal and dam" on behalf of the USRS; within nine minutes of Hill's filing, the Association's Frank Parker filed a nearly identical companion notice. Both cited the location of the new dam and headworks as the north bank of the Salt River, approximately 2,000 feet above the old waste gates of the Arizona Canal. Eleven days later, on February 17, the Secretary of the Interior (Interior) withdrew four sections (Sections 13, 14, 23, and 24, Township 2 North, Range 6 East), in protection of the government's interest in the new diversion dam's site.

While drill crews continued to search for an appropriate dam site within the withdrawn lands (and were hampered by wet weather), public speculation grew over the prospects for the future dam. Local papers

reported that a new road was to be built from Mesa to the dam site, and near the end of June Pacific Gas and Electric power company (PG&E) in Phoenix had secured a government contract to provide electricity for construction by extending its present line to Granite Reef. In early August 1906, Hill met with the Association's board of governors to present the dam's design, and estimated that if all went as planned, construction could be completed within a year. Hill was convinced that USRS force account labor could build the dam, rather than hiring a contractor and, on July 26, 1906, the USRS authorized the force account construction of Granite Reef Diversion Dam.

Located 3.75 miles downstream of the Salt and Verde confluence, about 2.25 miles from the defunct Arizona Dam site, USRS engineers designed the dam as an overflow (ogee) weir structure dependent on the topography, with a floodwater capacity flowing at the rate of 165,000 cubic feet per second (cfs). Because of the necessity for canal headworks on both sides of the river, spillways were not an option, hence the overflow design. As a structure comprised of rubble stone and some 40,000 cubic yards of concrete, the diversion dam was designed to raise the water level in the river channel by 15 to 20 feet, in order to divert water to the north side and south side canals. By replacing the six semi-permanent diversion structures already in place on the river, many viewed the permanent diversion dam as of greater importance than Roosevelt Dam for the welfare of the Salt River Valley.

Once the new government road was completed from Desert Wells to the construction site, a government camp was erected on the south side of the river near the dam site. Soon the camp took shape; residential buildings consisted of bunkhouses and sleeping tents, and by early December a hospital was under construction. In addition, there was an office, a store, a school house, garage, ice cream parlor/social hall, and a refrigerator room that could hold 2.5 tons of ice. Much like at other government camps, including those at Roosevelt Dam, racial segregation practices of the time resulted in the creation of a smaller camp for men of Mexican ancestry nearby, but separate from, the all-white main camp.

The dam's construction plan called for starting at each end and working toward the middle. While the camp was being built, excavation started on the south side of the river. Prior to full-scale work on the dam, however, crews constructed temporary outlet structures at either end of the weir's surveyed alignment. A coffer dam diverted water through the outlets to allow crews to work unimpeded in the streambed. This coffer dam diversion continued in use throughout the entire dam construction project. In addition to the coffer dam, the use of existing canals to draw river water away from the construction footprint was necessary. Crews also fashioned a cableway system designed to carry larger stone quarry blocks out to the riverbed construction area.

As excavation work began at the southern end, PG&E strung a construction power line approximately 1,400 feet long across the riverbed from the side of a mountain on the north side to a small bluff south of the river. This line would eventually send power to transformers that would power the cableway, railway, rock crusher, and cement-mixing plant. Additionally, an old Arizona Canal power plant on the north side was refurbished to provide electricity to south-side operations. A while later, a small power plant on the south side retransmitted electricity back to north side operations.

Despite having all the important logistics in place, construction on Granite Reef Dam slowed down for nearly a year, due to the delayed arrival of construction materials. Frequent flooding also delayed operations on the north side; however, crews made progress on the south-side structures during this time. Excavation there revealed substantial bedrock for the dam's foundation, while the south sluiceway gate floor and channel walls were completed and lined with two feet of stone. This insured that the south

abutments would hold firm in case of a strong floodwater surge. During this time, crews also finished the heading of the South Canal. Originating at a point nearly 20 feet above the elevation of the older Highland Canal, the added topographic advantage insured a more powerful flow of water to the south-side irrigation system.

The spring of 1907 witnessed further progress on the dam. By May, there were nearly 350 men in the work force, and the rock crushing operation was ready. Approximately 40 feet of the dam's south side was completed to the edge of the Highland Canal, a feat largely the result of low river water levels. This favorable condition allowed crews to transfer to the north side, where excavations proceeded with the help of an effective coffer dam/levee. With construction now at full swing on both ends, about 270 feet of structural work, 220 feet on the north side alone, was finished by the end of August. The most substantial delays at this time, however, were caused by missing cableway carrier cages. The cableway tram towers and cables had been built, but a patent suit delayed the cage delivery. Without a fully functional cableway, masonry work on the north side required hauling supplies by horseback, while no transfer mechanism rendered the south side quarry and railroad useless. To help speed up construction, the company that supplied the cableway shipped replacement cages so the work could proceed.

With both sets of headworks completed by the end of 1907, construction efforts shifted to the dam's 1,000 foot-long masonry wall and apron that spanned the riverbed. Prior to this time, segments of this wall were built out 100 feet from the south and 350 feet from the north; these figures represent the extent of bedrock available for structural foundations. While the original plans showed a foundation attached to the bedrock by steel tubing driven into the bedrock, excavations, however, went only one-third of the way down. Engineers then relied on rebar to support the three curtain or cross walls believed capable of withstanding overflow pressures.

Built on a 4.5 foot foundation of hand-placed boulders, the apron measured 18 inches deep and was laid in squares about 10 feet per side. At the end of the 450 foot section in mid-river, work on building the next 75 feet of apron wall slowed considerably when the absence of bedrock forced crews to shift to building cross walls. With the coffer dam diverting water from the excavation and building operations, crews pumped out water as the forms were going up. Foundation construction continued at a steady pace. In March 1908, crews finished the apron, and attention turned to finishing the main structure, the 29-foot-high dam wall, from waterline to the crest. Throughout the spring, timber form-work continued on the dam wall, proceeding by increments within the dry sections behind the coffer dam. About 500 feet of the dam and the entire foundation wall were completed by mid-March. At the same time, crews excavated for the sluicing gates in the Arizona Canal some 1,600 feet below the headworks. As the dam neared completion, a dredging operation widened and deepened the Arizona Canal's channel.

In mid-May, Project engineers projected a June 1908 completion date, by which time the final phase of constructing the canal headworks would be finished. Three small openings remained in the dam wall, marked by timber forms ready for the final concrete pour. On May 28, newspapers reported that Granite Reef Diversion Dam was essentially completed. With the main diversion structure complete, on June 13—the same day as the dam's dedication—crews turned to completing the south side canal, otherwise known as the South Canal, which they completed in June 1909. This new canal eventually connected with the older Consolidated Canal to send Granite Reef's diverted water throughout the entire existing delivery system to Mesa and Tempe.

As completed, Granite Reef Diversion Dam is a rubble-concrete weir that measures 1,000 feet long, with

a maximum height of 38 feet, a base 36 feet wide, and curtain walls at the weir's upstream end and toe extending to bedrock near the ends of the dam and to a foundation of compact sand, gravel, and boulders in the center of the channel, where a concrete apron 18 inches thick extends 75 feet downstream from the dam's toe.

The Gatekeeper's house sat on the south side of the Salt River within the government area, surrounded on three sides by a six-foot wire-block fence strung on heavy cement posts, which extended to the canal on the west side and to the river on the east. Gates were on the west and east side of the enclosure with the road running behind the house.

The house was two-stories, built of cement block, with a steeply sloping shingled roof, broad eaves and outside trim of wood, painted dark green. A wide high concrete front porch, reached by a short flight of steps, extended across the front of the house, which faced north toward the Salt River. The back screened porch with waist height boards had heavy canvas curtains on wooden rollers.

Windows on the north and west sides permitted light into the house and provided a good view of the headgate, the canal, and the roads which led to the corral and to the big gate in the high wire fence. Inside, the long living room had a large stone fireplace and high mantelpiece. On the west end of the first floor was the dining room, separated from the living room by counter-high glass front cases. Floors throughout the house were hardwood.

On the south wall of the dining room, to the left of the swinging door leading to the pantry was the government telephone operated by a crank. Roosevelt Dam, Evergreen, and the Gatekeeper's house on the northside of Granite Reef, the South Con Power Plant, and the hydrographer on the Verde River each had their own special ring. The Southside Gatekeeper's house was one long and two short. Beyond the pantry was the kitchen, dominated by a large wood-burning stove and attached hot water tank. Beneath the west window was the sink with wooden drainboards and cupboards. In the angle formed by the juncture of the pantry partition and the west wall of the house was a cooling closet, an air shaft extending from the ground to the eaves and fitted with a series of heavy screen shelves. Outside the kitchen door was a laundry room which contained two stationary laundry tubs and a hand-operated wringer. From this area, an inside cement stairway on the west side of the house led to a large cellar behind the kitchen and pantry where food items that needed to be kept cool were placed in an "Arizona cooler."

To the left of the living room fireplace, the narrow hall led to one bedroom on the east side of the house, a bathroom, and the west bedroom. Doors from each bedroom led out to the screened sleeping porch extending across the back of the house. Cots were placed on the porch in the summer. The bedrooms had large clothes closets. Opening off the hall on the south side was the bathroom with its high south window. A claw and ball foot tub stood against the east wall. The water closet was next to the tub, its high tank set just below the ceiling. Heating the house during the winter was accomplished with air-tight stoves in the bedrooms, living room, and upstairs study. These were taken out in the springtime.

A railed staircase, with a landing midway, led from the east end of the living room to the second floor. There was a large room at the front of the house which acted as a study for Edwin Hill, the first gatekeeper at Southside. Down the hallway to the back on the south side was another large bedroom with a view of the mountains. A low passageway under the eaves on the west side of the house extended from this room to the front room. This "secret passage" emerged through the small doorway into the study.

In 1913, A. L. Harris published an account of the dam construction at Granite Reef heralding its virtually unblemished five-year service by discussing the relationship between his design for the structure and the problems of siltation. As Harris explained, storm surges of floodwater carrying "sand, gravel and other drift" distinguished the siltation problems at Granite Reef from other diversion dams. Even after predicting a massive amount of siltation and floodwater overflow damage to the crest and rollway of the dam, the engineers decided to use a 1:2:4 mix of "natural gravel concrete" instead of covering the exposed areas with metal. The rollway was originally built for a flood-discharge capacity of about 165,000 cfs over the weir's crest. In his August 1913 inspection of the dam structure, Harris noted "little or no evidence of wear," but did point out the deposition of "a hard calciferous film" and "eighteen transverse cracks" on the weir's top, both of which he attributed to causes other than siltation and erosive wear. He interpreted the weir's cracks as a by-product of shrink swell due to its section-by-section construction.

Of special interest was Harris's description of the negligible erosion, tilt of, or seepage at the 75 foot-wide apron. The only noticeable damage from a seven-foot-high flood in early 1909 was to the apron sections abutting the bedrock, which in Harris' view were undercut "probably by the wear of the rock, which is a coarse-grained, friable granite." While the main structure was undamaged, repairs to the apron were needed and quickly completed. These apron sections would prove to be the most vulnerable to future flood damage. Harris identified one other vulnerable area of the dam structure in 1913, the sluiceway cut through the granite bedrock at the south sluice gates. Erosion in the form of holes and channels took such a toll on the sluiceway floor at the end of the dam's first year of operation that it had to be completely covered in concrete.

Despite Harris's satisfaction with the material sufficiency of the dam, concerns about siltation prompted a topographical study and report in November 1915 that addressed the increasing deposition in the canal headings. Measurements taken from the two steel truss footbridges over the Arizona and South Canals indicated that siltation was adversely affecting intake at both gates. According to this report, siltation within two feet of the weir's crest was reported as early as 1910; by 1912, the study noted the appearance of sandbars above the water about level with the crest of the dam. This 1912 study mapped 11 different "islands," "bars," and "flats" as far as 2,000 feet upstream, which resulted in the creation of new river channels. Four of the islands were old enough to have a "very dense growth of scrub willows." Farther upstream, shifting river flow patterns carved a natural channel through the old Arizona Canal head to the point of the rock-fill dam where it reverted back to the riverbed. In terms of the dam's intake structures, the variability of the river flow and its relationship to siltation was significant. It is unclear if the siltation study prompted any action or change in the dam's operation. In March and April 1914, the two-mile long 2,300-volt line from the South-Consolidated Power Plant was connected to Granite Reef. By the end of the year, new transformers, pumps, motors, and wiring were installed, and a new irrigation pump was ordered for the north side of the river.

The first extensive damage to the Granite Reef Diversion Dam occurred after two large floods on January 19 and 29, 1916. Water levels reached 11.5 feet above the weir's crest and the swirling reverse currents at the headgates undermined the north sluiceway wing wall. Its abutment collapsed, pulling down the riprap paving protecting the slope. The engineering assessment concluded that the lack of a bedrock foundation contributed to the failure of the footing wall supporting the concrete slope and downstream riprap. Reconstruction of the abutment began in the summer of 1916 when crews extended the sluiceway apron 120 feet downstream, and built a terminating cut-off wall to approximately 16 feet below grade. As with the abutments, reverse currents and powerful eddies coming from the spillway during the

floods undermined the end of the weir apron by creating a large hole in the apron paving. Repairs consisted of backfilling the hole with large boulder-filled wire sacks, approximately three feet thick and ten feet square, sized exactly to the original apron panels.

By the end of August, the new wing wall on the north side and repairs to the sluiceway and apron were complete. Problems with maintaining a sufficient intake of water for the canals in 1916 led to the recommendation by USRS consulting engineer D. C. Henny that the crest of the weir be raised by 12 inches rather than enlarging the canal section or encouraging the use of "sacks" to raise the water level. Erosion continued to threaten the riprapped slope walls, so Henny further advised the construction of "training walls" for the purposes of directing and increasing the flow of water. Others disagreed, arguing for lining a 200 foot-long section of the Arizona Canal with concrete. In the end, A. P. Davis, by then the Director of the USRS, approved a $5,100 expenditure for constructing a permanent 12 inch raise in the crest of the dam, with the exception of 48 feet of removable flashboarding at each end of the weir.

The most significant damage to the dam apron occurred as a result of heavy rains and flooding between November 27 and December 10, 1919. Surging at a height of 7.65 feet over the dam's crest, with a discharge estimated at 102,000 cfs, floodwaters destroyed a 500 foot-wide section of the apron in the same area damaged by the earlier floods. W. R. Elliott, the Association's project manager, wired Arthur P. Davis on December 18 stating that repairs were underway. According to Elliott, crews were repairing the erosion at the downstream cut-off walls "with good rock from old quarries" and "replacing [the] apron," and blamed a lack of available trucks as a barrier to expediting the repairs.

Concerns over the slow response prompted Lewis C. Hill to wire Davis at the USRS office in Washington, D.C. that "to date nothing has been done to replace it [the apron] if not replaced before next flood may lose Granite Reef Dam." After a flurry of telegrams, Hill appointed former construction superintendent J. M. Martin to be in charge of the repairs, and sent explicit instructions on December 31 to "excavate everything possible...and start excavation as soon as possible and put in as much concrete as possible" in order to forestall the looming disaster of another flood. By January 2, 1920, Martin had assembled a maintenance crew and camp, commenced dewatering by two pumps (10-inch and 12-inch) in preparation for excavation, blasted out sections of the damaged apron, and located a "very promising gravel bank...about one half mile downstream" in preparation for concrete mixing. The crew also constructed a cement storage shed, and already had "2500 sacks...with an additional supply promising for the immediate future need." Within a few days, three Ransome mixers were in place and the installation of floodlights for night work was complete. A "plank" system measuring 12 inches high was added to the top of the weir in order to prevent overflow from spilling into the dewatered excavation site at the toe wall of the dam while diverting excess water through the canal headings. Martin also followed Hill's instructions to begin amassing a large work crew of "200 men, 150 head of stock, [and] 25 wagons at least," and scheduled two 10-hour labor shifts in order to keep excavation and concreting crews in operation around the clock.

By January 3, 1920, Martin had more than half of Hill's specified work camp present, as well as "20 bottom dump wagons and 13 ordinary box stick dump wagons" with at least ten more on the way. The first excavation occurred at the dam's toe wall, where crews poured a 20 foot-wide preliminary concrete strip in order to shore up the wall prior to replacing the damaged apron. On the same day excavations were underway, Martin reported to Hill that it had begun raining again. After two separate episodes of flooding which required the removal of the dewatering pumps and men from the riverbed, work resumed on January 12.

Hill's reconstruction plan involved an excavation at the toe wall to the depth of eight feet across the entire width, and at least four feet for the full 75-foot length of the apron bed. In some places, the gravel fill under the apron had washed out to a depth of nine feet or more. Hill wanted a massive concrete apron capable of withstanding future flooding, describing it as being "of such a permanent character that there will be no likelihood of any damage." Crews excavated a new foundation at depths of four to nine feet, and built a downstream cross-wall on foundations excavated to 11 to 12 feet. After the excavation was complete, large boulders were placed in the foundation, and concrete poured over and around them. The 0.5 and 0.33 yard mixers were pouring concrete on the evening of January 14, with a crew of nearly 250 men and 200 head of stock. In little over a week, the concrete protective slab at the weir toe wall was connected with bedrock.

Added to the perpetual threat of rain and flooding was the fear of a labor shortage. Martin reported to Hill that, due to inducement from California and International Workers of the World (IWW or Wobblies) “propaganda,” a considerable number of men had left the work camp. In order to stem further exodus and to insure a large enough crew to maintain the three concrete mixers and two excavation shifts, Elliott, the Association’s liaison, hired an employment office in Phoenix to refer men to the camp and increased the daily wage by $0.25.

Although progress was not significantly impeded, the labor turnover rate continued to be high. On February 14, Martin made his final report to Hill on the apron repairs, with construction finished on the second protective layer of the apron at the toe wall on February 8. Approximately 7,000 yards of concrete were poured at the site in less than 3.5 weeks, which certainly qualified as "monolithic." According to Hill, the apron was now "thick enough so that it will probably never wear out." As long as proper maintenance and prompt attention to eroded areas was a priority, "they [the Association] need never worry about having to replace this dam."

Davis reminded the Association of the terms in the September 6, 1917 contract regarding their operation and maintenance of the works of the Project and the necessity for both informing the USRS of damage when it occurred and for quick action in order not to compromise structural integrity. Even with the arrival of Hill and Martin, Davis admonished, "it was largely a matter of good fortune that another flood did not interrupt the work sufficiently to undermine the lower side of the dam not founded on bedrock and cause the whole structure to topple over into the hole," thus losing a $627,000 dam and incurring untold thousands in damages to the agricultural economy of the area. Concluding that "a great disaster was averted only by a narrow margin," Davis's letter was answered with a resolution of support by the Association.

With the threat of a dam collapse ended, attention turned to the continuing problems of water diversion, namely the lack of sufficient head at the South Canal intake. As early as 1916, an attempt was made to increase the water flow with the use of plank flashboards "held in place by one-inch pipes fitted in drill holes" which raised the crest of the dam by 12 inches. By 1925, demand for water services on the south side, along with the Association’s agreement to furnish 500 cfs of water to the Roosevelt Water Conservation District (RWCD) (raising the total needed to 1,900 cfs), led to a reexamination of the diversion system. The plank flashboards were constantly washing away by floodwaters, which also bent the pipes or swept them away as well. After considering the addition of more headgates similar to the north-side intake at the Arizona Canal, collapsible steel gates were installed on the dam's crest creating a rise of three feet in the water level. Curved in alignment with the dam's crest, the gates measured six feet

long by three feet high. In order to make them watertight, a heavy rubber belt flange was placed between the individual gates. With the anticipated floodwaters in mind, the gates were hinged and supported by copper wire ties designed to withstand an overflow surge of two feet. The individual plates were constructed of 0.375-inch carbon steel and mounted with three hinge assemblies tied to the dam's concrete crest by 0.5-inch diameter drill-in concrete anchors. Sloping upstream at close to a 45 degree angle, the plates and tiebacks also utilized drill-in anchors. Construction of these features was completed in March 1928.

Over the decades, the rising levels of siltation documented by the 1915 survey further reduced the velocity (head) of water-flow into the canals. While the original sluiceway and regulator gate designs addressed the need for flushing out the accumulated sediment at canal headgates back into the river, the efficiency of these sluiceways depended upon annual floodwaters to scour out the deposited sediment. After the construction of Horseshoe and Bartlett dams on the Verde River, these floodwaters were impounded upstream from Granite Reef. Added to this dilemma was the fact that, by 1950, the Project could not afford to use impounded water to sluice sediment, either from in front of the headworks or from the upper end of the canal. As a result, water delivery to both north and south-side canals became critically impaired. Compounding the problem was the slow encroachment of hydric species of vegetation, such as willows and cottonwoods, which siphoned off water and impeded the flow through canals.

As a temporary remedy, periodic dredging cleared a channel in front of the dam in order to "connect the two headworks and make it possible to divert all the flow of the river into either canal." Between 1945 and 1954, this channel, in turn, filled with siltation to the point where a long-term solution, specifically the permanent placement of a dredge in the stream above the weir, was necessary. In 1951, SRP contracted a private dredge operation that removed approximately 48,000 cubic yards of deposited material.

Another issue was the necessity for ongoing reclamation of water used in the sluicing and dredging operations. When an economic feasibility study conducted in 1953 suggested that SRP establish its own internal dredging operation, the decision was made to buy a dredge and hire an operating crew on a permanent basis. The 1953 specifications for the dredge included "the complete steel hull, deck house, machinery, and floating discharge line for an eight...inch electric motor-driven, hydraulic steel cutter dredge" with a capacity for removing 78 cubic-yards-per-hour of deposited material from depths between 20 to 600 feet. Uniquely designed by Henry Shipley and SRP engineers for inland river dredging at the Granite Reef Diversion Dam, the "particular size... was arrived at by considering the sizes of the stones to be moved, the amount of material to be moved, and the apparent time available for movement."

The American Steel Dredge Company in Fort Wayne, Indiana, received the contract for the dredge in January 1954, and sent one of its foremen, Milt Adams, to supervise the work in Phoenix where the hull was built. The dimensions of the dredge listed the length of hull at 36 feet with a total length of 70.5 feet; weight, 42 tons; and length of pontoon discharge pipe at 500 feet. The total cost of the dredge was close to $70,000: $59,120 for the dredge and approximately $10,000 for "auxiliary equipment including additional discharge line, shoreline, spare parts, and equipment." Christened the "Katy Pickrell" after the wife of SRP president W. W. Pickrell on June 25, 1954, the dredge went into operation on June 28 with a three-man crew. The electric pumps, the main one with a 200-horsepower (hp) motor powered both a 10-inch suction line and an eight-inch discharge line, were connected to an on-shore 2,300-volt transmission line via cables. The dredge's discharge line, an eight-inch pipe on steel pontoons, was maneuvered by a small tug with a 180 hp Chrysler marine engine.

Differing from the original specifications, the dredge was actually removing an average of 156 cubic yards per hour (at 20 percent solids), while digging at a maximum of 20 feet, and averaging about nine inches, in the forebay. Two-thirds of the water discharged downstream by the dredge was recovered by a pump, which then diverted the captured water into the Arizona Canal. Initially, the dredge cut a "single channel for the river" before cutting away the siltation on the upstream face of the dam in an area 1,000 feet wide (width of weir) by 500 feet long (i.e., the forebay area).

Pounding rains on December 30, 1965, resulted in a runoff of 192,000 cfs into the Project reservoirs, and necessitated a downstream release of 70,000 cfs into the river channel. Although in a protected position at the dam and anchored by cables to high ground, the dredge was in a precarious position because of the flooding. The next day, five crew members were rescued by helicopter from the Katy Pickrell dredge, then swamped with water and cut off from the riverbanks. The dredge capsized just after the crew reached safety, and remained in the riverbed submerged by floodwaters until days later when salvage crews located it, and searched the area downstream for parts of the dredging operation washed away. A considerable effort was required to turn the dredge upright and bring it to dock at the shoreline. Parts of the dredge were then removed and sent to SRP machine and electrical maintenance shops for repairs. The dredge was completely overhauled, rechristened, and back in service by June 29, 1966. The cost of the repairs, $53,615, was 90 percent of the original cost in 1954 ($59,120).

An early warning system installed after this episode at the upper Salt and Verde rivers was of no assistance when floodwaters from the Sycamore Creek watershed, sited below the reservoirs, rose approximately 18 inches above the flashgates at the crest of the diversion dam between September 5 and 6, 1970. Normally moored against the flashgates, the discharge pontoon and the cable barge held fast until floating tree debris knocked over a 30-foot section of the gates. As a result of the increased currents and depth of water, the discharge pontoon and barge, as well as 30 feet of discharge pipeline, were swept over the weir. The damage was minimal, however, compared with the earlier destruction of the dredge. Only a 100-foot portion of tangled power cable was lost; the pontoon and cable barge were recovered downstream and trucked back to the dam's forebay.

By mid-century, the Granite Reef Diversion Dam had been in service for over 40 years. As a consequence of the rapid changes brought about by urban growth, changing land use patterns, insufficient surface water supplies, and depletion of groundwater, the efficient maintenance and operation of its aging structures was highly problematic. In 1950, funding authorized by Public Law 335 (the Rehabilitation and Betterment Act of October 7, 1949, 63 Statute 724) instigated a Project-wide program of rehabilitation and betterment (R&B), including work at Granite Reef. Reclamation engineers examined the condition of the dam in November 1956, and reported that the areas most in need of repair and replacement were the sluiceways, sluice gates, and regulating gates. The engineers noted that the concrete in the overflow weir, headworks, and sluiceways was in good condition considering the dam’s age, although some "major cracking" had occurred. The report recommended the repair of the regulating gates at both north and south side headworks.

The designs and specifications for sluice gate and abutment rehabilitation were drawn up in 1957, but not in time for construction to begin. The cost of the plans was $7,631. During the next fiscal year, the Fisher Contracting Company received the contract for the rehabilitation construction at the dam with the low bid of $110,103. The replacement of the original 1908 slide gates at the sluiceways by newer radial gates occurred in June 1958. SRP crews were also at work on the dam during this period, converting the

operation of diversion gates from manual to electrical means, and installing stand-by generators for sources of auxiliary power. The total cost of R&B work at Granite Reef by the end of the 1959 fiscal year was $148,649.

During the next three decades, periodic examinations by Reclamation and rehabilitation studies of Granite Reef Dam by SRP personnel noted continuing problems with siltation, vegetation growth along the downstream channel, and an increasing level of deterioration of the concrete structures, including the weir. Although the condition of the entire structure was reported to be structurally stable, a series of significant flood events in 1978, 1980, and 1993 battered the aging masonry in the apron and sluiceways, which required extensive repairs. Prior to these floods, there appears to have been little concern about the need for large-scale rehabilitation of the various structures of the dam. A 1972 Reclamation inspection noted the "very good condition" of the weir, canal headworks, and sluiceways, citing only routine maintenance needs. In 1974, the Central Arizona Project's (CAP) proposal for a new Orme Dam led SRP personnel to consider recommendations for the long range rehabilitation of Granite Reef Dam. At that time, floodwater damages had been minimal; as a result, the proposals focused on rehabilitating the flash gates and anchor support system, installing new measuring flumes in both canals as well as new individual motor operators and drive trains, and lining repair in the Arizona Canal. However, in light of the CAP's abandonment of the Orme Dam project, the Granite Reef Dam rehabilitation proposals were tabled.

Repairs due to several floods between 1978 and 1980 were costly. In the February 1980 flood alone, a maximum flow of 180,000 cfs ravaged the 70-year old structure. The rehabilitation projects were extensive, including forebay sediment and debris removal, filling an 80-foot breach in the north embankment, and replacing and resetting damaged flashgates. Erosion of the north sluiceway abutment wall and discharge channel required excavation for a new footing, backfilling and pouring a new concrete wall, as well installation of 1,064 rock anchors. Sections of the dam crest were repaired, and eroded areas in the apron slab filled with concrete. Total reconstruction costs amounted to $766,901. Even with the extensive repairs, a 1980 report pointed to the constant threat of erosion, citing the condition of the dam as "fair" and the need for further repairs to the apron.

In 1993, the dam sustained severe damage and significant erosion to the apron, south embankment (a warped wall) and spillway slab as a result of floods. An engineering report on the feasibility of repairs or replacement of the diversion dam in 1995 examined the extent of the damage, and recommended several design alternatives. SRP engineers refined the scope of the proposed repairs to primarily focus on the south-side structures, including: the removal of riprap from the south embankment and concrete and other debris from the apron and sluiceway; dewatering impacted areas as well as the downstream area; bedrock cleanup and rock anchor installation in the apron and sluiceway slab; replacing about 3,000 cubic yards of mass concrete in the apron and sluiceway; the stabilization and compaction of the warped wall, backfill, and shotcreting the wall; and finally, application of epoxy and polyurethane grout to the joints in the bedrock and dam. The contract for $868,913 was awarded to Edward Kraemer and Sons in fall 1995. Construction began in December, and took approximately two months for completion at a total cost of over $1,000,000 after construction support and inspection costs were added. According to SRP engineers, "these repairs have corrected the flood damage and brought the dam to preflood conditions of 1993." In 2000, SRP completed the installation of the Obermeyer Pneumatic Flashgate System, replacing the older flashboards on the Granite Reef Diversion Dam. This significant enhancement did not increase the height or modify the operation of the dam.

Today, the Granite Reef Diversion Dam still maintains the essential function conceived by its builders in the early twentieth century, that is, the diversion of water to the Salt River Valley for agricultural, municipal, and industrial purposes. Its location is no longer as remote as in the days of the Granite Reef Camp. Encroaching suburban development to the south is separated from the dam by the rugged Schlechts Butte, while further to the northeast along a paved highway the Sutton Recreation Area overlooks the waters upstream on their way to the diversion dam and the remnants of a once extensive riparian habitat along the Salt River. As a burgeoning urban center in the Southwest, the cities of the Salt River Valley continue to rely on the waters diverted at Granite Reef Diversion Dam. Although the dynamics of suburban development increasingly transformed irrigated agricultural land into urban neighborhoods and recreation areas, the dam remains an integral feature of the Salt River Project which was the foundation for twentieth century development of the Salt River Valley.

The North-side Conveyance System

The Arizona, New Crosscut Canal, the Crosscut Hydro Plant and Grand Canal

Arizona Canal

Source: *Arizona Canal, North of the Salt River, Phoenix Vicinity, Maricopa County, Arizona*. HAER No. AZ-19. Shelly Dudley, 1991.

The Arizona Canal is the northernmost canal in the Project divergence-conveyance system, located within the urban center of Phoenix in Central Arizona. The Salt River Valley, at the time of the canal's construction in 1883, already had canals on both the north and south side of the Salt River irrigating portions of the Valley. Yet the men who organized the Arizona Canal Company saw the scorched, desolate desert in the northern part of the Valley and envisioned thousands of additional cultivated acres if they could build another canal to provide the needed water.

In December 1882, three prominent men of the Salt River Valley filed incorporation papers for the Arizona Canal Company. M. W. Kales, Clark Churchill, and William A. Hancock planned on constructing a canal which would take water from the north bank of the Salt River, 0.75 miles below its confluence with the Verde River, and move it westward along the northern portion of the Valley ending near the Agua Fria River. The company proposed to irrigate approximately 100,000 acres north of and beyond the existing north-side canals. The company issued capital stock for $500,000 with each share having a value of $500. On March 10, 1882, Kales, Hancock, John Y. T. Smith, and W. W. Jones, on behalf of the Arizona Canal Company, filed for a water right of 50,000 miner's inches from the Salt River, which was granted in February 1883.

Valley residents watched the activities of the canal company with great interest. To start the project, the Board of Directors of the Arizona Canal Company contracted for the excavation of the Arizona Canal with William John Murphy in the spring of 1883. Murphy, finishing work on grading the roadbed for the Atlantic and Pacific Railroad in northern Arizona, journeyed to Phoenix when he heard of possible canal work in the Salt River Valley. By the end of April 1883 Murphy signed a contract to grade the Arizona Canal. He would eventually sign at least one other contract to continue canal work. The construction was divided into several phases, and required that Murphy complete the first 20 miles of the canal in the spring of 1884, with the rest of the canal and a diversion structure on Salt River completed the following year. He

did not receive cash as payment for his services, however, but obtained bonds in the company which he was required to sell to finance his own work. Because local capital was not sufficient to support this venture, Murphy spent much of his time in Los Angeles, San Francisco, Chicago, and New York attempting to sell bonds to investors while his crews worked on the canal. Backers of the Arizona Canal Company expected to garner profits not from the actual construction of the canal, but from the sale of land and water rights to new settlers.

As originally envisioned, the Arizona Canal was to extend 50 miles from its head on the Salt River, past the Agua Fria River. It was to have an approximate carrying capacity of 50,000 miner's inches of water. The construction plans for the canal project called for the first two miles of the canal to have a width of 36 feet on the bottom with a slope of sides of 1.5 to one feet in earth and sand, one to one feet in loose rock and six inches to one foot in solid rock. The canal carried a depth of eight feet of water with a capacity of 1,000 cfs. Below the head of the canal for the first 3.5 miles, the excavation was entirely in rock or gravel, with the gravel cut being 25 feet deep in places. The width at the bottom of the canal later narrowed to 30 feet and at the surface 65 feet wide. Below this work, the canal was located in a gentle sloping terrain and constructed half in excavation and half in embankment, except for one short rock cut. This cut was 15 feet deep with a fall built in solid rock 15 feet high, constructed both in order to drop the grade and avoid excavation in the rock. It was also designed for possible future water power generation. After mile 22, the bed-width of the canal was reduced to 16 feet and the depth of water to six feet. The grade of the canal was planned at two feet to the mile, which would give the water a velocity of 2.5 to three miles per hour. The first section of the canal had no berm, but after several miles the canal had an eight foot berm on the embankment side with the slope being 1.5 to one feet. The top width of the bank was eight feet and its crest was six to eight feet above the bed of the channel.

Construction began on the Arizona Canal on May 7, 1883. Engineer Andrew Barry had surveyed the first 20 miles of the canal by May 1883 so that when Murphy took the contract to grade the Arizona Canal he was able to begin construction almost immediately. The contract called for Murphy to finish the 20 mile-long western segment by March 1884. Within two weeks of beginning construction, work ceased on the headgate and eastern portion of the canal; however, construction continued unabated on the western segment. The headgate and eastern segment of the canal were located within the Salt River Pima-Maricopa Indian Reservation (reservation) and the canal company had failed to obtain right-of-way for the canal prior to initiating the project. Eventually, Secretary Henry N. Teller approved an agreement between the Arizona Canal Company and the federal government, which authorized the construction of the canal across the reservation in 1884. In exchange for the right-of-way, the company promised to construct two bridges across the canal and keep them suitable for the crossing of livestock, as well as construct and keep in repair a water tank for the livestock at each of the bridges. Another provision of the contract required the Arizona Canal Company to furnish the reservation with water for the irrigation of their lands, when practicable. The Salt River Pima and Maricopa tribal members, in open council, gave their approval to the agreement.

Along the length of the canal, Murphy subcontracted out the grading to different men: Pat McCormick had a crew of 80 men and 50 teams; William J. McCormick had 40 men and 30 teams, and Henry McKowen worked with 90 men and 60 teams. Murphy had other subcontractors during the construction as well, each working in specific sections of the canal. The first 800 feet of work was light until the crews struck a sand bluff where the cutting was the deepest at 16.5 feet, while the average depth was 12 feet for 2,800 feet. By August 1883, 47 men completed approximately 1.5 miles, with the cut being 30 feet wide at the bottom. J. H. Bryant, with his 30 men and 24 teams, excavated 2,800 feet and moved 43,000

cubic yards of material by November. Murphy expected to finish his five sections of work by the end of 1883. Two crew foreman worked on 1.25 miles of the heaviest portion of the project, with 100,000 cubic yards of wash boulders and solid rock moved. The depth of cut for their section averaged 10 feet with the deepest being 14 feet. McCormick employed 30 men and 14 teams on his section. The average cut in his area was four feet with sand cement in the bottom, which required blasting before a plow could be used. The contractors, during excavation, were paid by the cubic yard at varying prices per yard, as graded by the chief engineer. The engineer determined whether the work was soft dirt, loose rock, or hard rock.

The men excavating the canal worked in crews, each with its own particular function. The initial group of men cleared away the desert vegetation along the path of the canal with axes and grubbing hoes. Teamsters followed riding long steel-rail sweeps, bolted together, drawn by four horses. The next squad of men drove six- to eight-mule teams with heavy railroad plows to dig into the hard desert soil along the canal banks and bottom. Their work was finished by animal-drawn steel scrapers, each team closely following the one in front. Husky men at the bottom of the canal filled the scrapers, shaped like wheel-barrows, with the loosened dirt. Once work began again on the reservation, Murphy used new equipment, untested in the excavation process. On the initial trial, a new excavator failed completely because of the looseness of the soil, but Murphy planned further tests of the machinery. The men did not like to work on the hard compact soil, but preferred the ground with brush and cholla which indicated a looser soil. The large excavator used in the construction of the canal was later employed in grading the railbed for the Maricopa and Phoenix Railroad.

Floods in February 1884 delayed the excavation work on certain portions of the canal. Murphy was forced to move his camp two miles below his current position, being unable to continue his grading in Section 17, the district hit hardest with the flood waters. One week earlier, J. T. Simms moved his camp down to Mile 24, directly opposite J. T. Porter's crossing of the Grand Canal.

Murphy's initial contract required he finish the western portion of the canal, a distance of 20 miles, by March 1, 1884. According to local newspaper accounts, Murphy did so, but with much trouble. Because Murphy had difficulty selling the bonds to raise capital, a number of the subcontractors refused to continue their work until they were paid. Only one contractor, probably J. T. Simms, stayed on the job and Murphy met his deadline. Murphy signed at least one additional contract to complete construction of the eastern segment of the Arizona canal.

While Murphy was in San Francisco in the summer of 1884, he ordered special wagons built for carrying lumber, probably in preparation for the construction of the diversion structure, which came to be known as the Arizona Dam. The wagons were heavy-duty and the beds, as well as the trail and drawing attachments, were made in California. Murphy noted that the wagons were good, yet very expensive. About the same time he ordered the wagons, Murphy also ordered a car-load of powder. Both the powder and wagons were shipped on the railroad to Maricopa, Arizona, where they would then be hauled to the Salt River Valley.

By late fall 1884, construction of the Arizona Dam had begun. Because of time constraints imposed on the engineer of the project, a rough crib dam was built across the Salt River. The dam was composed of rubble and crib work 173 feet in length and 16 feet in height at the deepest point. The men threw one to three-ton stones in the river from a pontoon moored upstream until a bar was formed, causing the water to spill over the entire width of the channel. Shingle brought down from the river bed above filled the

openings between the blocks, slowing the flow of water. The men then formed cribs 12 feet by 22 feet, consisting of three 24-foot logs, each 12 inches in diameter and six feet apart. Four 14 foot by 12 inch logs, spiked together by iron bolts, were secured cross-wise seven feet apart on the crib. The crew then nailed to the longitudinal logs two-inch planking to form a platform. The cribs were constructed to a height equal to the depth of water where they were to be sunk.

The men floated the cribs out into the river and placed them in position, and loaded them with stone until they sunk to the stream bed. The cribs were then filled with stone to the level of the water surface, arranged diagonally to the line of the main weir so they overlapped. Fascines, made of willow two feet in diameter and filled with stone, were placed in the direction of the current, one end touching the crib work along the whole bed. An additional five rows of fascines were laid across the stream against the upper end of the first series with boulders and gravel deposited on top of them. Fascines were also located on the rock breakwater up to the level of the crib top, 16 feet above the river bed. Twenty-four fascines were laid over the crib top parallel to the stream, overlapping the boulder work and filling and binding the whole together. The crews continued to fill the weir with boulders and gravel 8.5 feet higher and topped the dam with a finishing layer of fascines ten feet long. Towards the end of the dam's construction, the crews moved 150 tons of material every 24 hours. The dam and adjoining headworks cost an estimated $10,000.

The Arizona Canal headgates were constructed of heavy timbers and solid masonry laid in Portland cement and set in solid rock on both sides and the bottom. The width of the headgates was 40 feet and built to let a depth of six feet of water into the canal. The structure was situated so that during flooding, the waters of the Salt River struck the gates with great force. Between the headgates and the dam were a set of seven scouring sluices, constructed to prevent silt deposits at the head. However, a large island formed in front of the head from siltation, which reduced the volume of water entering the canal, so that it was impossible for the full capacity of the canal to be attained. The eight timber gates which comprised the headgates slid vertically between wooden uprights and were operated from the bridge overhead. Levers raised six of the gates independently, while the last two gates opened by means of a hand gear and cogwheel when the pressure of the water was great.

East of the headgates the men built a waste weir, designed to relieve the dam from pressure during flooding and to scour out the area above the dam. Heavy timbers were used in its construction. The waste weir was the same height as the dam and 40 feet wide. It could be closed or opened at any time. Under the weir gate, a space was left open to allow for water to carry through silt, sand, and other deposits. After the construction crews finished with the headgates, they started work on the wasteway, approximately one mile below the head of the canal. The original Arizona Canal had a weakness it that it only had one wasteway, or escape, that allowed the discharged water from the canal back into the river. Below the escape was a set of regulating gates located across the canal which turned the water through the wasteway. The escape, constructed of wood, contained seven simple rectangular gates operated by a hand lever which raised the gates vertically between upright posts. The gates had a total width of 40 feet and the wooden flume was 80 feet long and 12 feet high. An apron of wood at the upper end of the escape extended at a 45 degree angle downward for 12 feet into the bed of the canal. The banks of the canal this point were safeguarded by wooden retaining walls.

During the construction of the dam, the Salt River flooded in the winter of 1884, causing damage to the structure. Despite this setback, the main headgate was completed on December 15, 1884, while over 100 men worked on the dam to complete it by January 1885. By the end of the month, water was turned

into the canal as far as the gates of the wasteway. Most of the canal was finished except for a portion opposite Phoenix and just below Cave Creek Road. Eighteen crews worked on those sections to finish the work within a week. Murphy's men started construction on the bridges crossing the canal at Black Canyon Road, Cave Creek Crossing, McDowell Road, and on the Salt River Pima-Maricopa Indian Reservation in February, 1885. Rock from the excavation at the falls was utilized to build the bridges at these crossings.

Besides flooding problems, the construction crews encountered difficulties in the actual building of the canal. The men at Mile 4, 8, and 9 blasted through cemented gravel (probably caliche) and boulders, while at Mile 26 and 27 cemented material was harder than solid rock. To cross Indian Bend Wash, a 1,200-foot flume was built on oak pile bents capped with heavy timber. At various times during the construction, the men turned water into the canal to test it. In February 1885, at Mile 27, the canal leaked repeatedly. The first repairs, which consisted of scooping out loose stone and filling in with waste material from the old corral and earth hauled in by the scraper, did not work, so an adobe mixture one or two feet thick was applied to the insides of the banks where the leaks occurred.

Because the Arizona Canal was constructed in the northern or upper portion of the Salt River Valley, flooding from desert rains washed into the canal. The canal crossed a number of small drainage streams which had flood discharges of 30 to 200 cfs. Simple level inlets permitted the water to flow into the canal so that the water would not be wasted. However, the Arizona Canal also cut through the Cave Creek stream bed which could have a 1,000 cfs flood discharge. During those early years there was no way to control the creek's flow, so each flood inundated the land surrounding Cave Creek and broke through the banks of the Arizona Canal. Repair work was a continuous need until more permanent flood control measures were taken.

Although the Arizona Dam was partially swept away in the spring flood, W. J. Murphy notified Clark Churchill, President of the Arizona Canal Company, that he completed the Arizona Canal in June 1885. The finished Arizona Canal extended for 42 miles with headgates at every section line. The developers expected the Arizona Canal to carry 375 cfs of water to irrigate over 75,000 acres. Churchill, Charles A. Marriner, chief engineer, F. C. Hatch, Director of the Arizona Canal Company, W. D. Fulwiler, General Superintendent, and John R. Norton, foreman, toured the canal. Churchill accepted the canal as complete and the local newspaper printed notices that the Arizona Canal Company was taking applications to furnish water for irrigating purposes. The final cost of the Arizona Canal and its appurtenant structures was $608,498.24, which included the repairs on the canal and dam after the 1885 flood event. At that time the Arizona Canal Company was selling water rights for $5,095 for 80 acres with the yearly water rental at $1.25 per acre.

Flooding in 1885 washed out portions of the Arizona Dam and it was not until December 1886 that a new dam was completed. Bids were printed in the local newspaper for 25,000 feet of timber to be immediately delivered at the head of the Arizona Canal. A later advertisement appeared seeking 50 teams to haul the timber from the railhead at Maricopa to the Arizona Canal. This second dam was composed of heavy timber crib boxes of nine foot-long logs, driftbolted and hinged together by wire cable so that no one section could float away. The crib boxes were filled with rock, while the spaces between the cribs were timbered and loaded with boulders. The facing on the upstream side contained rock and brush for 50 feet. The cribs were pitched across the river running upstream until the crest was at an angle of approximately 40 degrees from the head of the canal to a rocky point on the opposite side. Boulders filled the crib to a height of 11 feet above low water for a distance of 416 feet from the north end; the rest

of the dam, a length of 916 feet, was 10 feet above low water. The deepest part of the crib work in the river was 33 feet in height. The crest of each successive row of cribbing at the north end of the dam was two to 2.5 feet lower than the section above, giving the weir the appearance of broad steps. This feature was designed to brake the flow of water, reducing the chances of damage to the dam. The lower half of the dam formed an apron with the rails and cross-ties on the downstream side of the dam held together with double rods of iron and driftbolts. The base of the wooden structure extended to a width of 80 to 90 feet with cables running from the dam to the rocks and banks of the canal. The top of the dam was 22 feet wide.

The second Arizona Dam lasted longer than the first dam, but portions of it were washed away in the devastating flood of 1891, which exhibited flows reaching 300,000 cfs. George Murphy, son of W. J. Murphy, supervised the fortifications of the canal banks two miles below the head. Approximately 100 men and 40 teams hauled rock and earth while the crews applied brush, dirt and stone rip-rap to strengthen the outside banks of the canal to protect it from the flooding. Engineer Davidson suggested a different canal alignment near the proposed heading of the new Arizona Dam, to be located 0.25 miles above the present site. The new canal and dam location would involve a cut two miles long and ten to 40 feet deep, but spring floods would no longer endanger the waterway.

It is unclear whether the Arizona Dam was relocated after the 1891 flood; sources indicate both possibilities. If the dam was not moved, cost factors would have played a role in the dam being repaired at its location. However, whether it was repaired or moved, a more substantial dam was constructed across the main channel of the riverbed. The first 400 feet of the dam from the west bank of the Salt River was new construction. The remaining 900 feet was repaired as needed, with all sizes of lumber utilized, from planking to big timbers such as three feet by 12 feet or eight feet by eight feet. Crews again built the dam following a stair step design with 5 foot sections of the dam bound together with rods from top to bottom. The upstream row of cribs was planked on the upper side and on the top with its upstream edge two feet lower than the crest edge. The second row of cribs was 2.5 feet lower and the third row of cribs dropped another 2.5 feet. The swinging cribs at the base of the downstream side of the dam were attached by one inch wire cable. Sheet piling was driven at both the heel and toe of the renewed segment of the dam. This design broke the force of the water flowing over the dam with the water hitting the crest of the dam at about a 12 degree angle.

The eastern portion of the dam, according to one engineering report, was constructed with only a set of main cribs and a single apron. Bedrock sometimes reached 24 feet below the river bed. The crews raised the stone walls around the headgates four feet and strengthened them with rip-rap. After the 1891 flood, engineering reports indicate a dike was constructed across the low lying bed of the Salt River from the eastern end of the Arizona Dam to the bluff on the east bank of the river. The purpose of the dike was to prevent the Salt River from creating a new channel there. The dike measured ten feet high and 1,200 feet long. Exposure to the air and Arizona summer heat caused the planking and the timbers of the dam to decay over time. Towards the end of the century the dam was strengthened and the crest was raised two feet, for a height of 13 feet. Down the whole length of the dam, crews placed four rows of 12 by 12 inch sawed piling through the structure, with additional timbers laid horizontally on top. This new cribbing was filled with rock and covered with planking. This structure lasted until the floods of 1905.

The Arizona Improvement Company, formed in 1887 to promote lands under the Arizona Canal, wanted to facilitate the delivery of water from all canals located on the north side of the Salt River to both save water and reduce animosity. To accomplish this, the company obtained an interest in the Arizona, the

Grand, the Maricopa, and the Salt River Valley canals in 1887. While each canal maintained its own organization, the distribution of water would be merged. This action also helped the Arizona Canal Company in its litigation with the other canal companies in the Valley. The officers of the Salt River Valley, Maricopa, San Francisco, Mesa, Tempe, Utah and Grand canal companies had filed suit against the Arizona Canal Company on February 7, 1887 in District Court in the action entitled *Salt River Valley Canal Company v. Arizona Canal Company*. The plaintiffs claimed a prior right to the water based on their dates of appropriation, some rights as early as 1868. The canal companies declared that the Arizona Canal interfered with the flow of water in the Salt River when it constructed its canal heading and diversion dam upstream from the other canal headings in 1884, diverting water that would have flowed downstream.

J. W. Crenshaw, U.S. Court Commissioner, issued a temporary restraining order against the Arizona Canal Company after the complaint was filed. During the course of the trial the Arizona Improvement Company purchased controlling interests in the other north side canals which reduced the number of parties against the Arizona Canal Company to the Tempe Canal Company and Michael Wormser, owner of the San Francisco Canal. After the consolidation of the north-side canals, the case became known as *M. Wormser et al. v. Salt River Valley Canal Company*. Judge Joseph Kibbey of the Third Judicial District Court, Maricopa County heard the testimony of the case and issued his decree on March 31, 1892. This ruling, which was known later as the “Kibbey Decision” became the first important water rights case in Arizona Territory by establishing most of the critical principles of the Territorial and subsequent State water law. First, Kibbey held that only owners and occupants of land were entitled to appropriate water, and a right could only be established by appropriation and use of water on the land. Second, he upheld the custom of priority of rights based on date of appropriation and more or less continuous use. Third, he held that the posting and recording of a notice of intention to divert water did not give any right to water, but the actual diverting and applying it to land did. Fourth, he decided that canal companies were common carriers of water and could not themselves own water or water rights, and that the sale of water was not a use of water. Fifth, he held that the right of appropriation of water was permanently appurtenant to the land which it irrigated, and that the ownership of stock in a canal did not in itself amount to a water right. Kibbey's landmark decision divided the water from the Salt River among the various canals, but judicially more important, made the water appurtenant to the land.

To provide for a better distribution of water and avoid waste, the Arizona Improvement Company planned on the construction of a canal linking the Arizona and Grand canals. The river bed of the Salt River between the headings of the Arizona Canal and the Grand Canal was sandy and water often sank, thus diminishing the flow. The planned diversion of water at the Arizona Dam for the north-side canals would prevent waste. At Mile 25 of the Arizona Canal, the four mile-long Crosscut Canal was constructed between 1888 and 1889 to link the Arizona Canal to the Grand Canal. The Crosscut Canal contained 23 falls ranging in size from four to five feet and had the potential to provide 7,500 hp of electricity, if developed in the future. The Crosscut Canal and Power Company was organized to oversee the canal’s construction.

Water from the Arizona Canal initially irrigated crops such as grains and alfalfa. The Arizona Improvement Company planted much of its land in wheat and barley. W. J. Murphy experimented with new crops and induced the local landowners to try different types of plants. The Arizona Canal Company offered free water to the farmers if they would plant 40 or more acres of land in fruit trees. The Arizona Improvement Company's land produced prunes, almonds, apricots, figs, and peaches, as well as seedless Sultana, Malaga, and table grapes. In 1889 the company started orchards of citrus trees near

the Arizona Falls, growing oranges and lemons that were shipped to eastern markets. Because of the success of the citrus orchards at the falls, the Arizona Improvement Company expanded its acreage with different types of oranges and tangerines.

In order to gain more irrigated acreage, the Arizona Canal Company extended the canal on the west end of the Salt River Valley a distance of 5.41 miles. The company commenced work on October 5, 1893 and finished 12 days later on October 17. This brought the total length of the canal to 46.63 miles. The extension crossed Skunk Creek and New River and almost reached the Agua Fria River. This portion of the canal was later abandoned.

To help increase the water supply to the Arizona Improvement Company's lands, a project of enlarging the canals was inaugurated in 1894. A combination of a boat and steam dredge from the Marion Steam Shovel Company enlarged the Maricopa, Salt River, Grand, and Arizona canals, thus increasing their capacity to carry water during the rainy season.

The Arizona Improvement Company had a difficult time meeting its financial obligations due to the expenses for canal improvement and maintenance. The depression of 1893 and the drought conditions in the Salt River Valley in 1897 limited the sale of bonds, land, and water rights. On November 15, 1897, the Glendale Fruit Company as well as other water users filed suit in the Maricopa County District Court against the Arizona Canal Company. The plaintiffs requested the court appoint a receiver for the company, alleging the mismanagement of the company. The owners of the water rights under the Arizona Canal Company claimed they were unable to receive sufficient water to irrigate their lands and orchards because of the poor condition of the canal. The water users stated that the canal needed to be cleaned so that the necessary quantity of water could flow to the land. The plaintiffs also claimed that the company was insolvent and money paid for water rights and rentals was not utilized for the operation and maintenance of the canal.

The Merchants Loan and Trust Company filed a petition the next day against the Arizona Improvement Company and the Arizona Canal Company alleging insolvency of both companies. Both petitions requested a foreclosure of the mortgages and a receiver be appointed for each company. On December 16, Chief Justice Webster Street appointed C. J. Hall, cashier of the Phoenix National Bank, receiver for both the Arizona Canal and Arizona Improvement companies. Included in the assets of the Arizona Improvement Company was the Arizona Canal, over 100 miles of ditches and laterals, 5,000 acres of agricultural land, the Crosscut Canal, and over half the stock in the Grand, Maricopa, and Salt River Valley canals.

The bondholders of the Arizona Improvement and the Arizona Canal companies formed the Arizona Water Company in 1898. Incorporation papers were filed on November 7 with Arthur Leach as president and Osborn Bright as treasurer. They proceeded to purchase both companies at a foreclosure sale for $100,000 each to protect their initial investment. The Arizona Water Company was controlled by an eastern board of directors. The actual management of the company's local property was taken care of by a general manager under the supervision of a resident vice president. A general superintendent, in charge of the water distribution for the Arizona, Salt, Grand, and Maricopa canals, aided the general manager with repairs on the dam, headgates, and other appurtenant works.

By the turn of the century, the Arizona Water Company controlled over 100 miles of canals on the north side of the Salt River. To increase the water supply to the landowners, the company enlarged the

Arizona Canal with two dredges and raised the Arizona Dam 2.5 feet to capture a larger amount of flood waters. The Arizona Canal itself had 24 laterals varying in length from three to 14 miles. A comprehensive telephone system with over 70 miles of wire enabled the water company to handle distribution of water to the various canals and laterals.

In 1899, the Arizona Water Company intended to construct another crosscut canal on the Arizona Canal from a point in the northeast quarter Section of 22 in Township 2 North, Range 6 East within the Salt River Pima-Maricopa Indian Reservation, running in a southerly direction for 1,200 feet to the Salt River. On this crosscut canal, the Arizona Water Company planned to build a hydropower plant, use the water diverted from the Arizona Canal to turn the turbines, and then send it back down to the Salt River. A notice of appropriation for 15,000 miner's inches was filed on November 27, 1899, in the Maricopa County Recorder's Office. The notice stated that the Arizona Water Company would use the water belonging to the Tempe, Mesa, and Utah canals for power purposes, but the water would be returned to the Salt River above the head of the Consolidated Canal, which delivered water to those canals.

J. Hale Sypher applied for a permit or license from Secretary Ethan Allen Hitchcock to construct the power plant on the Salt River Pima-Maricopa Indian Reservation. Commissioner of Indian Affairs W. A. Jones did not object to the construction of the hydropower plant because it did not affect any cultivated lands. On February 12, 1901, Congress granted authorization to the Arizona Water Company to build such a power plant on the reservation. It was, however, the Phoenix Light and Fuel Company that constructed the hydropower plant on the crosscut canal 23 miles northeast of Phoenix. The power company signed a contract with T. T. Illness of Prescott to construct Power House No. 1 in September 1901. The structure was to be completed within four months, while most of the power transmission poles for the lines were in the process of being erected in the fall of 1901. Phoenix Light and Fuel also expected to start construction on a second power house, located on the Arizona Canal at the falls.

Arizona Falls hydropower plant transmitted the first power generated by water for use in the City of Phoenix on March 29, 1902, although its construction began after Power House No. 1 on the Salt River Pima-Maricopa Indian Reservation was started. President T. W. Pemberton of Phoenix Light and Fuel, C. O. Mailloux, a consulting engineer from New York, and D. W. Belden, electrical engineer and general superintendent, inspected the Arizona Falls power station on Friday afternoon and then turned the water wheel in motion at 5:13 p.m. Twenty thousand volts of electricity were generated, but the power was not transmitted until 10:00 a.m. Saturday morning, when it powered the lights of Phoenix. The electricity was turned off at noon to make adjustments to the water gate at the falls. Power was later restored to the city. By December 1902, the power plant on the reservation crosscut canal also supplied electricity to the City of Phoenix.

Beginning in 1897 the Salt River Valley experienced a severe drought cycle which affected the water supply. Both the farmers and the Phoenix Light and Fuel Company suffered from the lack of water flowing in the Salt River. In 1904 the water shortage caused both hydropower plants on the Arizona Canal to cease almost all operation. Too much water also created problems for the power company. Flooding in the Salt River Valley caused breaks in the Arizona Canal, which disrupted the flow of water through the power houses until repairs could be completed. Fortunately for the power company, it planned for this possibility and had already constructed a steam turbine plant to provide electricity to the city.

In 1902 Congress passed the National Reclamation Act, which authorized the construction of Federal irrigation projects in the West. In March 1903, the Salt River Project was one of the first five projects granted approval by the Secretary. The farmers and landowners of the Salt River Valley organized themselves into the Salt River Valley Water Users' Association to repay the federal government for the construction of Theodore Roosevelt Dam and appurtenant works. The newly formed USRS was charged with the responsibility for building the dam. Work began on the Project as early as fall 1902; Theodore Roosevelt Dam, the new agency's flagship facility, was completed in 1911.

During the construction period a large flood on the Salt River swept through the Roosevelt damsite, delaying work there. It also damaged the Arizona Dam further downstream. Three hundred feet of the dam washed away when the Salt River crested almost eight feet over the top of the dam. The April 1905 flood created a great hardship for the farmers on the north side of the river, since the diversion works of the Arizona Canal were destroyed and they could not get water to their lands. To irrigate their acreage, landowners installed pumps at the head of the Arizona Canal which provided some irrigation water to the citrus orchards.

Subsequent to the 1905 flood, the Association entered into negotiations with the federal government to build a new diversion dam and purchase the north-side canal system. The government decided to buy the north-side canals from Porter Steele, who had obtained possession of the Arizona Water Company in a foreclosure sale in April 1906. The government paid $235,168 for the main Arizona Canal system and $78,993 for the Crosscut, Grand, Maricopa, and Salt River Valley canals and appurtenant works. At the time the USRS took over control of the north-side canals, its annual report listed the length of the Arizona Canal at 42 miles. By the time the government purchased the canal, the extension constructed in 1894 was no longer functioning as part of the main canal, but formed a portion of a lateral still providing water to the remaining cultivated acreage. On May 15, 1907, the USRS took over the operation of the north-side canals. Temporary repairs were made to the Arizona Dam and canal to provide water to the landowners.

By the summer of 1906, the USRS started preparations for the construction of a new diversion dam, Granite Reef, located approximately two miles below the old Arizona Dam. The Power House No. 1 on the crosscut canal located on the Salt River Pima-Maricopa Indian Reservation provided electricity while building the diversion dam. Nearly 1,300 feet long, Granite Reef Diversion Dam raised the flow of the Salt River to a height of 15 feet. The new regulating gates at the Arizona Canal were given a carrying capacity of 2,000 cfs. Unlike the original Arizona Dam, Granite Reef also diverted water for the south-side canals with a capacity of 1,000 cfs.

Beginning in the fall of 1907, USRS started enlarging the Arizona Canal, under the direction of Engineer W. A. Farish, with a Bucyrus dredger. The machinery broke down before two miles of the canal were widened and a new boat was ordered to complete the work. By December 1908, the dredge was placed on a new boat and started operations for enlarging the Arizona Canal. During the next six months, the dredge removed over 113,000 cubic yards of material. The earth or spoil from the dredging operations was used to build a road on the south side of the canal. By the end of fiscal year 1908, the government spent over $76,000 repairing the earthworks, bridges, and laterals on the Arizona Canal alone. This did not include the construction of Granite Reef Diversion Dam or the new headworks on the Arizona Canal. The USRS also purchased a new Lidgerwood dragline excavator in 1909 and planned on starting its operation at Evergreen Wasteway. The excavator was a dry land machine and ran along the bank of the canal. Over 40 percent of the planned enlargement of the Arizona Canal was completed by June 1910.

USRS also began a program of replacing wooden structures on the canals with more substantial features made of concrete. By the end of the 1911 fiscal year, ten laterals with concrete turnouts had been constructed on the canal. The excavation of the canal continued, which required blasting in some sections; crews removed over 505,500 cubic yards of material that year.

Before the dredge could enlarge the canal below the newly constructed sluice gates of the Granite Reef Diversion Dam, rock needed to be blasted. The USRS employed approximately 500 men, working three eight-hour shifts, to drill and blow up the earth from January 19 through January 29, 1911. A gasoline engine and generator provided the electricity to power lights so the men could work at night. The dredge removed over 22,000 cubic yards of material from the blast rock and scrapers took away an additional 3,000 cubic yards of mud and rock. The dredge was used until it reached the Arizona Falls in April 1912, after which it was dismantled and most of the equipment sold. Work on the canal proceeded with the excavator.

USRS continued to widen the Arizona Canal, as well as work on the other government canals. Between 1911 and 1913 the excavator removed over 400,000 cubic yards of material. Animal teams were used to perform the work where the Arizona Canal crossed Cave Creek Wash. At Cave Creek Road, USRS built a combined check, drop, and bridge over the canal. The banks along the canal were pulled down and leveled where needed, including the building of a roadway on the south bank. Additional concrete structures were built; turnouts were constructed at the Indian Lateral for the Salt River Pima-Maricopa Indian Reservation and 12 other laterals within boundaries of the Project. By the end of 1912 the cost of the improvements and for operation and maintenance of the Arizona Canal reached $249,179. USRS listed the canal's construction charges, which included the purchase price, at $738,727.

As early as 1891, engineers from the USGS had recognized the lack of overflow escapes on the Arizona Canal as a weakness of the original system design. To correct this shortcoming, Reclamation erected additional wasteways, including one just below Granite Reef Diversion Dam. In the summer of 1911, over a dozen concrete waste drains were installed at various points on Arizona Canal laterals. Government crews started construction of turnouts at the Indian Bend and Evergreen wasteways in that same year. The structure at Indian Bend was a combination of both waste gates and spillway. Runoff from heavy rains in Paradise Valley, north of the canal, flowed southeast and impacted the canal at the Indian Bend over a 1,000 foot area, causing severe damage. The new combined gates and spillway had a maximum capacity of 3,000 cfs, and were operated by an electric motor with power supplied from the Arizona Falls Power Plant. The Indian Bend Wasteway was enlarged for a distance of 3,000 feet. Approximately 10 acres of thick mesquite brush were cleared and over 30,000 cubic yards of dirt excavated. Herbert J. Mann, under contract to the USRS, built both the Indian Bend and Evergreen wasteway structures. He enlarged the wasteway at Evergreen, approximately eight miles below Granite Reef, to be able to discharge the entire flow of the canal, or 2,000 cfs. In designing the different turnout structures and waste drains, the USRS standardized the plans for uniformity in both construction and operation. Except for slight variations depending on the width and depth of the waterway through the small laterals, the structures were designed and constructed to the same specifications.

The Association signed a contract with the federal government on August 30, 1910, for the construction of hydropower plants on the canals. The USRS aided in the design of a new hydropower plant at the Arizona Falls, the original plant having been closed soon after Federal purchase of the canal. The Association was in charge of its financing and construction. Unlike the Project power plant at Roosevelt Dam, the location of the Arizona Falls hydropower plant downstream of the confluence of Verde River

with the Salt permitted the use of flood water from either river for power production when the water was not needed for irrigation. The power generated there would be used for Project purposes, such as operating pumps or other equipment.

During fiscal year 1911, the plants' siphon spillway was completed and the foundation of the power plant commenced. The overflow spillway served as a trash overflow and was regulated by flashboards. The spillways also allowed additional water needed for irrigation to bypass the power plant when it was not needed for the generation of electricity. According to USRS engineer Robert Peabody, the siphons were a new component to the hydropower plant. The design and location of the siphons in the forebay created an air seal which permitted a discharge rate of 932 cfs. The adjustable control valves allowed the siphons to work independently and stop the flow of water at any time.

The power plant housed twin horizontal, direct-connected, open-flume turbines mounted in reinforced concrete pits with curved reinforced concrete draft tubes located outside the building. A grill, placed diagonally across the canal, protected the front of the intake, while sand traps behind the grill discharged into a tunnel around the north side of the building into a tail race. Motorized buckle-plated gates allowed water into the turbine pits. Submerged wooden bearings were provided with clear water lubrication. The runners and guide vanes were manufactured from cast-iron. The brass piping was located below the floor when possible. The turbines and governors were left and right-handed, making the power house symmetrical with controls for all the apparatus concentrated along the center line of the plant. The two horizontal three phase, 25-cycle, 11,000 volt generators were connected to the turbines by solid flanged couplings. The single 11,000 volt line was connected to the downstream wall of the building where switches were mounted. The Association constructed the power plant building with reinforced concrete, with a single generator room. It was supported by columns and foundation walls extending from the bottom of the lower canal. The floor was heavily reinforced to support the weight of the generators. The roof was made from galvanized corrugated iron on wooden purlins and supported by steel trusses.

During the summer of 1912, crews constructed the 11,000 volt transmission line between the Arizona Falls and the Power House No. 1 plants, which connected the new Falls power plant to the rest of the electric system. The Association put the new Arizona Falls plant into operation in May 1913 to provide electricity to the Arizona Portland Cement Company. With the exception of when the water was turned out of the canal, the plant generated electricity continuously. Because the canal below the falls was not yet brought up to final grade, the head of 2.7 feet was less than its maximum peak and the plant produced only about 700 kW with the gates wide open. In 1914 the bedrock of the Arizona Canal near the power plant was excavated to proper grade, which had not been done during the original excavation of the canal. This permitted the hydropower plant to operate at its maximum efficiency. The Arizona Falls plant provided power to the Project until it was dismantled in 1950.

In 1912, the Association constructed the new Crosscut Canal, replacing the older Crosscut Canal near 48th Street. The new canal would still deliver water from the Arizona Canal to the Grand Canal, but the water would also be used to generate electricity through a newly built Crosscut Hydro Plant. The intake structure connecting both canals had two double screw-stem, steel lift gates, 7 .83 feet by 17 inches. The gates were operated by either hand or electric motor through a shaft and gear train.

In January 1913, the USRS surveyed the Arizona Canal in order to find out how many gauging stations would be needed to measure the amount of water reaching water users from the main laterals. The following month, USRS started installing the gauges on the main Arizona Canal as well as on the sub-

laterals. H. M. Lewis, under contract with USRS, completed the tail race structure of the New Crosscut Canal in 1914, which created the head of Lateral 20. The original turnout for Lateral 20 was a wooden structure, deemed inadequate and unsafe. The new design consisted of a check, three turnouts, and an overflow spillway 50 feet long. During the construction, Lewis and his crews excavated over 6,000 cubic yards of material.

During 1914, the USRS finished the Cave Creek cut-off. This work had been delayed because government engineers wanted to evaluate ways to protect the Arizona Canal from damage when Cave Creek flooded. The engineers decided that the best solution would be to locate the canal below the natural ground surface, leaving portions of the northside bank open to allow the flood waters into the canal. The south bank would also have openings to permit the excess flood water to escape out of the canal. Both the inlets and outlets were constructed every 600 feet with the first outlet located 300 feet downstream from the first inlet. The USRS also constructed a number of concrete turnouts to the laterals in this section of the Arizona Canal. The total area encompassed by the cut-off was 3.5 miles. The USRS considered the Arizona Canal's reconstruction complete by February 1915.

Cave Creek continued to present problems for the Arizona Canal. The 1916 flooding caused some property damage to farm lands and to the canal, but damage sustained during the heavy flooding in November 1919 demanded the Association take action. Cave Creek flooded three times that winter, washing out the Arizona Canal each time, filling it with sand and gravel for approximately one mile. The creek also cut a large channel directly to the Arizona Canal, creating a potential threat to the project. To remedy this situation, Association engineers designed protective timber spillways along the banks of the Arizona Canal at the crossing with Cave Creek. One-inch redwood timbers were driven into the embankment of the canal approximately two feet down and extended to within six inches of the top of the bank. During the 1921 floods, gopher holes exasperated existing damage to the Arizona Canal along the Cave Creek channel. The redwood timber bulkheads, constructed two years prior, were washed away when Cave Creek flooded in August. The gopher holes permitted the water washing up against the embankment to break into the canal. The Association used material deposited from the flooding to repair the canal, which also helped seal it.

By the spring of 1922, various entities in Arizona, including the state government, City of Phoenix, Maricopa County, and the Santa Fe Railroad, as well as the Association, contributed money to construct the Cave Creek Flood Control Dam. John S. Eastwood designed a multiple arch dam for the project and the contract was awarded to Lynn S. Atkinson, Jr. The dam, operated by the Association from 1923 until the early 1970s, provided needed protection for the Arizona Canal and surrounding lands. The November 1919 flood waters also caused Association engineers to be concerned about the canal bank just below Granite Reef Diversion Dam. The flood destroyed a portion of the Consolidated Canal, and to prevent such an occurrence on the Arizona Canal, the Association constructed a concrete wall along the north side of the Salt River. Crews graded material from the top of the bank and placed it near the eroded bank on the river side at a natural slope, puddled into place. The side of the canal was then paved to a height of three feet above the maximum surface of the flood waters with boulders laid in cement, with a total of 2,935 square yards paved and 246 cubic yards of dry masonry placed. The work was carried on by unskilled laborers, but an inspection of the canal a year later did not show any breaking or settlement. The total cost of this protection amounted to $34,000. To aid in the protection of the Arizona Canal from other flood waters, the Association enlarged the Indian Bend Wasteway by digging a ditch through the slough, forming a better-defined channel.

During the mid to late 1910s, Project lands became waterlogged from intensive irrigation, yet additional water supplies were needed for farming. In 1918, the Association's Board of Governors authorized a program of pump development to alleviate the shortage of surface water and solve the drainage problem. Wells along the Arizona Canal right of way were installed to increase the water supply beginning in 1923; the groundwater was piped from these wells and discharged directly into the canal.

During the 1930s, the Great Depression resulted in a significantly reduced demand and lower prices for farm products, hitting farmers in the Salt River Valley hard. Furthermore, the Association did not have the funds to keep up with the proper maintenance of the water system. In a national effort to provide relief to the chronically unemployed, the administration of President Franklin D. Roosevelt instituted a number of "New Deal" work programs, including the CCC, which was established in 1933. This program enrolled young men between the ages of 18 and 25 in a variety of public works projects, most of which were located in national forests, parks, and range lands. The Association was able to utilize the CCC in the maintenance of the water system between 1935 and 1938.

Camps were built by the Department of the Army, who provided room, board, clothing, and tools for the enrollees and a small salary, in exchange for which, each participant was expected to work a 40-hour week and follow camp rules. While serving in the CCC, each enrollee was taught a new skill and could also attend classes to better his education. In the fall of 1935, two CCC camps were established in the Salt River Valley to work in conjunction with Reclamation and the Association. CCC Camp BR-14 and Camp BR-19 were both constructed near Papago Park, approximately eight miles east of Phoenix. Including supervisory personal, each camp boasted a population of about 200 men. The work done by the enrollees consisted of the repair or improvements to a wide variety of irrigation structures throughout the Project, including the Arizona Canal. CCC crews repaired the Arizona Canal after the summer floods of 1936 broke through an 80 foot section. Construction of concrete turnout structures and canal linings were carried out by the CCC, including a number on the Arizona Canal. The Burgess Lateral, off the Arizona Canal, was piped with over 3,300 feet of 24-inch and 30-inch concrete pipe. CCC crews also constructed a new headgate for the lateral and relocated 4,000 feet of the open ditch. The crews built a maintenance road to the north side of the Arizona Canal below Granite Reef Diversion Dam.

Under contract to the U.S. Bureau of Indian Affairs, the Association constructed a turnout at the Evergreen Wasteway for the Salt River Pima-Maricopa Indian Reservation in late 1938. The banks of the Arizona Canal were raised below Granite Reef to allow for an additional 125 cfs of water for 6,100 acres of tribal land. Construction of the siphon, turnout, and spillway was finished by January 1939. The cost to the Indian Service amounted to just over $10,000.

A new canal measuring station was constructed below the Arizona Falls hydropower plant in September 1942. The structure included an encased stilling well anchored to the left bank of the canal with a cleanout door, inspection door, and a recorder shelter. A staff gauge was mounted on the downstream side of the stilling well. A steel measuring bridge with a wooden deck was located 20 feet upstream from the gauge. An iron track was installed on the deck from which a boom car operated. A sheet iron shed was constructed the end of the bridge to house the car when not in use.

In 1940s, the Association started lining portions of the Arizona Canal to reduce seepage. Lands near the Arizona Canal in certain areas were becoming waterlogged and the situation was worsening. World War II Italian prisoners-of-war, located in valley camps, repaired and lined the canals in 1943. Because of the success of the canal lining, the Association utilized the technique to control the rising water table near the

canals. A Ruth dredger smoothed the banks of the canal after it had been graded and shaped. Crews discovered that the use of pre-mixed concrete on the bottom and gunite on the banks was the best method to line the canal. Gunite is a mixture of sand, cement, and water, called pneumatically applied mortar. Three inches of concrete on the bottom of the canal was less expensive and would do a better job than one inch of gunite. Wire was placed on the sides of the canal before the application of the gunite and extended to the bottom so the sides and bottom would be tied together.

After the war, the Salt River Valley experienced dramatic population growth. Many servicemen who were stationed in Valley military bases returned to the Valley to establish their homes. Farm lands became suburban subdivisions. The Project needed to provide water to residences and the system, having deteriorated during the war years, could not meet the demand. To check this, Congress passed legislation authorizing Reclamation to distribute funds R&B of existing Reclamation projects. Funding was requested and received to rehabilitate the Project water distribution system. In January 1952, the Arizona Canal was lined with gunite for a distance of 13 miles under the R&B program. That portion of the unlined canal had previously experienced seepage and evaporation losses of 12 percent annually. The cost of lining the canal with shotcrete mortar was $125,000, but the lining saved an estimated 13,000 acre-feet of water a year. This amounted to a yearly savings of $37,900 for the Project, thus the initial cost would be recovered in about four years. The canal lining also prevented the loss of water which would be utilized by the growing cities in the Valley as well as protect the banks from erosion during higher flow periods, thereby avoiding resulting damage to the neighboring lands. To aid in the operation and maintenance of the canal, in the late 1960s SRP employees installed trashrack structures. As part of the R&B program, an automatic moss and trash removal structure was installed at the end of the Arizona Canal on Lateral 20. Two other demossing bridges were built of precast concrete "T" beams with retractable screens.

SRP also experimented with innovative techniques in operation and maintenance during the R&B program that proved successful. Laterals were lined using a slipform process or piped with a cast-in-place pipe. The slipform operation used a Fullerform plow to make a trapezoid-shaped trench to predetermined specifications and then applied concrete along the sides and bottom of the lateral. Cast-in-place pipe was made by a machine moving along a newly excavated lateral and pouring cement around a rubber balloon. They replaced many of the gates on the laterals with the “Sabin gate," designed by SRP engineers. This friction lift gate allowed field crews to easily raise or lower the gate with control to within a fraction of an inch. Radial gates were installed on the Arizona Canal at Scottsdale Road, the largest structure of its type within the Project. Additional radial gates on the Arizona Canal were placed in operation during the 1970s.

Another feature of the R&B program was the development of an automated control and data acquisition (SCADA) system for all Project canals. SCADA enabled a single individual to manage the Project's 138-mile canal network from a master switchboard. The first phase of construction began in 1970, when SRP installed a master control console, the system controller, the automatic data logger, data printer, and the Supervisory Control electronic logic equipment at the Dispatch Center on Operations Drive in Tempe. From this sophisticated command center a dispatch operator could control 11 canal stations, and the remainder of the system was installed in four additional phases at a rate of one per year. Once completed in the mid-1970s at a total cost of approximately $3.3 million, this system featured 80 separate canal stations from which the control center received telemeter data regarding water levels and gate positions.

Because of the Valley's enormous urban growth during the post-World War II era, the Arizona Canal also began providing water for domestic and industrial needs. In 1954, the City of Phoenix constructed the Squaw Peak filtration plant. This facility diverted water from the Arizona Canal near 20th Street to supply the needs of the city residents. Ten years later, Phoenix built an additional filter plant, Deer Valley, next to the Arizona Canal at 31st Avenue, to purify and filter water for a growing population. The City of Glendale also obtained water for its residents from the Arizona Canal and treated it at the city's plant near 51st Avenue. Reclamation and SRP later permitted the diversion of water from the canal at the Arizona Biltmore Resort for cooling purposes.

To help various local governments promote Valley flood control, Reclamation authorized alteration of certain features of the Project water distribution system, including a number on the Arizona Canal. New headgates were installed on the Arizona Canal at the Old Crosscut Canal; the City of Phoenix converted the open ditch of the now-obsolete Old Crosscut Canal to buried pipe, and thereafter used it for flood control. It would receive storm drainage from the proposed Arcadia Channel at 56th Street, diverting it to the Salt River via the modified Old Crosscut. In the late 1970s, Reclamation and SRP, in conjunction with the U.S. Army Corps of Engineers (Corps), designed and constructed a siphon at Indian Bend Wash as part of Scottsdale's flood control channel program. The siphon carries water from the Arizona Canal under the Indian Bend Wash. The inverted siphon structure consists of three 15 by 15 foot boxes at the entrance converting to three 10 by 11 foot boxes at the exit. The underground length of the structure is approximately 750 feet. A safety barrier also serves as a trash track at the entrance to the covered boxes. Three eight-foot-high gates were installed in the open channel section of the inlet works with divider walls to separate the flows from each of the three siphon boxes. Two hundred feet upstream from the inlet transition, the Corps installed a wasteway with radial gates and baffled overchute.

During the 1980s, Reclamation and SRP continued to make improvements on Project canal systems. To reduce water losses through increased accuracy of water flow measurements, they modified an existing weir on the Arizona Canal by installing a broad-crested weir. This structure could more precisely measure the rate of water flowing in the canal. As part of a four-year canal program completed in 1984, safety steps and ladders were installed in canals to provide a quick exit for stray animals and people who accidentally enter the canal prism. Crews constructed 118 safety steps and 26 ladders on the Arizona Canal. Besides improving the Arizona Canal through safety and technical features, SRP attended to the physical appearance of the canal. In 1985, crews trimmed trees and removed brush and other vegetation along approximately 16 miles of the canal. The banks of the canal have become paths for bicyclists, joggers, and horseback riders. Fishing is permitted along the banks in many areas.

New Crosscut Canal

Source: *Crosscut Canal, North Side of the Salt River, Scottsdale/Phoenix/Tempe, Maricopa County, Arizona* (draft). HAER No. AZ-60. Dan Killoren, James LaBar, Sarah Stringer-Bowsher, no date.

The New Crosscut Canal, named for its primary function, has been an integral part of the water and power system within the Salt River Valley since its completion in 1913. The canal cuts across a small section of the Valley to deliver water from the Arizona to the Grand Canal. Its uses have included water transmission and distribution for irrigation, hydroelectric power, and municipal and recreational uses. The New Crosscut Canal is also one the earliest examples of the dual purpose of the Project as a water and power provider.

The design, construction, and operation of the New Crosscut Canal contributed to the development of water and power resources in the Valley in many important ways. The original design and construction effectively overcame the challenges of the natural environment, while maintaining an elevation that allowed for the development of hydroelectric power. The natural landscape and setting of the New Crosscut continued to serve as an important factor in determining its changing structure and use. The workers who maintained the Project canal system and resided along the New Crosscut are also an important part of the canal's history.

Additionally, the various uses of the canal by area residents highlight the changing role of the New Crosscut Canal within an increasingly urban landscape. The urban transformation of the Valley affected the operation of the canal in several key ways. The main functions of water transmission and power production were adapted to include domestic water deliveries to a water treatment facility and public recreational uses. All these factors contributed to the significant changes in Project water and power distribution systems.

The New Crosscut Canal was planned as a replacement for the Old Crosscut Canal, which was originally constructed between 1888 and 1889 as part of the Arizona Improvement Company's effort to consolidate the north-side canal system. The Old Crosscut Canal was designed for improved distribution of water, by saving water that would have otherwise been lost through seepage in the long stretch of river between the Arizona and Joint Head dams. The Old Crosscut Canal was built at Mile 25 of the Arizona Canal. The four-mile-long canal ran approximately due south until it spilled into the Grand Canal several miles west of the Grand's head. An elevation drop of 125 feet in four miles also offered potential for hydropower development at the lower end of the Old Crosscut. However, the Old Crosscut power development potential was never realized due to a combination of financial and natural set-backs. In 1897 the Arizona Improvement Company, owner of the Arizona Canal, filed for bankruptcy and the Old Crosscut was acquired by the Arizona Water Company. But an extended drought between 1897 and 1904 left little water in the river, and there were difficulties delivering water through the Arizona Canal because of a build-up of sand and debris. Then a 1905 flood destroyed the Arizona Dam. The federal government acquired the Old Crosscut in 1906 as part of a deal to purchase the entire north-side canal system. The federal government owning the north-side canal system resulted in a change in management practices, as they intended to operate the Project as a unified system. Project power development was part of the operational plan. The Old Crosscut retained its potential for hydropower development, but it was soon overshadowed by new plans to increase the Association’s power production.

At the time that Project development started in 1903, the USRS had authority to develop power only for Project purposes; however, it could not develop power to generate revenue. Therefore, the Project power component was conceived initially as only a construction necessity for Roosevelt Dam. Because the dam site was in a remote area, barren of fuel for the production of steam power, the most efficient means of providing electricity was the development of water power at the dam. The USRS anticipated that in the future the Project would need power to pump ground water to supplement surface water.

The limitation on USRS’ power development capabilities changed when Congress passed the Town Sites and Power Development Act on April 16, 1906. This Act gave the USRS the authority to lease or sell power that was excess to project requirements, and allowed the resulting revenue to be deposited in the Reclamation fund and be used toward project repayment. Before, repayment came only from

assessments paid by landowners on the projects. Later modifications to the law also allowed power revenues to be used for project maintenance. Power revenues could therefore be used to reinvest into the water and power facilities of Reclamation projects. The concept for the Crosscut Canal was one of the first examples of additional hydropower being a critical part of the Project.

Following enactment of the Town Sites and Power Development Act, USRS installed additional hydropower generators at Roosevelt Dam between 1907 and 1910 to supply power for the irrigation wells and to sell surplus power. In 1907, the USRS signed an agreement with PG&E of Phoenix, under which PG&E relinquished its rights to generate power from two hydroelectric plants on the Arizona Canal in exchange for receiving power supplied by the USRS under a 10-year contract. That same year the Association signed a power contract with the Gila River Indian Reservation to provide pumping power for the irrigation of 15,000 acres on the reservation.

The National Reclamation Act required that the landowners within an irrigation project repay the federal government the costs to construct the project. By 1909, it was clear that the construction cost for the Salt River Project would be far higher than original estimates of $3.75 million. USRS construction costs were approximately $8 million as of 1909 for Roosevelt and Granite Reef Diversion dams and purchase and improvements to the north and south-side canal systems, and construction was not fully completed. The Association agreed that power revenues would be an important part of repaying the government. Therefore, on January 10, 1909, the Board passed a resolution that stated, "It is the sense of this board that all power developed and generated by works connected with the Project, over and above the demands therefore for the purposes of the Association, be leased by the government upon the best possible terms, having due regard always for the best advantage that may accrue to this Association and people of this Valley."

The Association realized that additional hydropower facilities could be used to reduce members' repayment for USRS construction costs. During an October 1909 meeting, Judge Joseph Kibbey, John P. Orme, and Joseph Cope proposed a plan to build additional power plants and to sell the electricity with the profits being used for repay cost for constructing Roosevelt and Granite Reef Diversion dams and in acquiring and improving the canal systems. The only question was how to fund construction of the additional hydropower facilities. The Board of Governors wanted to request additional federal funds for more power plants, and at the same time they also were petitioning the Secretary to extend the period of repayment after the Project was deemed complete.

These political and financial realizations led the Association to develop a self-funded plan for the construction of additional hydropower plants. On December 6, 1909, the Association's Board of Governors, with the USRS present, had a broad conversation about Project power opportunities. The Association's discussion was about assessing themselves $2.00 per acre per year for two years, which would raise approximately $800,000 for the construction of the New Crosscut Canal and powerhouse, and one or two other proposed plants. A few months later, Secretary Richard A. Ballinger approved the extension of the Project's repayment period and for the Association assessing themselves for the additional power facilities.

Orme, the new Association president, also issued a statement supporting the power plants; this plan was formed into a contract between the Association and the federal government. Within the contract, the Association agreed to construct the New Crosscut Canal and pipeline from a point one mile east of Arizona Falls on the Arizona Canal extending to the Grand Canal; enlarge and extend the Grand Canal

approximately two miles east to meet the New Crosscut Canal; erect a 6,000 hp hydroelectric power plant at the junction of the Crosscut and Grand canals; construct a 3,000 hp hydroelectric power plant at the junction of the South and Consolidated canals, with a transmission line to the Mesa switching station; and replace the existing Arizona Falls hydroelectric plant with a new facility in order to generate 700 hp at the facility.

The contract also stated that the Association would furnish all the labor and equipment, while the USRS would provide the plans, rights-of-way, and engineers to oversee the work. Upon completion of the listed projects, the facilities would be turned over to the federal government to become part of the Project. Association shareholders approved the contract in a special election on July 21, 1910, and the Board levied a $2.25 per acre assessment on member lands for two years. The final contract was approved on August 30, 1910, and called for all the construction to be completed within two years of the contract approval date.

Motivation for replacing the Old Crosscut Canal with a new canal that could deliver water from the Arizona to the Grand Canal had to do entirely with power development rather than irrigation. The Association proposed the construction of a new canal two miles east of the Old Crosscut that could produce more power by carrying water on a higher line and take advantage of a 112-foot drop near the Papago Buttes. This canal would run the water through the hydro plant before returning it to the Grand Canal. The same steep terrain that made the path of the New Crosscut well-suited for building head to maximize hydropower generation also presented major engineering challenges for the design and construction teams. A location survey for the canal, completed in April 1911, revealed substantial elevation changes that required engineering solutions. The first approximately 3,000 feet of the Crosscut Canal alignment traversed an extensive surface depression that measured 12.5 feet below the required water surface level in the canal. An even deeper depression existed near the Papago Buttes that required the construction of an elevated flume. To complicate matters further, the ground in the area contained only a few inches of dirt with the rest consisting of hard pan and caliche that would make excavation difficult. A design was needed that maintained the gradient of the canal for hydropower purposes while crossing the uneven landscape.

USRS engineers and the Association's Board of Governors were undecided about the best form of design so the USRS formulated two structures that could cross the depression in the first mile of the canal. In January 1912 plans were completed for a pressure pipe option and for an open concrete-lined ditch option. Both designs were equal in hydraulic efficiency with a capacity of 720 cfs and a total loss of head of about four cfs. The USRS design for the pressure pipe called for the excavation of 15,000 cubic yards of earth and required 5,030 cubic yards of concrete. In contrast, the lined ditch required no additional excavation and instead specified 56,000 cubic yards of fill to create an elevated embankment and 1,320 cubic yards of concrete to line the ditch. For comparative purposes, bids were solicited for the construction of both options on March 28, 1912. The Association settled on the concrete-lined ditch for three reasons. First, in order to lessen excavation efforts a shallow type of conduit was preferred. Second, since the proposed location of the open ditch was further east than the pressure pipe, there was no necessity to conform the right-of-way requirements to accommodate a roadway. Third, and probably most influential, the concrete-lined, open ditch was approximately $30,000.00 less expensive than the underground pressure pipe. The Grant Brothers Construction Company was awarded the contract on March 29, 1912.

After the United States acquired all the necessary rights-of-way for canal construction, a survey team was employed in June 1912 to begin staking out the path of the canal in advance of the excavation teams. Grant Brothers began work in May on a contract that called for the excavation of 150,000 cubic yards of earth with the rate per yard being set at $0.13 for soil, $0.45 for loose rock, and $0.95 for solid rock. A letter from the Project Engineer to the Director of the USRS dated July 3, 1912, reported that the excavation work would be completed by August of that year. This did not come to pass due to a right-of-way issue that halted construction and ultimately caused the line of the canal to be relocated in August 1912. The new canal path was not as desirable for construction, but followed a shorter line. Part of the difficulty in acquiring the right-of-way was due to the fact that the land surrounding the proposed canal was highly valued for its citrus production. The Association finally agreed to purchase one section of land that ended a construction delay that had lasted for several months. The Association used the land purchased for the canal for housing workers and as a maintenance camp in subsequent years. Immediately after the right-of-way issue was settled in November 1912 the Grant Brothers Construction Company, under the supervision of USRS engineers, returned to work.

The work entailed the placement of 53,642 cubic yards of earth for the embankment and 106,914 square yards of concrete lining 4.5 inches thick. The intake structure for the New Crosscut Canal off of the Arizona Canal contained two double screw-stem steel lift gates measuring 17 by seven feet. A hand crank and electric motor with a shaft and gear trains were installed to operate the gates. This structure required 240.7 cubic yards of concrete. The first half mile of concrete-lined canal from the Arizona Canal was completed in 1913. The New Crosscut Canal crossed another extensive depression approximately 1,000 feet north of the location of the Crosscut Hydro Plant's penstocks. The depression was 19 feet below canal grade at its lowest point. The crossing of this gap was accomplished with a reinforced, rectangular concrete flume measuring 595 feet by 12.5 feet by seven feet. Concrete columns mounted with transverse girders supported the flume. At each alternate column there was a tongue and groove expansion joint extending across the structure. In order to make each expansion joint efficient and watertight, a flexible strip of copper was placed in between the joints. The construction of the flume required 810.64 cubic yards of concrete. The Grant Brothers Construction Company began working on the flume in 1912, and it was completed in March 1913.

The flume constructed on the New Crosscut Canal was not the first to be used within Project system. In 1903 a power canal was built at Roosevelt Dam for the production of power during the construction of the dam. The canal utilized several different types of flumes, including a steel-reinforced concrete flume designed by USRS engineer Jack Whitney. The flume at the dam bears a strong resemblance to the one constructed as part of the Crosscut, in that it also was used to cross a surface depression. The flume and many other features of Project water transmission and power facilities were similar as a result of being designed by USRS engineers. After the flume, the canal opened up into a forebay before entering the two penstocks of the Crosscut Hydro Plant. The forebay structure was 380 feet by 58 feet, and was formed by two walls with sloping faces supported by buttresses. The east wall was built to form a spillway where flashboards could be added. The overflow water traveled into a ravine and then into the extension of the Grand Canal below the Crosscut Hydro Plant. Six steel gates for sediment cleanout were built in the forebay wall at 50-foot intervals. Four panel trash racks that were each 12.5 feet long were added at the lower end of the forebay to keep debris from entering the penstocks. A sand pit with an outlet tunnel and valves was installed to permit the removal of silt and debris. The structure required 1,102.85 cubic yards of concrete because of the lack of natural fill in the immediate area. The materials and design of the forebay testify to the difficulty in engineering a canal over challenging terrain, while maintaining a sufficient head for the production of hydropower at the Crosscut Hydro Plant.

In addition to the canal itself, the initial construction effort also included facilities to meet the transportation and agricultural needs of the area. A four-panel wood and steel truss bridge spanning 54 feet was constructed at McDowell Road, as stipulated as part of the agreement in acquiring the right-of-way. A 27-foot two-panel wood and steel truss bridge was constructed over the waterway exiting the east side of the forebay. A temporary wood bridge also was constructed southwest of the forebay at the crossing of the Tempe Road (present day Van Buren Road) and the Grand Canal. The construction of the Grand Canal extension and the New Crosscut caused some damage to the Tempe Road, but provided opportunities to expand the regional transportation network. Construction and right-of-way delays led to the New Crosscut remaining unfinished by the August 30, 1912, completion date specified in the 1910 agreement. As a result, the contract date was extended several times. The New Crosscut Canal was finally completed in 1913, after which the Association entered into a contract with Martin & Gillis for the construction of the Crosscut Hydro Plant in July 1913. The hydro plant was completed in December 1915.

The lack of laterals for agricultural uses along the New Crosscut Canal is further evidence of its primary function as a power canal. As part of the 1917 contract that transferred operational control of the Salt River Project from the federal government to the Association, an inventory of Project facilities identified five laterals off the New Crosscut. The farm unit plats completed by the USRS in 1917 showed that most of the cultivated land was further east of the Crosscut in Section 27, with almost no agricultural land in Section 34. This was due in part to the unfavorable desert land further down the canal and in part because Association owned the entire west half of the southwest quarter of Section 27.

Drastic elevation changes and desert landscape that complicated the engineering of the New Crosscut Canal also contributed to the preservation of the land as a national monument. The effort to designate Papago Park as a national monument began shortly after statehood in 1912, by the City of Phoenix and the Maricopa Board of Trade. The abundance of desert plant life and impressive scenery were used as justification for the park's designation, but this reasoning did not convince the General Land Office which wrote to Arizona Senator Carl Hayden that "...topographical conditions seem to offer nothing but scenery, and the National Monument Act of June 8, 1906, does not provide for reservation of public land for the purpose of protecting scenery." After supplying additional evidence of the biodiversity of the land the final determination to establish the Papago Saguaro National Monument was made by the Presidential Proclamation of Woodrow Wilson on January 31, 1914. The New Crosscut Canal passed through the 2,100 acres that comprised the National Monument, in Sections 34, 3, and 10. The designation of the land did not significantly change the operation of the canal or the completion of the hydropower plant, which was located just outside the monument boundaries

But the designation of the park as a national monument did not stop the commercial and settlement pressures that challenged the preservation of the land. In the 1920s local citizens and municipalities continued to propose uses for the land within the monument. In 1928 the Arizona Fish and Game Commission started lobbying the National Park Service (NPS) and Interior to allow the construction of a bass fish hatchery within the monument boundaries in Sections 4 and 9. They planned to take water from the Crosscut Canal to fill several ponds. In making his recommendation on whether to approve the hatchery, NPS Assistant Director Arno B. Cammerer stated "there is an irrigation canal, and two power transmission lines that traverse the monument. My thought is that the Papago Saguaro is not a monument of great value and could well be turned over to the State."

Political pressure from Senator Hayden, along with the support of the local civic groups, culminated in a bill to abolish the park's national monument status. Hayden, however, delayed passage of the bill after Association General Superintendent C.C. Cragin asked him to stop action on the measure until the Association could address concerns about how the land's changing ownership might inhibit the operation and maintenance (O&M) of the Crosscut. Hayden removed the bill and reissued it in the next congressional session, where it passed on April 7, 1930. Federal, state and local authorities soon began discussion on how to best use the newly available land alongside the New Crosscut Canal.

To resolve the potential O&M issues, in 1930 the Association purchased 85 acres of land along the New Crosscut as part of the federal government transferring ownership of the monument to the state. The purchase price was set at $1.25 per acre, and in 1932 the Association acquired 54 additional acres, and transferred 20 acres to the state. That same year the Arizona Fish and Game Commission started construction of the Hunt Bass Fisheries facility, located on 200 acres to the west of the canal in Papago Park. In March 1932, the Association's Board of Governors approved the delivery of 200 acre feet of water to supply the fisheries facility at the cost of $2.00 per acre foot. In August, the Arizona Game Warden W. C. Joyner requested the allotment of 250 acre feet of water for the first year in order to increase the facilities from four to six ponds. The Board approved Joyner's request in October, allowing the hatchery to expand its operations to include six ponds, with the future yearly allotment being set at 200 acre feet.

In an effort to repair aging facilities during the Great Depression, Reclamation requested that CCC units conduct maintenance and construction work on the Project canal system. Two CCC camps were established in close proximity to the Crosscut Canal. In 1935, Reclamation established the first camp, BR-14, west of the New Crosscut Canal and north of McDowell Road, in an existing camp (SP-5A) previously established by State Parks in 1933. In September 1935, the Association's Board of Governors leased 10 acres within the western half of Section 3 to Reclamation for the second CCC camp in the Valley (BR-19). The camp was along the east side of the canal and south of McDowell Road. Although the camps were separated by the New Crosscut Canal, their collective work centered on the irrigation structures replacement and betterment. They built a pipe manufacturing operation at Camp BR-19 that included an office building, adobe warehouse for cement storage, blacksmith shop, concrete pipe casting shed, and a loading pit for concrete pipe. This nearly self-sustaining operation allowed CCC workers to make concrete piping directly on site, take the materials to the construction site, and install the products into the Project's canal system.

The location of the CCC camps in a central part of the Valley, along the banks of the New Crosscut Canal, allowed enrollees to adequately attend to the needs of the Project system. The CCC crews typically completed projects including: building fences, creating or repairing roads along canals, constructing levees or dykes, clearing sublaterals, lining and piping waterways, or upgrading water control structures with stone masonry or rubble lining, and installed more than 35,000 linear feet of precast concrete manufactured at Camp BR-19. In less than three years, men from Camps BR-14 and BR-19, working with the Association and for the Valley community, completed more than 700 separate jobs. The CCC also was positioned to respond to emergencies, such as the emergency repairs to an 80-foot section of the Arizona Canal and addressing flood damage to the Eastern Canal in 1936. While many saw the overall benefits of the CCC program, others claimed the government created unfair competition by allowing larger companies or organizations the opportunity to profit from less expensive CCC labor as opposed to hiring local workers. The purpose of the CCC projects was to make improvements to an aging system in need of repair that could not be otherwise be afforded due to the constraints of the

Depression. On March 30, 1938, Reclamation discontinued the CCC projects on the Project. The Department of the Army removed the materials and equipment from both camps to other programs or disposed of it in June 1938.

During World War II, the U.S. War Department's Camp Papago Park, a prisoner of war (POW) camp, was located next to the New Crosscut Canal. The Allies held three million POW's during the war, and 425,000 were kept in the continental United States. Camp Papago Park was one of 155 large POW camps operated in the United States. The War Department requisitioned all of Papago Park, except the Desert Botanical Garden, picnic grounds, and Hunt Bass Hatchery, between 1942 and 1946 for the POW facility. Camp Papago Park's first prisoners were primarily Italians, and the processing of detainees began in October 1943. The camp was re-designated in January 1944 as a German POW camp. By March there were approximately 3,100 detainees at the camp, with the largest portion of prisoners from the German Navy.

Camp Papago Park was located in the northeast section of Papago Park to the west of the Crosscut Canal. The boundaries of the camp were, approximately, from Thomas to McDowell roads and from the Crosscut Canal to 60th Street. With the support of two fences and more than a dozen guard towers, the Crosscut Canal served as a natural boundary on the east side of the camp. The POW camp utilized existing training barracks that the U.S. Army had constructed in 1941. By 1943 the fighting had turned in the Allies favor and POW camps needed to enlarge their facilities. The War Department contracted with the Kings and McKee Construction Company to build 14 new structures that formed the nucleus of the enlarged camp. The camp contained five prisoner compounds, a hospital area, an officers' recreation area, and an enlisted men's recreation area. In addition to the POWs, 300 American civilian and military personnel also resided at the camp to operate and maintain the facility.

The Crosscut Canal also served as a swimming facility for Camp Papago Park. In 1944 George Barber, Lieutenant Colonel and Commanding Officer at Camp Papago, requested permission from the Association to install temporary duck boards, diving platforms, steps, ladders, and benches in an area 50 yards along the canal bank about 0.75 miles south of Thomas Road and east of the camp. The improvements were for the convenience of the bathers, military personnel and prisoners, so they would not get muddy when they emerged from the water. The Association had no objection to the facilities as long as the installations were temporary, removed after each swimming period, and there was no liability to the Association. A year later, Camp Papago Park upgraded from the Crosscut Canal swimming hole to a separate swimming pool that used water from the canal. The Association's Board of Governors approved the water use permit on May 23, 1945. The camp built a swimming pool and bath house and installed a water pump and filters adjacent to and west of the Crosscut Canal in order to easily use the water from the canal.

Besides the Crosscut Canal being part of Camp Papago Park’s natural boundary and swimming facility, the canal had a role in the largest escape within the United States from a POW camp. On the night of December 23, 1944, 25 prisoners used a tunnel and temporarily escaped from Camp Papago. The prisoners had dug a 178 foot long tunnel that exited on the bank of the Crosscut Canal. A few of the prisoners crammed wood, canvas, and tar through the tunnel to build a raft. Their plan was to float down the Crosscut Canal to the Salt River, and then along the Gila River to the Colorado River and into the Gulf of California to Mexico. Their scheme was quickly foiled when they found the Gila River to be a series of puddles instead of a flowing body of water. Most of the prisoners turned themselves in, and all of the prisoners were recaptured within Arizona by the end of January 1945.

A major enlargement of the Crosscut Hydro Plant forebay was undertaken in December 1938. During this same time period a number of the Project's power generating facilities were in the process of switching from 25-cycle to 60-cycle generation, which resulted in a power production increase of nearly 30 percent. As part of this conversion at the Crosscut Hydro Plant, a larger forebay was needed on the Crosscut Canal to remove silt and debris. Removing the silt reduced the amount of wear on the plant's water wheel and helped prevent damage that could cause the generating station to go off-line. A “gravity dam,” approximately 300 feet by 30 feet, created a 20 acre foot desilting basin east of the existing forebay. The dam was designed with 15-foot-wide sections hollowed out with one-foot-deep solid buttresses in between. Contraction joints with copper seals were placed in between the monolithic piers, and ten-foot horizontal bars of one inch reinforced steel were placed on 12-foot centers across the thin sections. The entire structure required approximately 2,000 cubic yards of concrete. The structure was considered a gravity dam due to the "heavy horizontal piers with expanded upstream ends acting as corbels and meeting in the center."

Several modifications were made to the New Crosscut in the 1950s and 1960s as part of an effort to improve the efficiency of the canal and reduce water loss. In 1954, radial gates were installed at Lateral 2.0 and 3.0 of the Crosscut. In 1962, the New Crosscut was lined with 11,667 linear feet of concrete and pneumatically applied mortar as part of the R&B program. Federal legislation created the R&B program in 1949 to provide low interest loans to water user organizations managing Reclamation projects to improve their irrigation structures. SRP utilized this program through 1980 to pipe and line canals, install gates, and improve the distribution system.

In 1958, SRP petitioned Reclamation for funds through the R&B program to have Motorola design remote controlled electrical equipment to operate canal gates. The agency quickly approved the request but, due to technical problems and the rapid development of electrical components, Motorola abandoned the technology and SRP installed the new equipment at only one site. As computers became more powerful and labor prices and traffic increased with Phoenix's rapid growth in the 1960s, SRP solicited bids for a SCADA system utilizing a computer to remotely control gates. The bid called for the installation of the SCADA equipment on sites along the New Crosscut Canal, including at the headgates off the Arizona Canal, the hydro plant forebay, and several laterals. SCADA is a multifaceted computer-based network that allows for remote control and monitoring of the Project’s entire water distribution system. The contract was awarded to Gulton Industries, Inc., in 1969.

The headgates for the New Crosscut were scheduled for replacement as part of the fourth phase of the initial SCADA installation. The original headworks for the New Crosscut Canal utilized vertical gates that slid up and down, instead of the radial gates commonly used throughout the Project's system. The water flow for the Crosscut Canal exited the Arizona Canal at a right angle, which created an unusual line of flow that was difficult to calibrate. A study, using a model of the headworks, was conducted to understand the canal’s flow regime and gauge how new radial gates would affect water flow. A project engineer wrote that, "through this study, we hope to find ways to alter the gate arrangement so the flow will be more efficient and that calibration will be easier." A model of the headgates for the Crosscut was constructed north of Thomas Road about 30 feet east of the canal, which replicated the exact features of the Arizona and Crosscut canals. Water was taken from the Crosscut, flowed through the model, and deposited back into the Crosscut. The radial gates at the head of the New Crosscut Canal were intended to operate under free flow conditions, which reached a maximum discharge of 600 to 650 cfs. Due in part to the information gained from the modeling efforts, a design for radial gates was finalized in 1972 and was installed in 1974.

In 1984, the radial gates on the east end of the hydro plant forebay were removed due to erosion and leaking, and because new check structures constructed upstream as part of the Tempe Water Treatment Plant made them unnecessary to control the flow into the forebay. The section of the Crosscut Canal from the flume to the forebay was lined in 1994 with 863 feet of rubberized asphalt canal lining. Later that year, several structural problems were observed in the forebay, including seepage through the dam and cracks in two end buttresses on the west side of the forebay dam. The cracks in the dam were repaired by a combination of steel plates, dowels, epoxy injection, and patching the surface with a polymer-modified concrete.

Exponential growth of the Phoenix metro area necessitated the expansion of roads that crossed over the New Crosscut Canal. In 1992, residents in the City of Scottsdale voted to approve a plan to extend 64th Street from Thomas Road to Indian School Road along the east side of the Crosscut Canal. The project included the construction of a new bridge over the Crosscut at 64th Street and Thomas Road, as well as the relocation of the radial gate structure located 300 feet to the north of the proposed bridge. SRP granted an easement for the road, and the City of Scottsdale constructed the bridge in 1996 and 1997.

On January 1, 1964, the City of Tempe entered into a domestic water agreement with SRP to provide and deliver the water allotments for Project lands within their municipal boundaries to the city. The agreement allowed the City to divert water from Project canals and laterals at selected sites, including one on the New Crosscut Canal. On July 14, 1966, the City and SRP signed an agreement for the installation and operation of canal diversion facilities on the Crosscut. SRP was responsible for constructing the diversion that sent water to the new Tempe Water Treatment Plant to be located in Papago Park. Under the terms of the agreement SRP also agreed to install a check and diversion structure in the New Crosscut Canal and build a concrete flume with a capacity of at least 62 cfs. The City covered all the construction costs in addition to a maintenance fee for SRP's continued upkeep of the facilities.

As part of the work for the Tempe Water Treatment Plant, a new demossing structure was installed on the New Crosscut Canal. SRP also installed 1,260 square feet of gunite to line the canal and tie into the new demossing structure. The demossing structure included three bar screens and two radial gates, and was the first of its kind installed on any Project canal. The trash racks on the demossing structure functioned automatically and included a silt conveyor that lifted debris from the canal and deposited it on the bank. The installation of the demossing equipment also required new mechanisms to control the flow of water through the gate. A differential float control device was designed to manage the silting screens. The device automatically started when an accumulation of debris caused a differential between the upstream and downstream side of the screens. A conveyor then removed the trash, and the device there-after returned to normal operation. The installation of the new demossing structure was completed in 1966, and shortly afterward a similar device was installed on the South Canal. Work on the new facilities continued for the rest of the year, though construction was delayed temporarily due to rain and the fact that excavation of solid rock was required. Construction finished on the Tempe Water Treatment Plant in December 1966, with the City of Tempe formally dedicating the facility on February 11, 1967.

The challenge of controlling aquatic weed growth in the canal has existed within the Project's system since its inception. The introduction of fish that eat canal vegetation is one of the methods devised to alleviate the problem. The white amur is a fish that eats more than its weight in water vegetation every day. In 1989, as part of a pilot program for weed control, over 1,700 white amur were introduced into portions of the Tempe and New Crosscut canals. The white amur proved to be an effective form of weed control that minimized the use of chemical treatment in the canals. The pilot program was expanded in

the early 1990s to include other Project canals. The Crosscut Canal was used as a stocking pond for raising the white amur in addition to using the fish for weed control. SRP began a pilot project to grow the white amur in August 1994 after deciding that money could be saved by not ordering the full-size fish, which were twice the cost of the smaller amur. In order to raise the fish in the canal, SRP's special permit required that the canal be a closed system. The one inch grates on the Crosscut Canal provided a closed system and allowed SRP to proceed with the pilot project. SRP purchased white amur that were eight to ten inches in length and placed them in the Crosscut Canal, where they stayed for approximately a year. Once grown to a minimum 2.25-inch head width, the amur were transferred throughout the canal system. In 1995, 1,200 of the smaller white amur were stocked in the Crosscut Canal. By 2003, the use of the Crosscut Canal for raising amur was discontinued because of the extensive time required to measure the fish and transfer them to other canals. SRP currently orders full-size white amur (minimum *2.*25-inch head size) and continues to use the fish to control weed growth throughout the canal system.

As the urban area increased along the Project's canal system, the need to provide for recreational and multiuse activities along the canals became more apparent. The New Crosscut Canal, because of its proximity to Papago Park and several residential neighborhoods, served as an ideal setting for developing recreational activities along the canal right-of-way. Aware of the increasing interests of cities to utilize the canal landscape, SRP and Reclamation entered into an agreement in 1964 that allowed for the issuance of permits to counties and municipalities to develop the canal rights-of-way for recreational facilities and public use. The agreement allowed SRP to review development plans in advance to ensure that continued operation would not be inhibited.

By 1964 Maricopa County had started planning for 28 canal parks located throughout the Project system, with one facility to be developed along the New Crosscut Canal in Papago Park. Canal Park was constructed in 1973 and receives water from Lateral 3.4 of the New Crosscut Canal to supply a lake surrounded by trails and ramadas. The first hard-surface bike path along a Project canal was constructed in 1974 on the Crosscut Canal right-of-way through an agreement between SRP and the cities of Phoenix, Tempe, and Scottsdale. The 11.5 mile bike loop was part of a larger effort to make the Crosscut Canal available for recreational activities, including hiking, fishing, and horseback riding. The City of Scottsdale began construction in 2005 on a network of trails and recreational facilities along the New Crosscut that connect with the facilities offered by the City of Tempe in Papago Park.

Throughout its history the New Crosscut Canal has continued to serve the primary functions for which is was designed, while being adapted to meet the demands of the surrounding environment. The canal continues to transfer water from the Arizona to the Grand Canal and move water through the Crosscut Hydro Plant for the development of power that meets the needs of the growing Phoenix metro area. The advent of domestic water deliveries has expanded the use of the canal for the purpose of accommodating the City of Tempe's water treatment and recreation facilities. Urbanization has caused an increasing demand for recreational opportunities along the canal. As Papago Park continues to serve as an important retreat for the surrounding residential neighborhoods, the Crosscut will continue to play a prominent role in connecting the various recreational facilities in the area. Due to the Valley's dependence on a sustainable water and power supply, the Crosscut will remain an integral part of Project's network, but the operation and maintenance of the canal will continue to undergo changes in response to the surrounding environment.

Crosscut Hydro Plant, and Project Power System Development

Source: excerpts from *Grand Canal and Crosscut Hydro Plant, North Side of Salt River, Tempe and Phoenix, Maricopa County, Arizona*. HAER No. AZ-17 and AZ-30. Fred Anderson and Carol Noland, 1990. Additional material added July 2012.

A contract for the construction of the Crosscut Hydro Plant building was let to Martin and Gillis on July 21, 1913. Construction began in late September, and was completed in November 1914. The plant, designed to be a generating station and a transformer and switching station, was the most important facility on the system owing to its central location. The outside dimensions of the generator room were 176 by 42 feet, large enough to contain the six vertical generators located in a straight line along the main room, with the water wheels discharging into wheel pits connected to the tailrace, which ran the whole length of the building outside. Portions of the main floor were depressed to permit the location of oil pumps and tanks while a tunnel ran alongside the building with pipe connecting the various units. The floor of the transformer room was six feet above the main generator floor, the height of this floor being designed to conform as closely as possible to the topography of the site. The rectangular mass is divided into 12 bays (north to south) along the sides and three bays on the sides. The maximum height of the structure is 63 feet with the main generator floor 22 feet above the tailrace (water exit) grade. The concrete work is detailed with simplified classical motifs, expressed below the frieze panels by a corbelled band course and pilaster capitals. The windows (one per bay) are metal four-over-four light double-hung. The plant is entered from the north with a garage door access from the south. The generator room was covered with a steel truss, corrugated iron roof with four transoms and galvanized iron ventilators. To the east is the switching and transformer building (which measures 89 by 43 feet) and a shop (16 by 43 feet). These buildings are of concrete with similar detailing and openings, but with a flat concrete roof. The switch floor was supported by columns and beams while the main floors and walls rested on solid rock foundations. The interior walls were plastered throughout and the exterior reinforced concrete walls were finished with a cement wash. The windows were to be of metal and the doors metal covered.

The equipment consisted of six 1,000 hp Pelton turbines connected to six vertical shaft Westinghouse 11,000 volt generators of a 700 kW capacity. Each penstock drove three main water wheels. The main units were each turned by six nozzles, each with a maximum capacity of 20 cfs, which could be opened and closed individually by hand-operated needle valves. A governor, driven by pulleys from the top of the generator, controlled the opening and closing of deflectors in front of each nozzle. This affected the force of water striking the water wheel blades. This governor and deflector system was the mechanism by which electric load was derived from variable heads of water. The water wheels were custom-made to handle the expected large amount of sand and silt in the water; the number of parts most susceptible to wear was reduced, and they were designed for cheap replacement.

The generators were connected to the water wheels by a straight shaft with split clamp couplings. The weight of the rotating parts of the wheel and generator totaled 23 tons, and was suspended from the top of the generator by a single Kingsbury thrust bearing 24 inches wide. The lower end of the water wheel-generator shaft was held in place by a spider bearing. The transformers, switches, and bus bars were housed in adjacent rooms east of the generator room. The 12 transformers, produced by Allis-Chalmers Manufacturing, were oil-insulated and cooled by circulating water. They were connected to double 11,000 and 45,099 main bus lines through Westinghouse switches.

By spring 1914, the powerplant building was largely complete, and installation of machinery had begun. The most critical part of the process was the placement of machinery which had to be set in concrete or grouted in position. All summer long a flurry of correspondence between USRS Chief Electrical Engineer Orville Hiram (O. H.) Ensign and Superintendent of Construction William S. Cone in Phoenix was generated by the concerns over placement of the needle valves and nozzles, and the alignment of the water wheel, shaft, bearings, and generator. The specifications for the placement of the generator sole plate, which was to be grouted into position, were detailed as to the method of shimming and bolting to be used, and the tolerances needed; "Extreme care should be taken by the man using the engineer's level (transit) to be certain that the rod is held absolutely vertical, and that he is looking for a difference less than the diameter of his cross hairs. Specifications also called for a variation of less than one one-hundredth of an inch in the centering of the needle valve shaft in its seat.

By September all the water wheels and generators were installed, and the pipes and chambers were filled with water to test for leaks. When small leaks, caused by shrinkage cracks, were found, the pipes were refilled with "as dirty water as we could get," mixed with sawdust, to fill in the hairline cracks. In testing the needle valves, a serious vibration was discovered during the opening of the valves. These valves were intended to be operated only in a full open position, but had to be opened and closed slowly enough to prevent abrupt changes in water pressure in the pipes. The problem was such that, when operated slowly under a full head of water, the valves were subject to a vibration or "chattering" which could damage the valve seats and stems, and even crack the concrete around the stem guides. Ensign calculated that, if the valve could be opened and closed so that it passed through the vibration zone in three to five seconds, the water pressure rise would be within acceptable limits. During October and November, the Pelton Water Wheel Company and the USRS engineers experimented with several ways to alleviate this problem, and in November installed new valve guides with vanes which prevented the eddies which caused the vibration.

There were also problems with the butterfly valves at the penstock entrances, and with the efficiency of the water wheels, which at first seemed to be "drowning" in the backwash of water from the nozzles so that the turbines were operating more efficiently with four jets open than with all six jets. Work on all these problems was complicated by the operation of one penstock and three turbines for generating purposes, beginning December 19, 1914. This was done to take advantage of the flood flows of the Verde River, which allowed the Roosevelt Dam power plant to be shut down to store water. This operation of the untested Crosscut plant resulted in damage to several of the needle valves and water wheels. Eventually so many of the valves were damaged that the valve stem was redesigned and strengthened.

Through the rest of 1915, work continued on the various problems with the Crosscut Hydro Plant. Most of these repairs were done by the Pelton Water Wheel Company under the fulfillment of their contract to achieve required efficiency and reliability on the equipment they were contracted to supply. The contract between the Association and the USRS called for a 30-day test of the plant before acceptance by the Association. This test was not begun until December 15, 1915. Although not considered fully operational, the plant generated a total of 8,290,000 kW hours in 1915, operating on only one penstock at a time. This was the second largest production of any Project hydro plant that year, only 15 percent less than the output of the Roosevelt plant.

At the time it was put into service, the Crosscut Hydro Plant supplied about 40 percent of the generating capacity of the Project system. For the next 24 years the plant operated as a generally reliable power

source, despite increasing evidence that some features of the plant were less than ideal. The Pelton water wheels did not operate well on the low head available, and numerous problems were experienced with the transformers and distribution equipment at the plant. Nevertheless, this was a period when the Crosscut experienced "many repairs but little change."

The Association's operation of the power system, however, underwent great change over time. Project pumping and wholesale and industrial power sales both increased greatly during the World War I, but the power supply remained dependent on the flow of water, and the flow of water was determined primarily by the weather and irrigation needs. This meant that during the winter months, when the water stored behind Roosevelt Dam was not needed for irrigation, water was not released from the dam and so those generators were not available to produce power. At those times, power could be generated only by the canal hydro plants using Verde River water, but even these sources could be cut off by a general drought on the watershed.

The Project hydroelectric facilities lay within easy reach of some 80 percent of the 1920 electric load (demand for power) of the State of Arizona, and that load was growing rapidly. While this represented an opportunity, it also represented a threat. If the Association did not take steps to expand and firm up its electrical capacity, some competitor was sure to expand into the Project area. The Association had an investment of $4.5 million in electric generating plants to protect, and the opportunity to further reduce per-acre assessments on Association farmers through increased power revenues. As Association President Frank Reid put it, "We are in the power business. We cannot afford to stay out of the power business with the large and growing demand for pumping on our project and power needs on the farm. Never in the history of the Valley has there been a greater need for vision on the part of the members to see this great opportunity of our Association."

The Association management considered the best solution to this problem to be the expansion of hydro generating capacity by building more power generating dams on the Salt River. Between 1923 and 1929, three hydroelectric/storage dams were built on the Salt River between Roosevelt Dam and Granite Reef Dam. They were Mormon Flat Dam (begun 1923), Horse Mesa Dam (begun 1924), and Stewart Mountain Dam (begun 1928). This allowed water to be run through the upper dams for power generation and still stored behind the lower dams for irrigation. It also expanded the total hydro generating capacity of the Project from about 22,100 kW to 69,500 kW. The dams were financed by bond issues based on contracts to deliver power to industrial users, especially the mines in Globe, Miami, and Superior, and to Central Arizona Light and Power Company (CALAPCO). A 1928 contract to deliver 7,000 kW of firm power to CALAPCO, added to 9,500 kW previously contracted for, brought the minimum annual revenue from that source up to $240,000. This increased revenue made possible the $4.1 million bond issue to finance Stewart Mountain Dam. Of this financing, $1.44 million was used for the Association's rural electrification program. The construction of 712 miles of 4 kV line and eight substations made it possible to bring electric power to 4,200 Association members, making the Salt River Project "the largest completely electrified rural area in the world."

In 1929, continued drought endangered hydropower generation and led to power supply contracts with CALAPCO and the Inspiration Consolidated Copper Company. CALAPCO agreed to build a steam generating plant in Phoenix primarily to supply Association commitments, in return for guaranteed minimum payments through 1938. The Association also paid the total cost of the expansion of the Inspiration Consolidated steam turbine capacity ($463,000) in return for availability on demand of the expanded capacity through 1939. In addition, the Association was able to purchase as much as 14,000

kW from the Arizona Power Company's plants in Childs and Prescott ("wheeled" by CALAPCO).

With the pending expiration of the CALAPCO and Inspiration Consolidated contracts, the Association made plans to build its first non-hydro generating plant, and to modernize the Crosscut Hydro Plant. A 1937 report by a consulting engineer recommended the purchase of diesel generating units to provide 15,000 kW of standby power and the testing of the canal hydro units to determine whether upgrading these plants was feasible. Construction of the diesel plant began in October 1937, and in 1938 two 6,250 KVA, 25-cycle diesel generators were installed. Over the next 12 years, the Crosscut complex added and removed a total of three more diesel units and added four steam turbine units. The hydro, diesel, and steam units were all connected, and the changes at Crosscut were almost continuous over this period.

Up to this point all the generating capacity of the Project had been 25 cycle frequency, but the eventual conversion of the system to 60 cycles was anticipated. The first step in this direction was taken primarily to serve a single large customer, the City of Mesa, which had a 60-cycle system powered by an obsolete and inadequate frequency changer. The Association wanted to begin supplying 60-cycle power directly. In 1938, hydro units 4, 5 and 6 were decommissioned, and the penstock to unit 4 was reworked to accommodate a 4,100 hp, 327 rpm water wheel built by James Leffel & Company. This was attached to 3,750 KVA, 60-cycle vertical shaft generator, with a 3,000 kW capacity, produced by Electric Machinery Manufacturing Co. In 1940, a 9,000 KVA frequency changer was installed in the space formerly occupied by hydro units 5 and 6 to convert between 25 and 60 cycle.

Also as part of this retrofit project, a 21 acre foot desilting basin was built on the east side of the Crosscut Hydro Plant forebay, to further reduce the entry of sand into the penstocks. This was created by a concrete dam 30 feet high and 300 feet long. The dam was built of arches on 25 foot centers, designed not as a multiple arch dam, but as a structure of "heavy horizontal piers with expanded upstream ends acting as corbels and meeting in the center." This was the first use of "low-water-cement-ratio" concrete on an Association construction project, and "went far toward breaking down a residual feeling among some Association concrete men in favor of the old wet mixes." The new generator had a contract price of $44,400; the Leffel water wheel had a contract price of $42,400, including governor system; the desilting basin dam was designed by consulting engineer Raymond A. Hill, with a contract price of $36,000. Other less-expensive designs for the dam were rejected because they were less well suited to the capability of the Association’s workforce, in Hill's opinion.

In 1950 the Salt River Power District (as the electrical department of the Project was then known), began a concerted effort to convert all its facilities to 60-cycle power (except service to the mines). Also that year the District began construction of the Kyrene steam generating plant, a modern, outdoor-type facility which vastly increased the generating capacity of the Project. The three remaining 25-cycle units at Crosscut continued to be used through the mid-1950s, then were decommissioned and removed. The 60-cycle unit continued to be used as a small peak-load unit during the summer. The hydro plant building was used for storage and part of it was converted into a hydrology laboratory. After several years of disuse, the 60-cycle unit was renovated in 1976 and is still in use. As always, the generation is dependent on surface water irrigation flow of the Grand Canal. The unit is run continuously from May to September at extremely low cost and generates up to 3,000 kW of power.

Grand Canal

Source: *Grand Canal and Crosscut Hydro Plant, North Side of Salt River, Tempe and Phoenix, Maricopa County, Arizona*. HAER No. AZ-17 and AZ-30. Fred Anderson and Carol Noland, 1990

The Grand Canal, which helped unify the north-side irrigation system, is the oldest north-side canal still operating in the irrigation system. In 1878, a corporation called the Grand Canal Company began digging a canal on the north side of the river. The Grand Canal Company was the first corporation in Arizona Territory organized specifically for the construction and operation of an irrigating system in the Salt River Valley. As stated in the company's articles of incorporation, the object of the company was to "carry on and conduct the business of supplying a portion of Salt River Valley…with water for agricultural, milling, manufacturing and mechanical purposes, and to this end to purchase, construct, build or dig such canals, dams or flumes as may be necessary." Under this organization, water rights did not come from shares of stock, but were represented by a deed from the company to the water user. The company charged the water users an annual fee for water service.

The Grand Canal's head was about 2.5 miles east of the head of Jack Swilling's ditch, which had been dug 11 years earlier. The Grand Canal Company built the Grand Canal to supply water to approximately 17,000 acres of new land north of Phoenix. By 1878, claims to the Salt River exceeded 5.5 times its average yearly flow, and people did not respond favorably to the Grand Canal Company's claim to divert 10,000 miner's inches of water. Many feared that there would be no water left in the river after the Grand Canal took its claim. Reacting to this threat to the water supply, a mob tore out the dam of the Grand Canal just after its construction. The company rebuilt the dam, and the Grand Canal today is the oldest canal still in use north of the Salt River.

In an attempt to remedy the water problem north of the river, the stockholders of the Grand Canal Company appointed a committee on August 30, 1879, to meet with the directors and owners of the other canals on the north side about the possibility of supplying all of the canals through a single head. The Farmers' Canal Company, Griffen Ditch Company, and Monterey Ditch Company responded to the proposal with a lawsuit, each asserting a priority to the water ahead of the Grand Canal. The plaintiffs also named the Mesa Canal Company as a co-defendant. The court agreed with the priority claim but it refused to issue an order to stop the defendants from taking water. The court based its decision on the grounds that the water the defendants took out of the river would not make any difference in the amount available to the plaintiffs.

In February 1881, Territorial Assemblyman Peter J. Bolan made the first attempt at a legislative solution to the water question. Bolan introduced a bill to establish each canal's priority to water and the amount each could take from the river. The measure appeared to have support in Phoenix, but Tempe Canal users opposed it, and the Legislative Assembly overwhelmingly defeated it.

In 1883 the Arizona Canal Company constructed a canal with a dam above all other canals in the Valley, and claimed a right to divert a quantity of water greater than the normal flow of the river. The other canal operators naturally considered this new organization a threat and on February 7, 1887, they filed suit against the Arizona Canal Company to enjoin it from diverting the water claimed by the plaintiffs. After the plaintiffs filed the suit, the Arizona Improvement Company, which had acquired the Arizona Canal, secured a controlling interest in the Grand Canal Company, the Maricopa Canal Company, and the Salt River Valley Canal Company, effectively controlling the north side of the river, and withdrew them from

the suit as plaintiffs. Later, all of the canal companies on the south side of the river except the Tempe Irrigating Canal Company and Michael Wormser, the operator of the San Francisco Canal, withdrew from the suit.

By the time the trial began in March 1890, the Tempe Canal Company and Michael Wormser had named all of the other canal companies in the valley as defendants. The case is therefore known as *M. Wormser et al. v. Salt River Valley Canal Company*. Judge Joseph Kibbey in the Third Judicial District Court, Maricopa County, heard the case. Judge Kibbey rendered his decision in April 1892, and made the accompanying decree in October 1892.

Kibbey's landmark decision divided water from the Salt River among the various canals, and set the judicial precedent that water was appurtenant to the land. Despite the importance of the legal principles established, the Kibbey Decision had only one immediate effect on water distribution in the Valley, which was to assure the water supply of the Tempe and the San Francisco canals against all the other canals. Since the defendant companies had joined in a contract to share and divide all the water not required by the Tempe and San Francisco, even before Kibbey made his decree, the only function of the court appointed water commissioner was to designate the supply for those two canals.

In 1889 the Arizona Improvement Company, which had a controlling interest in the Grand Canal Company, created the Crosscut Canal and Power Company to construct a canal connecting the Arizona Canal with the Grand Canal and the Joint Head Canal, that would serve the Maricopa and the Salt River Valley canals. The Crosscut would supply all of the north-side canals with water from the Arizona, thereby creating a unified northside system. Because the Arizona carried water to the Grand Canal through the Crosscut, the original head of the Grand was abandoned. In 1898 the Arizona Water Company, headquartered in New York City, secured the majority interest in the Arizona Improvement Company and solely controlled the distribution of water to all the lands on the north side of the Salt River.

With the passage of the Reclamation Act on June 17, 1902, the farmers of the Salt River Valley formed a Water Storage Committee to submit a plan to USRS for building a reservoir on the Salt River at a site in the Tonto Basin, later known as Roosevelt Dam. A prolonged drought during the 1890s had shown the farmers that dependence on the natural flow of the Salt River was risky, and that the best solution was a storage dam on the upper Salt. Under the Act, the USRS could build and finance selected irrigation projects and the committee was hopeful that the Tonto site would be among the first projects constructed under the Act.

On August 9, 1902, George Maxwell, executive director of the National Irrigation Association, addressed a meeting of the farmers of the Valley. He emphasized the importance of the farmers owning the canal system that the reservoir would supply. He told them that the government would not build the Tonto dam if it was being constructed for "the eventual benefit of…shareholders in a canal company instead of the owners of the land which would be irrigated by the system." He proposed that the farmers organize a single company to buy the canals so that they would have "a common distributing company as the agent of each and all land owners to receive the water from the government and distribute it. In order to buy the north-side system, the farmers would therefore have to deal with the Arizona Water Company. Maxwell had already met with Arthur Leach, president of the Arizona Water Company, and told him "that it was absolutely useless to undertake to get the government to build the reservoir and put any of the water on the lands under the Arizona Canal unless the Arizona Canal was willing to fix a valuation upon its property which the land owners under the canal would accept." While Leach made no immediate

response to Maxwell's suggestion, a few days later, William H. Cleary, general manager of the water company, reported that he did not foresee any problems in arranging for the water users to acquire the north-side canals, although he did not say how it could be done.

On October 2, 1902, the Water Storage Committee proposed a plan to form an association of all landowners, based on land ownership, thus preventing the canal companies from participating. Any landowner wanting water rights would have to join the association, which would have a central governing board to deal with the government, and to control all matters of common interest. However, the central board would not control the separate canal systems. Individual landowners would supervise the management of the canals and the distribution of water. The amount of water each landowner would receive would be determined in proportion to his acreage of land.

While this plan did not address every concern about a merger association, it was a start. The Water Storage Committee named Judge Joseph Kibbey and George Maxwell to write the articles of incorporation for the Salt River Valley Water Users' Association. The draft articles were presented to the Water Storage Committee in January 1903. Although some of the members of the older canal companies expressed concern that their investment in land improvements and their superior water rights would be diluted, the committee passed the articles on January 21, 1903.

The Association incorporated under Arizona Territorial law on February 7, 1903. Soon after incorporation the Association turned its attention to restructuring the canals into one system. At that time, however, the Arizona Water Company still controlled water distribution on the north side. Initially the cost of buying the water company's interests was too high for the Association to seriously consider purchasing them. But after a flood in 1905 destroyed a large portion of the Arizona Dam and canal, the water company, not wanting to bear the cost of repairs, was more willing to negotiate. Unable to agree upon a fair price, the Association and the Arizona Water Company agreed to let a government-appointed commission appraise the value of the water company's holdings.

Secretary Ethan A. Hitchcock approved the request for a commission and appointed George Wisner, W. H. Sanders, and A. E. Chandler on June 14, 1905. In the meantime, the Association and the water company prepared a contract providing for either the Association or the government, subject to Hitchcock's approval, to purchase the water company. The Association would levy assessments on the water users to pay the company directly or to repay the government for the purchase. Upon reviewing the contract Secretary Hitchcock decided that "the interests of the government will be best served…by the purchase of the property of the Arizona Water Company directly by the United States." After many months of negotiations, on March 7, 1906, Hitchcock approved the contract for purchase of the north-side canal system. “On June 15, 1906, the United States purchased the Grand Canal for a price of $25,731.34. This price included all headgates and lateral ditches, including the North extension of the canal, also including its banks, bed, right of way, extensions, enlargements and additions, as the same is now constructed, used and operated by the Grand Canal Company….Also the one third interest owned by the said Grand Canal Company in the canal and water way known as the Water Power Canal (Old Crosscut)." The USRS commenced the operation of the north-side canals on May 15, 1907.

At the same time these negotiations were occurring, actions were on-going related to water delivery issues affecting north-side farmers. From 1897 to 1904 a virtually continuous drought plagued the Salt River Valley. Many farmers, dependent on the river to irrigate their crops, thought that relief had finally come when, on July 21, 1904, after nine months without rain, more than 0.5 inches fell on the Valley.

Although the Arizona Canal filled with water, and water two-foot-deep plunged over the Arizona Canal Dam, many farmers north of the river could not get any water because the canals were filled with silt, sand, brush, and weeds. The farmers blamed the Arizona Water Company for the poor condition of the canals, but the Water Company did not respond to their complaints.

The farmers then took matters into their own hands. On July 30, 1904, Lincoln Fowler and Patrick Hurley formed their own canal company to dig a canal parallel to the Grand using the former head of the Grand Canal in the Salt River. Their intent was to divert flood water that came over the Arizona Dam as an additional source of water for users on the north side. The head of the Grand, located 1.5 miles north of the Tempe Buttes, had not been used since the opening of the (Old) Crosscut Canal in 1889. Fowler, Hurley, John P. Orme, Henry Wilky, and Thomas Armstrong, Jr. incorporated the Appropriators' Canal Company on August 6, 1904, with a capital stock of $50,000.

It took from August 1904 until January 1905 for workers to complete the six miles from the canal head to a point 0.25 miles east of the intersection of the Grand and Crosscut canals. They could not cross this last quarter mile to the intersection because the Arizona Water Company owned the property. Good luck fell on the Appropriators', however, when bad luck hit the Arizona Canal. After flood waters partially destroyed the Arizona Dam in April 1905, the Appropriators' became the main source of water for all the land under the Grand, Maricopa, and Salt River Valley canals. The Salt River Valley and Maricopa canals could still get some water from the Joint Head Dam, but the best opportunity for the Grand Canal was to make an arrangement with the Appropriators'.

In late April, Lloyd B. Christy of the Grand Canal Company approached the Appropriators' with a plan to connect the two canals. Christy wanted the Appropriators' to repair and lease the Grand Canal from its headgate to the intersection with the Crosscut Canal, while the Grand would pay for water delivered at the Crosscut until it could get water from the Arizona again. The Appropriators' returned with two plans of its own. The first called for the Appropriators' to finish the canal at its own expense provided the Grand would obtain the Arizona Water Company's permission to cross the last 0.25 miles. The second plan called for the Grand Canal Company to finish the work at the Appropriators' expense. In return, the Grand Canal Company would agree to obtain water from the Appropriators' until the Grand could get water from another source. When the Grand Canal Company and the Appropriators' Canal Company could not reach an agreement, the Appropriators' stockholders, feeling they had no other choice, decided to link the canals anyway. The farmers on the north side needed water while the Arizona Water Company repaired the dam. This decision meant that the Appropriators' would have to dig a canal parallel to the Grand since the Grand Canal Company was not cooperating in the effort.

On May 1, 1905, a party of men began extending the head of the canal 0.5 miles east into the river bed. They made the drop from the river bottom to the canal high enough that building a dam would not be necessary. A second party of men worked to connect the Appropriators' Canal to the Grand Canal. They accomplished this by digging under the Crosscut and constructing a flume, 20 feet wide and three feet deep, to carry the Crosscut. The Appropriators' Canal then continued a short distance westward where it joined the Grand Canal. On May 30, workers turned water into the Grand Canal and began work on the parallel canal which was to cross the property that belonged to the Arizona Water Company. On June 9, the Arizona Water Company obtained an injunction ordering the Appropriators' to cease the delivery of water through the Grand Canal and the construction across the Company's property. The Appropriators' continued to deliver the water, arguing that the farmers had an extraordinary need for it. They also brought their own suit to condemn the Arizona Water Company's land for use as a canal. On June 14,

Judge Edward Kent dissolved the injunction, and ruled that the Appropriators' could construct the canal but had to pay the water company for the right-of-way.

To continue the canal the workers needed to go through an 80-acre parcel of land reserved as part of the Phoenix Indian School, about 3.5 miles from Phoenix. On July 12, 1905, Lincoln Fowler wrote to C. M. Goodman, Superintendent of the Indian School, requesting that the Appropriators' be given a right-of-way across the southeast quarter of Section 21, Township 2 North, Range 3 East to construct its canal line. For this right-of-way Fowler proposed "to give the capital stock of the Appropriators' Canal Company, at par value, $1.00 per share, in exchange for land occupied at $40 per acre. We will also ask that your institution take stock for the remainder of your land which lies below our line of service, and approximates 170 acres." Superintendent Goodman then wrote to the Commissioner of Indian Affairs recommending the request be granted. Goodman pointed out that after the Arizona Dam broke, the Appropriators' built part of the canal "by which means the settlers under the Grand Canal (including the Indian School) were enabled to obtain water some weeks in advance of the repairing of the Arizona dam. The Indian School assisted in this work…and has doubtless already been benefitted to the amount of the capital stock subscription desired." On August 26 the government granted the right-of-way and became a shareholder in the company.

Despite the Appropriators' success in supplying water to the north-side farmers, the company ran into financial problems. A flood in November 1905 submerged the canal head and three miles of the canal. Further west the river broke through the southern bank of the canal, requiring the construction of a berm to restore the canal's channel. Additional floods in March 1906 and January 1907 brought even more damage. The high cost of repairs increased the company's debt and led to talk of selling it to the government. On March 23, 1907, shareholders elected John Orme, Dwight Heard, and Patrick Hurley to a committee to sell the canal to the federal government as soon as possible at a price to be determined by government engineers. The committee met with Louis C. Hill of the USRS, but the negotiation process was slow. Although the committee wanted the government to set the price for the canal, they wanted to receive at least enough money to cover their mortgage of $30,000. The government, however, did not consider the canal worth that much to the overall water distribution system, since it already owned the Grand Canal. The fact that the canal company could not show clear title to their right-of-way also concerned the government.

On June 30, 1908, the Appropriators' and the USRS reached an agreement whereby USRS would supervise and direct the distribution of water while the Appropriators' paid all expenses. The Appropriators' continued to reduce its debt and before the end of 1908 had settled with all its creditors. On January 19, 1909, the Appropriators' transferred title to the canal to the government and filed a quit claim deed with the Maricopa County Recorder. According to the quit claim deed the government paid one dollar for the property, although it is not known if the government made any other monetary compensation. The government used portions of the Appropriators' Canal in the enlargement of the Grand Canal, but abandoned the majority of it.

The USRS began work on the reconstruction and enlargement of the Grand Canal in November, 1907, at Park Road (16th Street in Phoenix), and ended at the New River, a distance of 15 miles, in June 1909. According to a report from the constructing engineer to the project engineer dated May 27, 1912, "during this time, nine drops, two checks, fourteen siphons, eighteen turnouts, three concrete arch bridges, fourteen truss bridges, two stringer bridges, eighty-two lateral structures, and about thirty-two and a half miles of laterals were built." Despite the extensiveness of the work, workers interrupted water service as

little as possible, which made the effort more expensive than if it were dry excavation.

During the two years of enlargement there were several mishaps. At the site of a newly constructed lateral, farmers caused problems when they flooded the excavation. The top of a siphon 0.5 miles west of Alhambra failed, and once workers repaired it, floods washed out the canal bank around the intake of the siphon three times. The constructing engineer blamed the washouts on "farmers who objected to having water delivered to their lands from the Arizona Canal." Due to floods from Cave Creek, engineers had to set the structure at the head of the Salt Lateral three times. Waste water from the Alkire Ranch caused additional problems at this site. At a place known then as Green's Corner, light soil caused difficulty with the paved walls at the end of the turnout. In the Arizona Lateral running north from the Salt Lateral, one structure had to be lowered one foot after its completion, and the forms of two others reset, having been originally set too high.

Between the months of February and September 1911, workers constructed Lateral 16 of the Grand Canal, located at 43rd Avenue, to serve approximately 9,000 acres of land. This work comprised seven miles of main lateral, 17 miles of sub-laterals, three pipe siphons, 35 wooden bridges, and 10 concrete road crossings, containing 528 cubic yards of concrete. The soil material they excavated through was mostly all compact earth. The equipment used included two and four-horse Fresno scrapers and slip scrapers. During the construction project, workers used 3,526 sacks of cement, 79,970 feet of lumber and 18,781 pounds of iron. Builders completed most of the work by July 1 but heavy rains and extremely hot weather caused delays and damage which prevented the completion of the project until the end of August. Total costs amounted to $46,149.97, $11,117.82 over the original estimate.

In 1910 the Association reached an agreement with Interior to extend and enlarge the Grand Canal two miles east as part of the Association's plan to increase hydropower production. Under the contract of August 30, 1910, the Association would finance the construction of a hydro generating plant at the fall between the new Crosscut Canal and the Grand extension through a special assessment levied on its members. On November 28, 1911, the Association asked for bids for the enlargement of the Grand Canal from the old Arizona Canal Crosscut to Park Road, a distance of five miles. The Association split the work into three divisions: Division 1 covered 50,000 cubic yards; Division 2 comprised 35,000 cubic yards; and Division 3 covered 40,000 cubic yards. The Association accepted two bids, each for one division only. The Grant Brothers Construction Company of Los Angeles bid only on Division 1 for $0.18 per cubic yard. J.C. Norton of Phoenix bid on all three divisions but only his bid on Division 2, at a cost of $0.26 per cubic yard, met with approval. The parties accepted each contract with the understanding that, if there was time, they would work Division 2, connecting the old Grand and Appropriators' canals.

Grant Brothers began work on December 15, 1911, and completed their section, including all lateral connections and header laterals necessary for water distribution, on February 1, 1912. J. C. Norton began work on January 1 and completed his division and the connection with the Grand and Appropriators' canals and about 1,800 feet of canal on Division 2 by February 1, 1912. Throughout the enlargement the contractors built all laterals and fences, with the exception of a private lateral built by a Mr. Osborne. Because this lateral was to go through Mr. Osborne's yard where there were trees he wanted to protect, USRS wanted to be relieved of any liability in going onto and damaging this property. The Association offered Mr. Osborne $85, the average cost of building a lateral, to do the work himself, which he did to his own satisfaction.

On June 30, 1911, the Association called for bids for the extension of the Grand Canal from the old Arizona Crosscut to the New Crosscut site a short distance west of the Tempe Railroad Bridge over the Salt River. This contract was for the excavation of 150,000 cubic yards of earth, loose rock, and solid rock. The Grant Brothers Construction Company were low bidders for the excavation work, with prices of $0.15 per cubic yard for Class 1 material (earth), $0.45 per cubic yard for Class 2 (loose rock), and $1.10 per cubic yard for Class 3 (solid rock). The contractors estimated the quantities of material to be 102,198 cubic yards of Class 1, 5,125 cubic yards of Class 2, and 40,277 cubic yards of Class 3. Grant Brothers began work on October 1, 1911, and worked continuously until January 1, 1912. They then put their work force on Division 1 of the Grand Canal enlargement until that contract was finished on February 1, and then returned to the extension. They had removed all but about 200 cubic yards of material when heavy rains made it necessary for them to leave the work until the concrete contractor finished the siphon.

The Association granted the concrete contract for the extension to Shumway & Bowen of Mesa, Arizona. The contract included a reinforced concrete girder wagon bridge across the Grand Canal at the Tempe Road crossing, wastegate structures into the Salt River, two siphons under the Phoenix and Eastern and Maricopa Railroad tracks and two small lateral siphons under the Grand Canal. In April 1912 the contractors began excavation for Siphon No. 1, which involved cutting through the existing railroad bed to a depth of 27.5 feet, and a width of 24 feet. Per a contract between the Arizona Eastern Railroad Company and the Association, the railroad company provided a foreman to take care of the track and build necessary trestles and bulkheads to protect and insure the safe passage of trains. Arizona Eastern also had final approval of all operations that crossed their tracks. Workers completed the siphon on June 15, 1912, ending all work on the canal enlargement and extension.

During January 19–27, 1916 a severe flood on the Salt River caused by floods on the Verde and an overflow at the Roosevelt Reservoir, did considerable damage to the Grand Canal. The flood washed out a portion of the canal extension from the Crosscut Hydro Plant to the Joint Head Dam, a distance of about one mile, which had to be entirely reconstructed. Flood waters broke into the old, unused portion of the canal, at one point, spilling over and eroding a cross bank, which had separated the upper section of the old canal from the new canal. When the water receded, government builders relocated the canal farther north of the river and gave it a straighter alignment. Also, workers constructed a dike across the dam to raise it six feet. Contractors used loam mixed with sand and gravel, considered the best material, to build the dike and built it on a sand and gravel foundation. To further protect the dike they anchored woven wire fences piled with brush to the embankment. Workers also planted willow trees on the river side, which, while not providing any immediate protection, would be useful after a year or two of growth.

This construction project, completed in May 1916, required from 200 to 250 head of stock and an average of 200 men earning $2.25 per day. These workers moved 23,770 cubic yards of solid rock and 91,800 cubic yards of earth, and used 9,250 pounds of dynamite and 3,200 pounds of black powder for rock excavating. The total expense was $58,936.62.

In the fall of 1935, Reclamation assigned two CCC camps, with about 200 men each, to assist the Association. One of the largest CCC projects was the construction of a forebay (regulating storage basin) on the Grand Canal at Lateral 23. Lateral 23 was a low delivery point on the canal and received waste water from areas west of Phoenix, north of the canal. Due to this influx of waste water and also to unavoidable operation losses and gains, the flow of water was subject to fluctuations at this point. These fluctuations made it impossible to accurately forecast the quantity of water available at the head of the lateral. To correct this problem, workers enlarged a section of the canal extending west 0.5 miles from

Lateral 23. The enlargement was on the north side and required the purchase of a new right-of-way. The forebay held a capacity of approximately 21 acre feet and was successful in regulating the fluctuations without wasting water. CCC workers also deepened and widened Lateral 23 at the head so that they could install a float-controlled eight-foot radial gate, capable of regulating the water level to within 0.5 inches. Work began on this job on July 15, 1936, and ended February 1, 1937.

Another works project involving CCC workers was the elimination of Maricopa Canal in 1937. The Maricopa, built in 1872, had a very low velocity due to its flat slope which led to a build-up of silt deposits and made it very expensive to maintain. Because the Grand Canal paralleled the Maricopa less than a mile to the north, the Association and Reclamation decided the Maricopa was unnecessary. CCC crews also had the task of enlarging some of the outlets on the Grand and increasing the capacity of the Grand laterals running south to connect with the laterals of the Maricopa. Workers began the project on March 11, 1937, completing it on July 20.

Due to the Great Depression and the outbreak of World War II, many Reclamation projects in the West suffered from neglect. The lack of finances and manpower meant that regular maintenance on Project structures was not possible. The deteriorated condition of many Project facilities led to a substantial decrease in the efficiency of water distribution. By the end of the 1940s, the federal government recognized the poor state of the early Reclamation projects and undertook to repair them. In 1949 Congress passed legislation authorizing Reclamation to fund R&B work on older Reclamation projects, including the Salt River Project. R&B work on the Grand Canal consisted mainly of lining areas where erosion and scouring had occurred, particularly below canal structures. Workers generally lined canals with concrete or sprayed gunite. Before the gunite could be applied, workers reshaped and formed the canal by excavating accumulated sand and debris from the bottom of the canal and placing compacted gravel along the sides for reinforcement. To add structural reinforcement, they placed steel mesh along the sides and bottom.

The first major lining job of the R&B Program on the Grand Canal was from Lateral 18 to Lateral 20. In 1951 workers lined approximately 2.5 miles (611,970 square feet) of the canal with 1.25- inch-thick gunite on the sides and bottom. The approximate total cost for this portion of the lining was $170,000, which included reshaping ditches and removing trees. In some portions of the canal, horses were used due to the swamp-like conditions which prevented the use of heavy equipment in the bottom. During 1959 workers placed approximately 1,350 square feet of gunite and 3,900 square feet of unreinforced concrete lining in the Grand Canal. This increased the amount lined in the Grand Canal to 633,233 square feet, almost three square miles. By 1969 workers had lined 715,876 square feet of the canal.

Another priority of the R&B program was the replacement of obsolete gates and structures. At the end of the program workers had replaced several thousand wooden lateral gates with metal gates, termed standard steel screw stem gates. These gates were fabricated on a mass-production basis, sand-blasted and sprayed with a protective zinc coating in SRP's machine shop. The most significant feature of these gates was the water-tight rubber seal which became a very popular design both in the United States and abroad. Workers replaced five of the redwood turnout gates on the Grand Canal with new metal gates and constructed two radial gate structures at Laterals 21 and 22.

Southside Conveyances

The South, Consolidated, Eastern, Tempe, Western, and Highline Canals

South Canal

Source: *South Canal, South Side of the Salt River, Mesa Vicinity, Maricopa County, Arizona*. HAER No. AZ-52. Shelly Dudley, 1998.

The USRS constructed the South Canal to carry water to the farmers on the south side of the Salt River as part of the Salt River Federal Reclamation Project. Built between 1907 and 1909, the original canal measured only two miles and diverted water from the newly erected Granite Reef Diversion Dam. The South Canal eventually became the only irrigation structure to divert water directly from the Salt River and deliver it to the south side shareholders of the Salt River Valley Water Users' Association. Controversy surrounded membership in the Association for many of the landowners south of the Salt River. A majority of the farmers held early water rights and did not see any advantages to joining the Salt River Project (or Project) when the Project first opened. The canals that supplied water to these people had their own headings or diversion points in the Salt River.

The original South Canal was enlarged and extended to accommodate all the water users on the south side of the Salt River, encompassing portions of the Eastern and Consolidated canals. Because Association founders saw the potential of hydropower, they contracted with the federal government in 1910 to build three power plants on Project canals. Eventually three hydropower plants would be built on the South Canal. They provided needed power to an expanding Salt River Valley for commercial and domestic use.

Although the USRS did not begin to construct the South Canal until 1907, its original purpose dates back to the last quarter of the nineteenth century when other irrigation canals were built by farmers located south of the Salt River. Austin Carrington first filed a notice to appropriate 50,000 miner’s inches of water about one mile southeast of the Arizona Dam, and then with J. Frank Meador and J. Butler, incorporated the Highland Canal Company on December 13, 1887. The company planned to irrigate land east of the Mesa Canal after the Highland Canal was finished in November 1887 and the South Canal later followed the same general path as the upper part of the Highland Canal. The Mesa Canal Company constructed their canal in 1879 for the local landowners and the City of Mesa. The Mesa Canal's heading had a capacity of 175 cfs and was in the Salt River approximately 2.5 miles above the head of the Utah Canal, one of the earlier canals constructed by southside farmers. Dr. A. J. Chandler approached the Mesa Canal Company with a proposition to enlarge the Mesa Canal in 1889 so that he could use it to carry additional water for his proposed canal. After a year of negotiations, Chandler signed an agreement with the shareholders of the Mesa Canal Company and assumed control over a portion of the canal in 1891. Chandler, with Dexter Ferry and Charles C. Bowen, two of Dr. Chandler's former employers, formed the Consolidated Canal Company in March 1892 to bring water to uncultivated farm lands on the south side of the Valley.

By the turn of the century, the farmers on the south side of the Salt River were irrigating approximately 56,000 acres from a number of canals. Farmers, however, could not expand their irrigated lands without federal help because of the uncontrolled flows along the Salt River. A prolonged drought during the

1890s had shown the farmers that dependence on the natural flow of the river was risky and that the best solution was a storage dam on the upper Salt River.

The enactment of the Reclamation Act in 1902 and the subsequent authorization of the Salt River Valley Federal Reclamation Project promised some relief to Valley farmers. As work progressed on construction of Theodore Roosevelt Dam, problems with the irrigation systems in the Valley came to the attention of federal officials. Because the flood of 1905 had destroyed the Arizona Dam and the farmers on the north side of the river could not get water, the United States purchased the property of the Arizona Water Company and the individual canals in 1906. Other landowners approached USRS engineers for assistance in either purchasing their system or constructing new canals. To distribute the water to the canals on both the north and south sides of the Salt River, the USRS designed and constructed a new diversion dam downstream from the damaged Arizona Dam.

In 1908, the government completed Granite Reef Diversion Dam which would distribute the flow of water to both sides of the Salt River. To deliver water to the south-side farmers, a new canal (the South Canal) would be necessary with its head at the diversion dam. Preliminary survey work on the South Canal by the USRS began during the construction of the Granite Reef Diversion Dam in the fall of 1906. By the middle of 1907, a portion of the canal and regulating gates were completed, but full-scale construction of the South Canal would wait until the diversion dam was finished in 1908. Work on the two-mile-long South Canal began in earnest in the late fall of 1908 and was completed in June 1909. Water was initially released into the canal on March 20, 1909, to test the gates. The original canal was approximately 11,000 feet in length, with a bottom width of 47 feet and side slopes of 1:1 grade. The depth of the water was seven feet with a free board of two feet. The engineers designed the irrigation structure with a hydraulic gradient of 0.0002 and a capacity of 1,600 cfs. Expenditures for excavating and moving approximately 187,000 cubic yards of earth, gravel, and boulders totaled $112,223.51. Construction costs for building the South Canal, amounting to over $157,000, were high, considering the delivery structure was only two miles long.

Among the significant features on this initial stretch of the canal was a sluice gate, located 1,600 feet below the headgates of Granite Reef Diversion Dam, which served as a combination waste gate, check gate, and bridge. The edifice was made from reinforced concrete with the three five by seven-foot cast-iron waste gates operated by a gasoline engine. The six massive timbered check gates were each 9.5 by nine feet and swung on hinges at the upper edges. When dropped, they were held in place in an inclined position by gravity and the pressure of the water on the upstream side. Zanjeros, ditch riders who tended the canals, raised the gates by means of copper cables and a windlass operated by hand. The bridge was composed of three semi-elliptical arch spans, measuring 17.5 feet at one span and the other two at 17 feet. During the construction of the sluice gates, the USRS excavated 4,780 cubic yards of material and used over 680 cubic yards of concrete. The USRS spent $18,317.66 for the sluice gates, including materials and labor.

The other important components on the South Canal were the culverts or siphons, a headgate to the Eastern Canal, and the structure at the end. Three culverts or siphons, needed to convey surface drainage under the South Canal, were composed of double barreled structures with the dimensions of the separate conduits being four by five feet and four by six feet. Crews used a total of 735 cubic yards of concrete to build the structures. The original Eastern Canal turnout consisted of four screw stemmed lift gates of cast iron faced with bronze, each having a three-and-a-half-foot wide by five-foot high opening, which was operated by hand. The work force used over 113 cubic feet of reinforced concrete. They

constructed a wooden bridge over the top of the turnout structure. At the end of the canal, the engineers designed a combination spillway and drop, to carry the waste water above the normal depth of seven feet. A wooden bridge was built over this structure. Permanent taintor gates were not installed until 1913, with wooden flash boards used initially. This site, utilizing the drop of about 25 feet for 1,000 second-feet of water, would later be used for the construction of a hydropower plant.

Construction techniques for building irrigation ditches had not progressed much since the last quarter of the nineteenth century. Men and horses still did most of the actual excavation. Teamsters cajoled teams of horses or mules dragging plows to dig into the hard desert soil. Animal-drawn steel scrapers finished the work with men filling the wheelbarrows with the loosened dirt and urging the teams leaden with earth up the banks of the canal. By October 1908, 125 head of stock and almost 250 men were employed to do this work. They experienced considerable difficulty because of the soils, which required the removal of large boulders.

Shortly after the USRS finished the South Canal, they completed the construction of the Eastern Canal. The United States also purchased the Main Consolidated and the East Branch Consolidated canals for $187,000 from A. J. Chandler, president of the Consolidated Canal Company. In anticipation of their purchase for the Salt River Project, USRS engineers had started operating the Mesa Canal system and the Eureka Canal, a part of the Utah Canal system. The South Canal diverted water from the Salt River to the lands under the Tempe Canal after its landowners decided not to join the Association. A similar contract agreement was made with the farmers who received their water from the Utah Irrigating Ditch Company.

In the spring of 1910, the Association's Council and the Board of Governors adopted resolutions presenting their proposal to complete the project by constructing a new Crosscut Canal, enlarging the Grand Canal, and installing three power plants on the canals in the Salt River Valley. The Association proposed to accomplish these plans at its own cost with designs and specifications prepared by USRS engineers. The power plants were to be located on the new Crosscut Canal, at the Arizona Falls on the Arizona Canal, and on the South Canal. On August 30, 1910, the Association signed a contract with the federal government for the construction of these hydropower plants on the canals.

The agreement included a hydroelectric power plant designed to generate 3,000 hp on the South Canal. The plant was located at the junction of the Consolidated Canal and the South Canal, some 50 feet from the old intake of the Consolidated Canal. The head from the water surface in the South Canal to the water surface in the Consolidated Canal varied from 26 to 29 feet, and the entire irrigation flow of the canals, amounting to a maximum of 1,200 cfs, was available for power production. Within a year after approval of the contract, the USRS completed its field surveys and was preparing the plans and specifications for the work, while no actual construction had started. The S. Morgan Smith Company received the contract for two 1,500 hp hydraulic turbines at the cost of $16,590, and the General Electric Company was awarded the contract for the two alternating current generators for $30,600. The contract for the physical plant itself was given to Olsen and Graf on October 17, 1911.

The designs for the South Canal power plant facility called for a single-room structure, 102 by 44 feet, which housed the generators, transformers, governors, and switching equipment. Olsen and Graf starting excavating the site in November 1911, and by February 1912 they were fabricating forms for the cement and erecting the reinforcing steel for the building. The building's two-foot thick walls constructed of reinforced concrete reached a maximum height of 68 feet, had a rhyolite plaster interior finish and a

brushed-cement wash exterior finish. A double layer of No. 28-gage galvanized iron supported by wooden purlins and steel trusses formed the gabled roof over the generator room. Circular galvanized iron ventilators were positioned on the apex of the roof and 15 windows aerated the generator room. Large tungsten lamps, mounted between the roof trusses, and small incandescent lights located throughout the plant, illuminated the building, augmented by light admitted through the windows. Because it extended over the Consolidated Canal, a combination of piers and foundation walls supported the building.

The generating equipment consisted of two horizontal generators, direct-connected to twin horizontal, open-flume, hydraulic turbines, mounted in reinforced concrete pits outside of the building proper. These two pits, directly in line with the South Canal, butted against the intake end of the building. A draft chest, mounted over the nine-foot draft tube opening in each pit, encased each twin turbine runner. The two turbine shafts, each powered by a runner, entered the building through the intake wall and direct-connected to the two generators. Two sets of twin buckle plate gates regulated the volume of water that entered the turbine pits from the South Canal, and two electric motors, using a combination of gears and pinions, and worms and wheels, raised and lowered the gates. A trash grill of 0.38 by 2.5-inch steel bars with one inch spacing protected the open pits from trash, while equipment behind the grill, composed of conical valves opening downward, removed sand and discharged the water into a sluicing tunnel.

In May 1912, crews employed by the Association began installing the two generators, with a rated capacity of 1,000 kV, 3-phase, 25 cycle, 2,300 volts, with a total weight of 62,100 pounds. The seven oil-insulated, water-cooled, 333 kV transformers were connected in two banks of three each, with one spare transformer. Clear water for cooling the transformers and lubricating the submerged bearings was obtained by filtering canal water through sand in a specially constructed filter. The filtered water was pumped to an elevated concrete tank where it flowed to the transformers and then to the bearings. Initially, the Association planned to obtain the water from a well under the powerhouse, but no water-bearing stratum was encountered. Eventually a sufficient clear water supply was found in a well drilled about 600 feet northeast of the plant.

The station was designed to have only one person on shift, with the hand-operated switchboard located in the center. The operating force consisted of a Chief Operator in charge of the plant and three power plant operators to stand regular shifts. No difficulties were encountered with having only one person employed on each shift, however additional men were needed to clear the accumulation of trash on the grill at times. At least two cottages were required for the operators and were built under contract at a cost not to exceed $4,000. One of the houses had two extra bedrooms to accommodate the single men expected to be employed.

Work on the construction of the power house was completed by July 1912 and the plant placed in operation on October 23. The 40,000 volt power transmission line connected the facility to the Mesa Switching Station. USRS Engineer Harris suggested the same USRS force account crew that put up the electric line to Granite Reef Dam be employed because no other outfit in the Salt River Valley could install the transmission line as cheaply as the government crew. In the early months of 1912, USRS force account crews constructed the eight mile single circuit transmission line on tripartite steel poles set in concrete. Crews positioned the poles 440 feet apart, varying in height from 41 to 51 feet, and also carrying a telephone line. Over the next year, the Association constructed a 2.42 mile long 2,200 volt transmission line from the power plant north to Granite Reef Diversion Dam, and the $2,800 wooden pole structures carried a telephone line to the GRDD.

In 1914, the USRS undertook additional work to improve the South Canal at the power plant. The South Canal sluice gates located at the power plant consisted of a sand and gravel trap which reached across the canal and a concrete turnout equipped with Taintor gates. The sluice gates were to catch all the sand, gravel, and silt that came down the canal and then flush the deposits into the Salt River. The structure was built in the forebay of the powerhouse just above the trash racks. The turnout discharged into a chute of grouted paving which carried the water down the side of the hill and into an opening which ran into the Salt River. The sluice gates also acted as a safety feature on the South Canal in case there was a break in the canal below the powerhouse.

A wooden truss bridge was built across the wasteway since it crossed the main road to Granite Reef Dam. The sluiceway channel below the gate opening had a bottom width of 12 feet with one by one-foot side slopes and a capacity of 1,500 cfs. The first 19 feet of the channel was built with a 2.7 percent grade and then changed to a 25 percent grade as it continued to a pool and drop structure. The channel widened out to 60 feet below the pool and was lined with cobblestone paving for 50 feet downstream. Reclamation engineers also worked on the concrete flume by-pass at the power plant in 1914 at an estimated cost of $4,900. The by-pass was necessary to carry the water around the hydropower plant and deliver it at the head of the Consolidated Canal when it was not needed for power purposes. The concrete flume could carry the full capacity of the Consolidated Canal, approximately 1,200 second feet, replacing the smaller original wooden structure which had deteriorated into a dangerous condition.

R. A. Munger was placed in charge of the construction which began on May 31 and he finished the work by July 29, 1914. The dimensions of the flume were 57 feet long, having a bottom width of 30 feet at its upper end and 16 feet at the lower. Above the structure, the eight-foot-high by-pass canal was lined for 25 feet with eight inch cobble stones grouted into place. Engineers were able to use the original downstream concrete pier support. The bond between the old pier and the new concrete pier was accomplished by drilling 29 inch holes in the pier and placing 0.5-inch dowel pins in them. Sand for the concrete was hauled from the Salt River while other supplies were transported from the government warehouse in Mesa, eleven miles distant.

Despite these improvements problems plagued the South Consolidated Power Plant. When operating at full load, bad eddies above the turbines necessitated putting a raft in the turbine pit to prevent the turbines from sucking air. Slow velocity in the head of the South Canal at Granite Reef Diversion Dam caused the deposit of a large amount of silt, making it impossible to get sufficient water to the plant for it to carry a full load. The power house was only able to produce a maximum load of 1,400 kW within its first two years of operation. Following a 1916 flood event, the Association considered moving the power plant downstream from its current location, but the cost was prohibitive. Deterioration of the power equipment wheels on the back side of the vanes due to the oxidizing effect of a partial vacuum caused by water discharge would eventually require new runners, since the action could not be prevented. Flooding again created problems for the plant, after a February 1920 flood required reconstruction of the Consolidated Canal. The necessity to raise the canal grade during construction created a back-up of water in the canal below the plant, causing a loss of head and reduction in power output.

After the 1920 flood, the Association staff prepared plans for a new South Consolidated Power Plant as part of an enlargement of the Eastern and Consolidated canals. Because additional land would be needed to operate and maintain the new hydropower plant, the Association requested USRS Commissioner D. W. Davis withdraw the northwest quarter of Lot 2, Section 6, Township 1 North, Range 6 East, under the first form for use by the Project. Davis passed on the request to the Secretary of the

Interior with his recommendation and on July 17, 1923, First Assistant Secretary E. C. Finney approved the withdrawal. Initial work began on March 29, 1923, that involved constructing a camp, installing light and power, building a coffer dam in the Eastern Canal to protect the power house excavation site, and setting up machinery. A temporary substation was installed on the 40,000 volt line near the location of the new plant to supply power for the construction. One electrician and helper were kept on the job during the building of the new plant to take care of motors and wiring and to install the conduits in the concrete work. On April 2, actual work on the excavation began with the Monighan two yard dragline, which was used until June 18, 1923, when it was moved to the Mormon Flat dam site.

A Lidgerwood 1.5 yard dragline excavator was brought to the site to aid in the removal of the Monighan equipment and to continue the digging. The excavator was a dry land machine that ran along the bank of the canal. It also assisted in building the road and removing the coffer dam. The machines handled 7,000 cubic yards of material from March to September 1923, when the work was finished. Association work parties poured the first concrete at the powerhouse on May 1, 1923. A daily average of 48.5 man-days of effort was employed on this work, in addition to the eight head of stock hauling gravel from March to September. The machinery from the original plant, including new water wheels, was moved to its new location and the new South Consolidated Power Plant was in service on January *5,* 1924. The capacity of the plant was increased more than 50 percent under the improved hydraulic conditions and increased head, developing approximately 1,600 hp under a 34-foot head at 83.4 percent efficiency. The Association estimated that the additional power income from the relocated plant was at least $30,000 yearly, which was more than 12 percent of the total cost of widening the Eastern Canal and relocating the power plant. While it cost the Association $125,438 to move the plant, that expense was considered justified to safe-guard the water supply for the south-side farmers.

A three-foot additional head was created at the power plant as an incidental benefit when the Association lined the South and Eastern Canals for the Roosevelt Water Conservation District in 1925. Provision for this was made by adding a three-foot-high wedge at the power plant forebay to the lining required at the normal water level, the additional height of lining slowly disappearing 10,000 feet upstream. While the cost amounted to approximately $3,000 for the wedge, anticipated additional revenue was expected to be $5,000 following an increase in capacity of 10 percent or 500,000 kW-hours yearly.

While the original South Canal only measured two miles in length from the Granite Reef Diversion Dam, the canal travels today all the way down to the division gates encompassing parts of the historic Consolidated and Eastern canals. See the following sections on The Consolidated Canal and The Eastern Canal for additional information.

With delivering water to its own shareholders and also providing water to the RWCD in the mid-1920s, the Association needed to increase the capacity of the diversion structure at Granite Reef Diversion Dam for the South Canal. To get the required head to divert enough water to meet the irrigation demand, it was necessary to maintain plank flashboards on the crest of the dam, but unfortunately these were destroyed with every freshet on the river. The service of water on demand instead of on an eight day rotation plan also caused higher peaks in the amount of water ordered, along with the Association's obligation for the delivery of 500 cfs for the RWCD. The total water to be diverted and carried amounted to 1,900 cfs, which required either additional head gates or collapsible steel gates. The Association management decided to install three-inch-high steel gates.

During the Great Depression, Reclamation and the Association utilized the services of the CCC to

construct headgates, line canals, and help repair damages to the irrigation structures throughout the Project, including work on the south side. On April 3, 1937, a 100-foot section of the right bank of the South Canal below the wasteway suddenly washed away when unusually high water reached a gopher or muskrat hole above the paving. This incident cut off the water supply to a major portion of the lands on the south side of the Project. Reclamation's Commissioner John C. Page telegraphed authorization for the men of the CCC already working in the Valley to repair the break as an emergency job. The CCC crews restored the canal bank and service was complete by April 6, while the contracting firm of Vinson & Pringle replaced the gunite lining. CCC work on the Project was discontinued because of trade union complaints charging the CCC members were doing the skilled work of the union laborers.

By 1947, the Association called the irrigation canal which ran from Granite Reef to the division gates the South Consolidated or "South Con" Canal. The cement-lined structure had a carrying capacity of 60,000 miner's inches of water. The division gates continued to divert water into the three canals and two laterals. The Tempe Canal, running west, carried usually 12,000 miner's inches, although it could transport 18,000, and brought water to west Mesa and Tempe landowners. The East Branch of the Consolidated was also cement lined with a normal flow of 12,000 inches and it delivered water to Chandler and Gilbert. The Mesa Canal ran south and, with the Moot and Woy laterals, served the Mesa area as well as the city itself for irrigation purposes. The South Canal continued to deliver water to the Eastern and RWCD canals.

Many Reclamation projects fell into disrepair during the Great Depression and World War II. Lack of finances and manpower meant that regular maintenance on the irrigation structures was not possible. The deteriorated condition of many projects led to a substantial decrease in the efficiency of water distribution. In 1949, Congress passed legislation authorizing Reclamation to fund R&B work to correct these issues at some of its projects, including the Salt River Project. SRP's Board of Governors approved the contract with the United States which loaned the Association approximately $1,250,000 interest-free and repayable over a 20-year period. Crews working under this program replaced lateral gates made of aged redwood with concrete and metal structures, repaired and replaced siphons, bridges, and other facilities used for the delivery of water, and lined canals and laterals which experienced weed growth and seepage problems.

SRP experimented with innovative techniques in operation and maintenance during the R&B program that proved successful. The laterals were lined using a slipform process which employed a Fullerform plow to make a trapezoid-shaped trench to predetermined specifications and then applied concrete along the sides and bottom of the lateral. Also utilized on the laterals was cast-in-place pipe which was made by a machine moving along a newly excavated lateral and pouring cement around a rubber balloon. These techniques are no longer used by SRP and the laterals off the South Canal are now piped with rubber gasket reinforced concrete pipe (RGRCP).

SRP also replaced many lateral gates with the "Sabin gate," designed by their engineers. This friction lift gate allowed field crews to raise or lower the gate easily to within a fraction of an inch. Other wooden lateral gates were replaced with standard steel screw stem gates. These were fabricated on a mass production basis, sand blasted and sprayed with a protective zinc coating in SRP's machine shop. The most significant feature of these gates was the water-tight rubber seal which became a very popular design both in the United States and abroad. In 1962, SRP installed an automatic control system at the three division gates and the forebay on the South Canal. The supervisor controlled the gates and forebay by remote telemeter from the Power District Office Building some distance away and this was one of the

first uses of this type of operation.

During the initial years of the R&B program, South Canal work consisted mainly of lining areas where erosion and scouring had occurred, particularly below canal structures. Workers generally lined canals with concrete or sprayed gunite. Before gunite could be applied, workers reshaped and formed the canal by excavating accumulated sand and debris from the bottom of the canal and placing compacted gravel along the sides for reinforcement. To provide structural reinforcement, crews placed steel mesh along the sides and bottom and an emulsion seal was placed prior to guniting. Later, SRP crews placed a chemical sealant along a 4,000-foot reach of the canal to retard seepage. Measured losses in that portion of the South Canal tested indicated a reduction of water loss by 60 percent after treatment. To help prevent seepage losses, SRP continues to repair and place new lining on the South Canal. Studies showed that, on an average, lining of canals reduces water losses by as much as 10 percent.

Crews also had to raise the lining of the South Canal to accommodate the diminished capacity because of the silt that was carried down the Salt River and delivered with the water through Granite Reef Diversion Dam. The accumulation of silt and sand further reduced the flow into the Arizona and South Canals because it was almost impossible to get full heads of irrigation water. To rectify this situation, SRP purchased a dredger in 1954 to suck up the sand, rocks, silt, and weeds behind the dam, pipe it through an 8-inch steel tube, and deposit it in the river bed on the other side of the structure. Christened the "Katy Pickrell" (named after the wife of Bill Pickrell who retired as SRP President in May 1954), the dredge was designed by SRP engineer Joe Hales for the special conditions at Granite Reef Diversion Dam.

Completed in 1967, but not placed into operation until 1968, SRP constructed the South Consolidated Canal control facility when it abandoned the second South Consolidated Power Plant. This new structure contained the largest moss screening unit in the Project as well as two radial gates. The complex also included two precast concrete bridges, a sand removal structure, and a super-critical velocity channel at the head of the Eastern Canal, discharging into an energy-dissipating basin. During the initial construction phase in 1967, SRP crews relocated 0.25 miles of the South Canal. Modifications were later made to the silt removal conveyor in 1969, providing six different speeds and more power. The system could remove up to 35 cubic yards of sand per day without difficulty. Additional changes were made in 1994 when the trashrake was completely revamped and a modern Atlas-Polar screen installed. At the same time, a new cabinet for the radial gates Motor Control Center was designed and constructed as part of the trashrake renovation project. The new cabinet, the first design update to the equipment in 25 years, was larger than the original one and made of anodized aluminum to prevent rusting. Safety features were increased so that operators did not have to reach through wires to operate the circuit breakers and selector switches. The switches were mounted on a dead front protective panel with all energized components behind the panel.

In the late 1970s, when rising fuel prices prompted utilities to reevaluate alternative forms of power generation, the Department of Energy (DOE) embarked on a program to study the feasibility of using existing dams and waterways to generate electricity where there was a difference in water level of 65 feet or less. In 1978, DOE determined that a canal generating station was once again practical. The new South Consolidated Canal station became one of seven hydroelectric projects in the nation sponsored jointly by DOE in their Small-Scale Hydroelectric Power Demonstration Program. The United States agreed to pay 15 percent of the projected $2.4 million cost to build a new plant. The 1,400 kW powerhouse, located slightly downstream from the second South Consolidated plant, contains a hydro-

turbine generator, water intake structure, and a tailrace which channels water back into the canal. Completed by May 1981, most of the structure is underground to keep the environmental impact at a minimum, but SRP crews were required to modify the canal forebay before the installation of the generating unit and the engineers designed a new check structure, intake, and spillway. The hydropower is produced when water pressure turns a turbine, which then powers a generator. The greater the height of the water, the greater the pressure on the turbine, and consequently the greater amount of power can be produced. The drop in elevation on the canal near the third South Consolidated plant site is 35 feet, which has the same potential for producing power as a 35-foot-tall dam. The station was expected to produce about 6,000,000 kW-hours of energy annually and save between 4,000 to 11,000 barrels of oil each year.

In another phase of the R&B program, SRP utilized the new water SCADA system. SCADA is a complex computer-based system which allows remote control and monitoring of the entire water canal system, a major portion of the deep-well system, and numerous sites of interest to water accounting concerns. The system remotely scans and operates over 120 sites on the canals and will control 22 off-project flow and special-delivery sites, and an ever-expanding number of water quality monitoring stations throughout the system. To reduce water losses through increased accuracy of water flow measurements, SRP engineers also designed a broad- crested weir below the head of the South Canal.

With the urbanization of the Salt River Valley, agricultural acreage farmed within the Project has decreased by over 13,000 acres in the past ten years. As part of that change, the South Canal began providing water for domestic and industrial use when the Cities of Mesa and Phoenix constructed a water treatment plant near Val Vista Road in 1975. Water is diverted to the Val Vista Water Treatment Plant and delivered to the Cities of Mesa, Phoenix, Tempe, and Scottsdale. With the shift from agricultural to urban deliveries, the Val Vista plant first received about 12,500 acre feet of water in 1976, and in 1996 it processed over 125,200 acre feet from the South Canal.

To assist the cities and farmers in the Salt River Valley in bringing additional municipal and irrigation water to the Valley, SRP entered into a joint venture to construct the CAP – Salt River Project Interconnect Facility on the south side of Granite Reef Diversion Dam, where the CAP aqueduct siphon crosses under the Salt River. To accommodate the new structure, crews lowered the north bank of the South Canal in case the CAP siphon broke and water washed into the canal, thus preventing the possibility of flooding the cities in the Valley. The interconnection permits deliveries from the CAP aqueduct into the South and Arizona canals as well as into the Granite Reef Underground Storage Project (GRUSP) facility in the Salt River bed. Water for the GRUSP, the largest underground water storage facility in Arizona, is delivered from the South Canal by way of the Hennessey gates, where it artificially recharges the aquifer and augments the groundwater resources. The facility consists of the headworks, a delivery channel, four recharge basins and five monitoring wells. The South Canal was also the test site for another recharge project when SRP began recharging water from the canal into a Mesa well near the intersection of Gilbert and McDowell roads on April 23, 1989.

As a means of keeping the canals clean of aquatic moss and weeds without chemical applications, SRP instituted a program of stocking the South Canal with white amur fish in 1991. The sterile weed-eating fish is a grass carp that originally came from China and is considered an economically and environmentally safe alternative to chemical and mechanical weed control. To accommodate this plan, fish grates were designed and installed to keep the white amur from traveling outside the main canal. New grates were constructed for the drain below Granite Reef, Hennessy Wasteway, and the intake structures at the Val

Vista Water Treatment Plant and the RWCD pumping station. Grates were later installed at minor sites along the South Canal.

Besides improving the South Canal with safety and technical features, SRP maintains the physical appearance of the canal. Crews trim trees and remove brush and other vegetation along the canal. The banks of the canal have become paths for bicyclists, joggers, and horseback riders and fishing is permitted along the banks in many areas. The South Canal is part of the Sun Circle Riding Trail and the gates along the maintenance road have openings to accommodate the horses. SRP is working with the cities to help establish guidelines for canal multiple uses. In 1989, the City of Mesa approached the project for land located near the old South Consolidated Power Plant, and now Sheepherders Park is situated on ground once occupied by the houses of the plant operators.

Although not among the first irrigation canals constructed in the Salt River Valley, through the years the South Canal gained in importance as the main, and finally the only, structure to divert water from the Salt River for the farmers on the south side. It has grown from its two mile inception to incorporate portions of the Eastern and Consolidated canals. While the canal's initial purpose was to bring irrigation water for the cultivation of Project lands, its mission now includes the delivery of domestic and industrial water to the municipal water treatment plant. Seen as a source of hydroelectric power for the Valley almost since its inception, the South Canal continues to provide falling water to its third South Consolidated Power Plant. With the growing urban population needing opening space, the South Canal is now utilized for recreational activities such as fishing, jogging, and horseback riding. Through its 90-year history, the contribution of the South Canal remains significant to the growth and development of the Salt River Valley.

Consolidated Canal

Source: *Consolidated Canal, South Side of the Salt River, Mesa/Gilbert/Chandler, Maricopa County, Arizona* (draft). HAER No. AZ-55. Catherine L. May, n.d.

The Consolidated Canal can be attributed to Dr. Alexander John Chandler, the individual who masterminded its creation. Canadian by birth, Chandler studied veterinary medicine in Montreal before moving south to the United States during the early 1880s. Chandler worked for D. M. Ferry & Co., a seed firm based in Detroit, Michigan, before the Arizona Sanitary Livestock Board hired him in 1887 as the territory's first veterinary surgeon. He settled in the Salt River Valley and became one of the region's preeminent citizens, contributing significantly to the early development of the area, particularly on the south side of the Salt River.

Dr. Chandler was committed to the development of large tracts of desert land that lay south of the Salt River and the small town of Mesa. The success or failure of his investments hinged on the availability of water, an exceedingly precious commodity. To secure adequate water for his newly acquired lands, Chandler, like the settlers that had come to the area before him, looked to the river that brought life-sustaining water. He envisioned an irrigation arrangement on the south side to mirror the elaborate canal systems supporting successful agricultural production on the north side of the Salt River. At the core of Chandler's vision was the Consolidated Canal; success was dependent on completion of the canal and thus, the flow of water to his uncultivated lands.

Well aware of the difficulties associated with water supply and fully expecting that additional water would be needed for the undeveloped south side lands, Chandler embarked on a plan that aggressively acquired large sections of south side property, developed a more extensive and effective system of canals and laterals under the Salt River, and produced power for groundwater pumping to supplement the available surface water. Backed by investment dollars from his former employers, millionaires Dexter M. Ferry and Charles C. Bowen, the project moved forward so quickly the Arizona Gazette declared that Dr. Chandler was certainly a "hustler in desert reclamation." On a less positive note, Chandler's extraordinary efforts led to a 1912 congressional subcommittee investigation into the rather devious nature of some of the methods he used to achieve his goals. While no one was punished for fraudulent activity it is clear that his land acquisition scheme was questionable.

During the early 1890s, Dr. Chandler amassed his vast land holdings under the Desert Land Act of 1877, he arranging for separate individuals to file so-called "dummy" entries for 640 acres of public land. The individuals agreed to swear on a signed affidavit that no one else had an interest in the property. In exchange for their name and signature, each acquired 40 acres of their own land at no cost. Chandler and his partners paid the required homestead entries plus any legal fees associated with the filings. They also provided the funds necessary for clearing and irrigating the land. Each entrant then mortgaged the remaining 600 acres to Chandler at $25 per acre and agreed to compensate him and his backers with their land if for some reason they defaulted on their mortgage. All of the individuals who participated in the plan failed to make their payments, and Chandler purchased numerous 40-acre tracts from those individuals. It is unclear if the entrants actually wanted the land or were helping Chandler to secure the acreage for himself.

It is evident, however, that unlike the stereotypical 'robber baron,' Dr. Chandler invested 30 years of his life and considerable monies to transform a desert into the thriving town of Chandler, Arizona and fully irrigated and productive farmland. In spite of any questionable practices, his entire project ultimately played a key role in the development of the lands south of the Salt River. There can be no doubt that Dr. Chandler profited financially from his activities, but he was also driven by a civic-minded desire to help oversee the development of the full, productive potential of the Salt River Valley.

The events that led to the completion of Chandler's Consolidated Canal began with a proposal in 1889 to enlarge the first two-mile stretch of the Mesa Canal and replace its problematic headworks. A group of intrepid settlers associated with the Church of Jesus Christ of Latter-day Saints (also known as Mormons) working under less than ideal conditions, initiated construction of this canal in 1878 and, after forming the Mesa Canal Company, completed the project one year later. Portions of the Mesa Canal actually existed prior to its nineteenth century incarnation. USGS engineer Arthur P. Davis reported that sections of its alignment followed the bed of an ancient prehistoric canal. In fact, a roughly two-mile stretch of the Mesa Canal followed a Hohokam canal cut through a rock and hardpan formation, conveying water from the river to the elevated mesa for which both the canal and nearby Mormon settlement were named. The head works of the Mesa Canal were located in the Salt River approximately 2.5 miles above the Utah Canal, another early south side canal constructed by local Mormon settlers.

Unfortunately, the Mesa Canal Company experienced many problems with the canal's headworks and was constantly repairing it throughout each irrigation season. Chandler's investigation of the canal's operation detailed numerous inefficiencies that he determined could be eradicated with a widened and improved heading. Such a project would greatly increase the Mesa Canal's capacity and would enable Chandler to supply his proposed connecting canal with water to irrigate his lands to the south. It was with

this goal in mind that he approached the Mesa Canal Company and recommended that he be made manager of the corporation. A series of negotiations led to the formulation of an agreement placed before Mesa Canal Company stockholders for their approval on January 10, 1891. Among the nine provisions of the agreement was one that held Chandler responsible for the cost of widening and enlarging the two-mile stretch of canal between the Salt River and Ayers Headgate (a point presently known as the Division Gates, located north of Brown Road and midway between Mesa Drive and Stapley Drive in Mesa). Chandler planned to construct new headworks on the banks of the Salt River capable of diverting enough water to serve both the existing Mesa Canal and the proposed Consolidated Canal.

Additionally, Chandler agreed that any legal expenses incurred due to the enlargement would be borne by him and that all water due the Mesa Canal shareholders was to be delivered before any other use was made of it. Prior to being presented with the proposed contract, stockholders were paying annual water rates of $30 per share. Under Chandler's management, shareholders were assured that they would pay only an annual cost of $17.50 per share. Finally, the contract acknowledged that any failure on Chandler's part to fulfill the terms of the contract would result with the Mesa Canal Company retaking full control of the canal.

The attractiveness of the offer was obvious, and shareholders of the Mesa Canal Company accepted it after a vote of 221 to 130. Chandler was so certain that the contract would be passed that he deployed workers to begin the task of widening the Mesa Canal before the deal was even accepted. His crews built a diversion structure in the Salt River composed of large boulders with granite masonry abutments and wing walls. To expedite the work Chandler contracted with the Marion Steam Shovel Company of Marion, Ohio, for one of their medium-sized ditching dredgers, which was put into use early in 1891. Completed by 1894, the 44 feet by 24 feet headgate was constructed from "rip-rap" laid in cement to which massive timbers salvaged from Fort McDowell were fastened by iron bolts. Ten wooden gates, treated with preservation paint, controlled the flow of the river into the canal.

The work of widening both the canal and enlarging the headgate was made much easier with the use of the Marion steam dredger. The successful implementation of this mechanical marvel compelled Chandler to order another even larger model. Construction of the new, wooden-clad machine required a shipment of thousands of board feet of lumber. The new dredge's hull measured approximately 46 feet by 84 feet and included an 80 feet long boom with a shovel, or "dipper," capable of excavating to a depth of 25 feet below the water's surface. A 50 hp engine driven by a 60 hp boiler powered the entire assembly, which weighed approximately 200,000 pounds, and carried up to 175,000 pounds of equipment. In spite of its weight and size, the dredge drew only 2.5 feet of water. In contrast with the earlier model, which cost the Consolidated Canal Company $10,000, the larger dredge cost $25,000. Further, the company paid $50 per day for a four-man crew and the purchase of enough fuel to keep the dredge in constant operation.

Chandler's investment in steam-powered earth moving equipment also included a dry land excavator to aid in constructing the miles of new canals. In addition to reconditioning portions of the old Mesa Canal, which was renamed the Mesa Consolidated Canal, the project included two newly constructed canal branches. The western branch, a two-mile long waterway, known initially as the Cross Cut Power Canal and later as the Tempe Crosscut, coupled together the Mesa and Tempe canals in 1892. The eastern branch, which was originally named the Ferry Canal, was designed to carry water from the new diversion gates (known earlier as "Ayer's Headgate") at the end of the Mesa Canal along a 19-mile journey to lands south of Mesa.

While work was being carried out to build these structures, Chandler co-founded the Consolidated Canal Company in March of 1892 with partners Dexter M. Ferry and Charles C. Bowen. As with the original Mesa Canal, the improved canal was occasionally threatened by floodwaters from the Salt River and the Consolidated Canal Company spent large sums of money to protect and maintain its investment from the dangers of erosion. Nevertheless, over time the river channel encroached on the nearby canal banks and, in some locations, even gophers threatened to undermine the integrity of the canal structures.

Chandler and his partners toyed with the idea of constructing a dam to store water for use in times of shortage before creating the Consolidated Canal Company in 1892. They had discussed building a masonry dam on the Salt River just below the point where it converged with the Verde River, but the idea was rejected, presumably due to the tremendous costs involved. A national debate over using federal money to reclaim western desert lands eventually led to the creation of legislation which sought to limit the federal government's ability to extend its power over irrigation projects. Nevertheless, when private capital proved either unwilling or unable to fully advance western irrigation projects to their full potential, federal intervention emerged as the only solution. Thus, after months of political deliberation, Congress passed the Newlands Act, also known as the Reclamation Act, in the spring of 1902 which introduced a progressive program designed to transform unproductive arid lands into small family farms through the development of large-scale irrigation projects.

On March 14, 1903, the Secretary authorized the Salt River Federal Reclamation Project. To facilitate the repayment of construction costs, the Water Storage Committee presented a plan for the formation of an association of all landowners in the Valley based on land tenure, which became the Salt River Valley Water Users' Association. This Association was formed to represent the interests of area farmers, as well as to guarantee repayment to the federal government and provide an organization to operate and maintain the finished system. Most local farmers approved the articles of incorporation and the document was filed with the county recorder's office on February 7, 1903. While construction of Theodore Roosevelt Dam was underway, surveys of the Valley's irrigation systems determined that there was considerable need for rehabilitation and reconstruction of the areas canals, laterals and appurtenant features. By 1906, the USRS had begun purchasing irrigation systems from the existing canal companies and planning construction of new canals. In addition, construction of the Granite Reef Diversion Dam, for distribution of the flow of water to the northside and southside systems, was completed in 1908. That same year, the USRS began the rehabilitation of the south side water delivery system with the purchase of the Consolidated Canal.

On November 19, 1908, the Consolidated Canal Company contracted with the United States for the sale of its entire water delivery system. Because extensive structural repairs were needed, the necessary costs for remediation were deducted from the purchase price of $187,000. While the sale included the Cross Cut Power Canal, the Company chose to retain possession of its powerhouse near the Tempe Canal. The sales agreement stated that the United States would continue to furnish water to the Consolidated Canal Company in order to generate electrical current at the facility. However, the United States reserved the option of furnishing electric current instead of water for the development of power. On December 13, 1912, the United States and the Canal Company signed an additional contract for federal delivery of electricity to the Canal Company.

On the heels of the sale of the Consolidated Canal holdings, the water rights for Valley lands under the federal project were adjudicated. Resulting from the lawsuit known as *Hurley v. Abbott,* the Kent Decree of March 1, 1910 reaffirmed the principle established by the Kibbey Decision that water was appurtenant

to the land, and assigned appropriative rights to the irrigable acreage in the Salt River Valley. Kent established a simple, three-level classification methodology based on time and the continuous use of water. "Class A" lands were those irrigated before 1903 and continuously to 1909. "Class B" lands were those irrigated before 1903 but not continuously to 1909. "Class C" lands were those that had never been irrigated. Only 2,330 acres off the Consolidated Canal had received a designation as "Class A" land and of the remaining land, an additional 3,985 acres were assigned a "Class B" appropriative right. Unfortunately for Chandler, the majority of his property was determined to be "Class C" land.

The entire structure of the southside canal system was altered significantly under the USRS' ministrations. While the Consolidated Canal remained a vital part of the system, the upper reach of the South Canal had been built between 1908 and 1909 in order to receive water from the newly constructed Granite Reef Diversion Dam and carry it over a two-mile route to the main branch of the Consolidated Canal. The diversion dam had altered the course of the Salt River and moved it far beyond the reach of the original Consolidated Canal headworks. Between July and August of 1908, in anticipation of buying the Consolidated Canal, the USRS rebuilt a new head for the canal at a point located a short distance below its original location.

Prior to purchasing the aged Consolidated Canal, the USRS considered building an entirely new canal parallel to the weathered one already in existence. However, it was quickly determined that such a course of action would have been even more costly and time-consuming. As it was, the task of reconditioning the existing Consolidated Canal "required several years of extensive repair work and a good many dollars." During the 1912 investigation into Chandler's land deals, it was revealed that various portions of the Consolidated Canal were in less than pristine condition at the time the waterway was purchased by the United States. Not only was the canal full of debris, but also the structure itself was in poor condition. The run-down condition of the canal was due to Chandler's alleged fraudulence and that he managed to take advantage of the federal government a second time by selling the USRS a substandard canal. The Tenth Annual Report of the USRS noted that all Valley canals purchased under the Project were in "exceedingly poor condition," and the Consolidated was no exception. However, once taken over by the USRS, tremendous efforts were made to rectify the situation.

Ultimately, the USRS would pay in excess of $100,000 for the repairs and upgrades. Improvements to the original canal included the replacement, in 1914, of the worn-out timber wastegates that sluiced silt out of the main canal and otherwise provided a means to turn water back into the river that was not always needed beyond that point in the canal. The rotted wooden wastegates were removed and replaced with taintor gates. A new wastegate structure was built a few hundred feet farther downstream on the boundary between Sections 28 and 29, Township 2 North, Range 6 East. The associated check gate was of reinforced concrete, with six clear openings of 6.58 feet, each equipped with timber flash-boards and a concrete footbridge along the top to be used when operating the structure.

Repairs also occurred at the end of the Main Consolidated Canal, located approximately 1.5 miles northeast of the City of Mesa. Here, a structure (earlier referred to as Ayers Headgate) diverted the flow in five directions, into the East Branch Consolidated Canal, the Tempe Crosscut Canal on the west, the Mesa Canal on the south, and into two small laterals, Moot to the southwest and Woy to the southeast. Over the years the gate timbers had rotted, putting the structure into an unsafe condition and made it difficult to operate. In 1914, crews constructed a new reinforced concrete headgate structure, supported on foundations installed to a solid caliche formation at a three to 12 foot depth. To protect the structure from upward pressure, crews constructed a cut-off wall and drilled weep holes to relieve the floor from

any additional pressure. The division gates utilized four steel gates at the Tempe Crosscut intake, six steel gates at the East Branch Consolidated Canal intake, one steel gate for the Mesa Canal heading, and two cast iron gates at the heads of the small laterals. The Mesa turnout dropped a distance of 470 feet to reach the grade of the Mesa Canal below. From there, water was carried under a road through an inclined culvert that discharged into a pool and emptied into the Mesa Canal via a cobblestone-lined 50 feet passage. Two reinforced concrete bridges were built adjacent to the gate structures to allow traffic across both the Tempe Crosscut and the East Branch Consolidated canals.

In order to carry out all this work, the Main Consolidated Canal was drained of all water for the entire month of December 1914. Groundwork for the project began in November when teamsters hauled lumber, sand, gravel, and cement to the site and work crews initiated the construction of forms in addition to starting preliminary excavation work. Further, a lighting plant was set up to facilitate around-the-clock work on the project. Initially, the lighting was powered by a gasoline generator. However, the energy yielded by this method proved insufficient for the task at hand and a power line was installed to connect the lighting plant to Chandler's old transmission generator.

Project foreman Frank Winter supervised laborers who placed 598 cubic yards of reinforced concrete, 200 square yards of pavement, and numerous steel gates for the canal headings. The canal gates were all hung by January 1,1915, and water was turned back into the Main Consolidated Canal. The small lateral gates were hung and all backfilling was completed by January 11, at which time the work camp was disassembled. The total outlay for building the new structure amounted to $17,043.78, which included all labor, equipment, and supply costs.

In the first quarter of the twentieth century, several major floods caused significant damage to irrigation structures throughout the Project. Portions of the upper reaches of the Consolidated Canal and its appurtenant structures were particularly hard hit. The first deluge was from a series of snow and rainstorms during January of 1916. Across the watershed, warm rains interspersed between significant snowstorms resulted in a torrential runoff into the Roosevelt reservoir. By the end of the month, water was passing over the spillways at Roosevelt Dam at a depth greater than 10 feet. The series of storms produced an estimated total of 2,046,058 acre-feet of water flowing down the Salt River. The resultant flooding devastated portions of the southside canal system. As a result, by the mid-1920s, significant changes had been made to the Project southside water and power systems.

As the floodwaters receded, repairs were immediately needed in preparation for the coming irrigation season. In March, the Association’s Board of Governors appointed a committee of five members to inspect the flood damage to the Consolidated. It was during that time that plans were first conceived for enlarging the Eastern Canal up to the south line of Section 31, Township 2 North, Range 6 East and moving the South Consolidated Power Plant to that same point. The new plan envisaged an enlargement of the Eastern Canal to a capacity sufficient enough to accommodate the water delivery under both canals. Water would be diverted through the new power plant and into the Consolidated Canal. Thus, the portion of the Consolidated Canal that was exposed to river flooding (approximately 4.5 miles) could then be abandoned. However, project costs, estimated at $209,300.00, were too high and the plans had to be scrapped. Eventually, however, persistent flooding and the resultant damages compelled the redesign of both the Consolidated and Eastern canals.

The temporary repairs made in 1916 included rebuilding the canal banks and protecting them by constructing rock jetties along the river. Even though floods in 1917 assaulted the canal upriver from the

earlier damage sites, the rampaging waters threatened to get in behind the new jetties. In response, the Association installed three additional jetties upstream that successfully delayed additional destruction. The 1917 floodwaters also seriously undermined the cutoff wall and apron at the end of the sluiceway at the South Consolidated Power Plant. The new apron was lowered at least 10 feet or until it reached bedrock and extended an additional 17.5 feet downriver. It was constructed of 12-inch river boulders grouted together then covered with six inches of concrete.

During a flood on Thanksgiving in 1919, construction and maintenance crews were able to save the same reach of the Consolidated Canal that was threatened in 1917. However, when flood waters tore through the Salt River Valley again in February 1920, efforts to save the canal were unsuccessful. Water levels overtopped the canal, completely eliminating the canal bank for a distance of 2,300 feet and flood waters significantly deepened and widened the adjacent river channel. Rebuilding the canal required substantial work in what had become the riverbed. This crisis coincided with the beginning of the irrigation season, and the structural damage caused to the main distribution artery of the south-side water delivery system threatened to undermine crop production throughout the area. To forestall such an outcome, the Association immediately began repair work. They constructed a camp in the vicinity of the break and strung lights to facilitate night work. The Association and community leaders worked tirelessly to recruit a workforce of nearly 700 and secure an equal number of draft animals to repair the damage. Hand and animal operated equipment, such as Fresnos and slips, were immediately available to begin the work and a Marion dragline (steam shovel), in use on the Eastern Canal, was dispatched to the site.

The condition of the Consolidated was reported to the Association's Board of Governors on March 23. Members reiterated the importance of enlarging the Eastern and eliminating the compromised reach of the Consolidated. In the meantime, the Board determined to purchase a much-needed second steam-operated shovel, a 0.5-yard capacity P. & H. dragline, and moved it from Phoenix to the work site. It was determined that any effort to build this channel on a grade corresponding to that of the original canal would require a cut averaging 20 feet in depth along a roughly 3,500-foot section. Rather than attempt this arduous and time consuming task, engineers decided that it would be more practical to build a bypass channel around the damaged area. A fill "dam" was put in place in the Consolidated to divert water into the new bypass channel. The new channel was excavated at a comparatively shallow depth. Nearing the completion of the repair project, workers and machines had moved an estimated 70,000 yards of material. The fill was constructed primarily of light and sandy material that could not be adequately packed in spite of all efforts to do so. Instead, limited volumes of water were periodically turned into the canal during the construction work in order to allow the fill to settle gradually. The decision to repair the canal in this expedient fashion proved to be an error.

By late March, the fill across the old channel of the Consolidated Canal was in place, and excavation of the new bypass was nearly completed. On March 27, the decision was made to turn water back into the canal and through the powerplant. Water behind the fill rose to a depth of 10 feet and then began to feed water into the newly excavated bypass channel. After an hour the stream was running at approximately a one-foot depth when a small rivulet was observed flowing from the down-stream face at the south end of the fill dam. The small stream rapidly grew and in spite of all efforts, the fill was completely washed away within 15 minutes. Fortunately, workers were able to remove the P. & H. dragline from the north end of the fill dam just in time to save it from being carried away in the current.

The loss of the original fill was a serious setback, but work was immediately resumed to build a more durable blocking structure. Workers, the draglines, and draft teams labored to move gravel and river

boulders into place, and the continual traffic of men, animals and machinery over the site helped achieve greater compaction. Once work was completed on April 2, water was again turned back into the canal. This time the fill held, and the canal was put back into use. Due to the precarious nature of the temporary structure, it was deemed necessary to post watchmen at the dam site. A 900 cfs discharge raised the water behind the dam from six feet to a depth of 17 feet and this comparatively deep lagoon reduced the water's velocity to about one cfs. The slow current combined with the irregular condition of the banks and the presence of numerous trees and other growth in the newly formed pond caused a significant loss in the rate of flow in the canal. This in turn caused a marked reduction in the output of power from the perennially troubled South Consolidated Power Plant.

The new 3,700-foot-long bypass canal was designed to carry 900 cfs (36,000 miner's inches) of water, and 925 cfs was considered to be the capacity limit. The first 3,100 feet of the bypass had a bottom width of 30 feet and a grade of 0.0008 to the point where the ditch emerged from the deep cut. For the remaining 600 feet it had a more narrow width of 20 feet and featured a very steep 0.0045 gradient. The bypass reentered the Consolidated Canal with a bottom elevation of 1,272.6 against the original elevation of 1,264.2, almost 8.5 feet higher than originally designed. Water moved through this area at a velocity of nine fps. No lining was needed to guard the bypass channel against the erosion because it was cut through the durable hard pan and naturally cemented gravels, protecting the bottom and banks at this part of the bypass. However, the walls of the Consolidated had to be reinforced with river boulders laid in cement mortar up to a height of three feet above the water surface, and this paving was continued for some distance in the straight-away downstream from the bypass mouth.

In addition to the paving, a substantial bulkhead with its base four feet below and its top four feet above canal bottom was built into the canal prism immediately downstream from the left edge of the bypass. Fabricated out of river boulders embedded in concrete across the canal, this bulkhead served to create a stilling basin and to intercept boulders washed down the steep part of the bypass. The downstream floor of the canal was paved with concrete and boulders to prevent erosion from undercutting the bulkhead. A "tappoon" of earth, gravel, sand, and boulders was erected in the main canal upstream from the bypass in order to prevent water from backing up the abandoned segment and into the river through the damaged upper reach of the canal. The entire cost in 1920 of rerouting the Consolidated Canal amounted to approximately $95,000.

The havoc in the wake of the 1920 flood renewed plans to enlarge the Eastern Canal to replace the upper portion of the Consolidated Canal and to relocate the original South Consolidated Power Plant. Fortunately, the temporary fill dam and bypass canal on the Consolidated held, and the power plant continued to function at a reduced capacity until the new measures could be implemented. The Lidgerwood "behemoth" that had been abandoned in 1915 after it had completed the task of excavating the Consolidated Canal was reconstructed and placed into operation to widen the Eastern Canal. The task of widening the Eastern Canal continued intermittently, with delays due to lack of funds, between 1920 and June 1923, when the project was finally completed. As it neared conclusion, work began on a new power plant located six miles below the old one, where the newly refurbished Eastern Canal delivered water to the reconfigured Consolidated Canal. A temporary substation was installed on the 40,000-volt line near the proposed location to supply power for construction purposes, and one electrician and his helper were kept on the job throughout the process to service motors and wiring, and to install conduits in the concrete work.

In September 1923, the building's construction was far enough advanced to begin moving machinery from the old plant to the new. The generator and turbine of Unit No. 1 were removed first, while the second unit was left in place to continue producing power. Worn parts were either replaced or rebuilt at the Association's Crosscut Shop; two transformers and Unit No. 1 were installed at the new site. In November, three cottages were ready for the plant operators to move in, in time for Unit 1 to begin producing power. Subsequently, Unit No. 2 was taken from its old home, refurbished, and installed next to the first unit. The new South Consolidated Power Plant was in full operation by January 5, 1924, after which the old powerhouse was completely abandoned. The increase in power income from the relocated plant was estimated at not less than $30,000 yearly, which was calculated to amount to more than 12 percent of the total combined cost of relocating the plant and widening the Eastern Canal.

The prevailing worldwide financial and industrial depression of the 1930s was reflected within the Salt River Valley by greatly reduced demand and lower prices for farm products. Gross crop returns for the Project fell by 40 percent between 1930 and 1931, and the Association felt the repercussions of this devastating trend. Between 1931 and 1932, the Association instituted a regime of curtailment and retrenchment. All personnel deemed to be unnecessary were laid-off, and a general wage cut of 10 percent was introduced. The construction of any new laterals or other irrigation structures was limited to the absolute minimum required for the Association to fulfill its obligations. In fact, the Association dissolved its separate department of construction and engineering in 1932, and the irrigation division took over all responsibility for the upkeep of Project facilities. In a national effort to provide relief to the chronically unemployed, the administration of President Franklin D. Roosevelt instituted a number of "New Deal" work programs, including the CCC, which was established in 1933. The Association was able to utilize the CCC in the maintenance of the water system between 1935 and 1938.

CCC workers carried out extensive repairs to the flood-damaged canals, including the Consolidated, and replaced numerous decayed wooden irrigation structures scattered throughout the Valley, some of which dated back to pre-Project years. This work included grading roads alongside canals, constructing headgates, and replacing stretches of lining. The extermination of gophers, a task that proved unpopular with most of the young men, was another important aspect of CCC activity. Gophers were a perennial menace to the integrity of irrigation structures and a 1938 report noted that CCC workers had trapped 60,000 of the pesky beasts over a three-year period. In spite of its successes, however, the CCC was abruptly withdrawn from the Valley on March 31, 1938. This decision was attributed to complaints made against the agency by labor interests that claimed skilled union jobs were being lost to the make-work program. Whatever the reason for its termination, the loss of the CCC program represented a temporary setback for the care and upkeep of Project facilities.

Even while CCC activity was at its height, the Association continued with its own efforts to increase the efficiency of canal and lateral maintenance. Beginning in the spring of 1934, employees began a "clean-up campaign" designed to give all irrigation structures a more uniform shape and capacity. Workers cleared vegetation and rubbish away from ditches and canals and a new Ruth dredger was purchased for realigning and reshaping the waterways. Up to that point, the most effective method of removing unwanted grasses along the banks as well as the persistent waterweeds was crews armed with scythes and shovels. Other weed removal techniques that had been tried included chemical applications, which proved only partially effective, and grazing livestock, particularly sheep and goats. While the animals efficiently devoured the overgrowth of vegetation, they were challenging to transport as well as control in unfenced areas.

In 1935, the Association purchased a dozen "Knapsack Type No. 99" oil-fueled weed burners from the Aeroil Burner Co., and began testing the new equipment on heavily overgrown sections of ditch. It was found that the most unclean ditches could be cleaned at a cost slightly in excess of one season's work with the hand scythe and shovel operations. In addition to killing the grass, however, burning carried the added benefits of destroying weed seeds and insects, leaving a clean ditch with no grass in the bottom to aid in collecting silt deposits. After the initial experiments proved to be successful, the Association purchased a larger "Power Weed Burner" with a double-nozzle power oil burner to compliment its Knapsack models. This unit was mounted on a low-geared truck with extended derrick hangers, coil spring suspended and adjustable for use with various widths of ditch. During 1936, burning operations were enlarged to include 36 Knapsack burners and six power double-nozzle machines. Canals and laterals fouled with vegetation growth were burned over at least once, and in some cases from two to eight times in a single season. As a result, Superintendent of Irrigation C. W. Lillywhite was able to report that the 1937 season "started with many miles of our laterals, formerly the foulest on the project, entirely clean."

This method of weed control was maintained until 1945, when the Association initiated a new weed control program. At that point the use of flaming oil was replaced with the application of non-burning diesel oil. This liquid was sprayed on weeds such as Johnson grass, and the sun's lethal rays completed the process. Within hours of treatment, the vegetation withered, turned black, and dried up as if burned. The oil even penetrated into the soil to kill roots, and it was far less hazardous than open flame. However, limited weed-burning operations were reintroduced in 1954 to service areas were weed-killing oils threatened to pollute the water.

Although the south-side canal system had been transformed into its modern configuration long before the late 1940s, its various canals were only then coming to be known by their present-day designations. The channel that ran from Granite Reef Diversion Dam to the South Side division gates in Section 11, Township 1 North, Range 5 East, came to be known as the South Consolidated or "South Con" Canal. The portion of this canal that ran from the old South Consolidated Power Plant and the headgates of the Eastern Canal to the division gates incorporated much of the same channel formerly designated as the Main Consolidated Canal. Prior to connecting with the division gates, this canal supplied the Eastern Canal and RWCD Canal with water. This canal is now known as the South Canal, although as late as 1968 the portion located below the second South Consolidated Power Plant was still occasionally referred to as the Consolidated Canal. At the division gates the South Canal was diverted into three other canals and two major laterals. The Tempe Canal carried water daily to Mesa and Tempe, and a portion of the old Mesa Canal, together with the Moot and Woy laterals, carried water south to Mesa. The canal historically called the East Branch of the Consolidated, which carries water to Chandler and Gilbert, has come to be known as the Consolidated Canal.

In addition to serving as an important diversion point, the division gates on the South Consolidated also housed a number of monitoring devices, including gauges for measuring water flow and a telemeter for warning of dangerously high waters. An Association employee (and the employee's family) lived in a company house at the site to serve as both a gate operator and water flow monitor. Gauge readings were regularly taken three times a day and reported to the Hydrographic Division Watermaster. In addition, reports on changes in water flow were made to the Chandler Falls Power Plant, located downstream from the division gates on the Tempe Canal. A telemeter attached to each canal forebay was connected to the operator's home and alerted the couple when the water climbed too high in the canals. The wife of one operator recalled that situations at the division gates could "get pretty peppy"

following a rain or windstorm.

In spite of the routine maintenance of canals and other irrigation structures, by the end of the 1940s it was apparent that many ditches in the Project were in very poor condition. Although many canals (the Consolidated among them) had been lined with gunite for less than 30 years, cracked and leaking canal linings caused an estimated 25 percent loss of water throughout the Project. Inexpensive solutions such as sealing ditches with oil were tried. One such experiment was carried out in 1946 at Lateral 12 of the Consolidated Canal, where a ditch length measuring 0.625 miles was treated with 2,700 gallons of oil. Although the results were described as "very satisfactory," the negative environmental impact of such a practice was equally obvious, and the 'oiling' of ditches was not maintained for long.

Fortunately, Congress passed legislation in 1949 authorizing Reclamation to fund a variety of R&B campaigns on Reclamation projects throughout the West. The SRP Board of Governors subsequently approved the first of several agreements with Reclamation in which the United States loaned SRP approximately $1,250,000 interest-free and repayable over a 20-year period. Subsequent loans made between 1950 and 1982 obtained more than $27 million in federal aid for SRP to modernize the Project irrigation system. During the 30 years of R&B federal funding, crews working throughout the Project replaced wooden gates with concrete and metal structures, and repaired and replaced siphons, bridges, and other works used for water delivery.

R&B-related work on the Consolidated Canal took place mainly between 1963 and 1967, although 3,800 square feet of new lining had been added to the canal between 1950 and 1957. Indeed, a major component of the program consisted of extensive lining replacement in all canals and this was generally directed at areas where erosion and scouring had occurred. Before any gunite or concrete was placed, however, SRP work forces prepared the canal by removing silt and other accumulated debris, placing compacted gravel along the sides for reinforcement, laying steel wire mesh along the sides and bottom, and by applying an emulsion seal immediately prior to guniting.

Workers hired by contracted firms lined canals with concrete or sprayed gunite, and in some cases SRP crews applied a chemical sealant to the freshly laid concrete to further prevent seepage. By 1967, the Consolidated Canal had received a total of 29,850 square feet (0.18 miles) of new lining, most of which had been put in place that same year. While noteworthy, this amount was rather small in comparison with the Tempe Canal, for example, which received in excess of one million square feet (8.63 miles) of new lining during the R&B program.

In addition to lining replacement, the R&B program included the installation of numerous metal gates for controlling water movement. For example, new radial gates (designed to back water up for delivery to laterals) were placed at various points along canals throughout the Project. Several such structures were installed along the Consolidated Canal, one of which was located near the north line of Section 5, Township 1 South, Range 6 East, just south of Baseline Road in the City of Gilbert. The three five by 12-foot gates and related hardware (three cable drum shafts, five gate bearings, and the catwalk railing assembly) were fabricated at the Crosscut Machine Shop and installed by SRP workers on July 13, 1971.

Another feature of the R&B program was the development in the late 1960s of an automated control system for all Project canals. Advances in electronic technology allowed SRP to design its first computer-operated Supervisory Control system, which enabled a single individual to manage the Project's 138-mile canal network from a master switchboard. The original plan for this system described 11 separate

Supervisory Control station locations along the Consolidated Canal. In addition to the electronic monitoring equipment, these stations also featured remote-controlled drive mechanisms, motors and motor controllers for raising and lowering 331 separate radial gates located at lateral heads throughout the Project. When completed, the system also allowed for the remote control of 46 deep well pumps, eight large booster pumps, and the low-yield hydro plant at the South Consolidated drop structure. This was a significant technological evolution from the days when gate operators relied on bells installed in their homes to alert them about potential canal problems.

Starting in the post-WWII era, the Salt River Valley has been undergoing a monumental transition from an agricultural and rural community to a major urban center. The population of Mesa, the Valley city where the headgates of the Consolidated Canal are located, grew from 152,404 people in 1980 to 288,091 by 1990, making it the nation's fastest growing city that year with a population growth rate of 89 percent. As the Consolidated Canal flows south, it also moves water through the Town of Gilbert and the City of Chandler. Gilbert's population doubled every five years after 1980, increasing from a population of 5,717 to approximately 100,000 by January 2000. When Chandler died in 1950, the town which carried his name boasted a modest population of 3,800. The land that formerly comprised his 18,000-acre ranch now forms the core of a bustling metropolis. The ever-expanding city of Chandler grew from a population of 30,000 in 1980 to more than 183,000 in 2000.

At one time, the Consolidated Canal meandered through mile after mile of farmland and desert. At the beginning of the twenty-first century, the canal is part of a modern, urban landscape with housing developments, strip-malls, and busy city streets surrounding much of it. While the primary function of water delivery and the physical nature of the canal itself have changed very little over the years, the uses of the delivered water have been rapidly changing. The demand for farm irrigation has continued to decrease and the water delivery off the Consolidated Canal is now also providing for the soaring municipal and industrial needs. In 2000, the canal delivered 11,411.74 acre feet for agricultural production and 32,510.62 acre feet for urban irrigation, public parks, industrial sites, and urban drinking water by way of the Chandler Water Treatment Plant.

In addition to providing domestic water, the Consolidated Canal has become a source of recreation for many area residents. SRP has allowed licensed recreational use of the canal banks since 1964. Since that time, canal multiple use projects were a growing urban trend. Because the canal system continues to be an active operating water delivery system, SRP has worked with the cities to ensure their use is compatible with operation and maintenance needs for the canal. Two linear recreational features have been located along the Consolidated Canal, one by the City of Mesa near the headgates and a second by the City of Chandler called the Paseo. The Paseo is a multi-phase park project that incorporates urban art projects, bridges, a multi-use pathway on the east side of the canal, and an equestrian trail on the west side of the canal.

In the early 1970s, plans were made to develop a historic park in the city of Mesa. These plans became reality over the decade that followed and the Park of the Canals was developed along Home Road and south of McKellips Road. The South Side division gates and the head of the Consolidated Canal lay only a short distance to the south of the park. Today the park encompasses remnants of the early Utah Canal, as well as prehistoric irrigation structures dating from 700 B.C. that were also used later by Mormon settlers in the Lehi area. The modern cement-lined South Canal runs along the eastern boundary of the park, but the original channel of Chandler's 1891 version of the Consolidated Canal also runs through a portion of the park. The pond where Chandler is said to have housed one of his mammoth dredges after

excavating the Consolidated Canal is also located in the park, and some people claim that the sunken wreckage of the machine is still buried there. Although the actual fate of the dredge remains unconfirmed, the pond's existence in the park is a picturesque reminder of the Consolidated Canal's early existence.

With increasing public use of the canal rights-of-way, concern for public safety has led to the installation of steps and ladders in all SRP canals. These safety features provided exit opportunities from the swift-flowing canal water for both people and animals. Over time, following the termination of the R&B program in 1980, additional new safety features were installed along the Consolidated Canal during routine maintenance procedures. Major portions of the Consolidated Canal, from the head gates to Citrus Heights Road, were lined, and in 1990 the canal was relined between Warner Road and Williams Field Road. The work also included the installation of safety steps and ladders. Bridges were replaced at Southern Avenue and Citrus Heights Road. Check structures and lateral head turnout structures were installed.

In addition to this routine work, in 1990 SRP also initiated an innovative new plan for controlling waterweeds. SRP implemented a pilot program of biological weed control using reproductively sterilized white amur fish in 1980. The white amur is a type of grass carp originally found in the rivers of China, and a mature specimen is capable of eating the equivalent of nearly three-quarters of its body weight in aquatic plants each day. A similar concept had been tried in the mid 1970s using an exotic, vegetarian fish species known as tilapia, but the results had not been very successful. However, the white amur pilot project yielded much better effects as the canals stocked with this fish were clean and smooth flowing after only two years.

This process of modernization also included an upgrade of the Supervisory Control system between 1989 and 1991. The SCADA system allowed for even greater remote control and monitoring of the entire SRP irrigation network. This improved system allowed for the remote scanning and operation of more than 120 sites throughout the Project, including the sophisticated monitoring probes installed along the Consolidated Canal to detect unsafe nitrate levels. SCADA also featured an active map board, sophisticated color graphic consoles, and a greatly expanded alarm system that included voice enunciation.

In 1993, a new six by six foot radial gate with SCADA controls was installed in the Consolidated Canal at Lateral 5-16.1, just north of Queen Creek Road. However, even with these technological advances, older forms of maintenance continued to be carried out. In 1996, for example, approximately one mile of lining was replaced and safety ladders were added to the Consolidated Canal between Pecos Road and Germann Road, in the immediate vicinity of the Chandler Water Treatment Plant. As long as the Consolidated Canal exists and as long as scouring and erosion occur, lining replacement will be necessary.

The development and rehabilitation of the Consolidated Canal played a significant role in the early progress of south-side agriculture, the evolution of the City of Chandler, and the unification of the Salt River Project's consolidated south-side canal system. Although the upper-most portion of the historic Consolidated Canal is now incorporated into the South Canal, the modern Consolidated has maintained its separate status as a crucial element of the Project irrigation network. In addition to its continual role as a water conduit essential for modern agriculture, the Consolidated Canal is also a vital source of water for the growing urban population in the southeast portion of the Salt River Valley. With the area's continued transformation into a major urban center of the American Southwest, the Consolidated Canal, from its

headgates to canal end at Hunt Highway (U.S. Highway 87), will undoubtedly continue to serve as an important element of the region's infrastructure.

Eastern Canal

Source: *Eastern Canal, South Side of the Salt River, Mesa/Gilbert Vicinity, Maricopa County, Arizona*. HAER No. AZ-56. Marc C. Campbell, 2000.

The Eastern Canal, named because of its geographic location, sits at the eastern edge of the Project in central Arizona. Originating near Lindsay and McDowell roads in northeast Mesa, the Eastern today stretches 14.65 miles south from its head in the South Canal. Built between March and December 1909, the canal replaced the Highland Canal and providing irrigation water for lands lying between it and the Consolidated Canal to the west and also serving as a vital source of domestic water for the Town of Gilbert. Despite modifications over time, the Eastern Canal remains an integral structure in the water delivery system of the Salt River Valley.

Although the Eastern Canal proper was not constructed until 1909, entrepreneurs took steps to establish a canal in its vicinity almost 40 years earlier. In August of 1870, four men representing the newly formed Salt River Ditch Company traveled to the Salt River Valley in search of a promising canal location. "At a point almost five miles above the crossing of the McDowell and Florence roads…and opposite a red mountain on the south side of [the] river," they claimed 40,000 miner's inches of water for irrigation. Although the Salt River Ditch Company never progressed much beyond the initial ambition of its planners, the general area selected as head of their canal ultimately became an important part of the Eastern Canal and Arizona's built environment. In time, as more irrigation cooperatives formed and federal reclamation efforts focused on the desert southwest, the land near the red mountain came to house both the Highland Canal and its eventual replacement, the Eastern Canal.

During the 1880s, population growth in the Salt River Valley placed a higher demand on irrigation systems, transforming water development into a profit-oriented enterprise. Rather than working informally as cooperatives to manage water shortage problems and distribution primarily for agricultural purposes, as they had in the early ditch days, most canal companies during this period began to organize as corporate entities. These newly fashioned businesses issued capital stock and leased and assigned water rights within the service boundaries of an irrigation ditch. Unlike their predecessors, corporate canal companies did not concern themselves as much with accepted water use practices, in particular the doctrine of prior appropriation, as they did with generating income through land sales. By extending the irrigation system and connecting undeveloped areas of the desert with a water supply, such concerns sold property at much higher prices than they previously commanded.

This burgeoning land development renewed interest in the area around the red mountain. In 1887, the same year that crews completed a railroad spur from Maricopa to Phoenix enabling the Salt River Valley to market its products nationally via the mainline Southern Pacific Railroad, local businessman Austin Carrington rekindled the idea of building a canal near Mesa. Although an extensive canal system already crisscrossed the Valley, providing more carrying capacity than available water, Carrington had ambitious plans. On November 10, 1887, he filed a water claim appropriating 50,000 miner's inches on the south side of the river, approximately one mile southeast of the Arizona Dam. One month later, on December 13, Carrington, along with Prescott residents J. Frank Meador and T. J. Butler, incorporated the Highland

Canal Company with the idea of reclaiming 30 sections of land (19,200 acres) east of the Mesa Canal. Envisioning a string of improved 10-acre tracts, the company divided its capital stock of $100,000 into 1,000 shares, issued them, and began construction in early 1888.

Problems plagued the endeavor almost from the start. Unlike many of the Valley's earlier canals, the Highland did not follow a pre-established course set by remnants of a Hohokam canal, and crews had to dig their way through rocky desert terrain for the entire fourteen miles of the proposed waterway. The work proved to be tedious, backbreaking, and hazardous. On June 16, 1888, an explosion killed two workers when blasting powder used to break large boulders ignited prematurely. Even Carrington, who served as superintendent of construction, fell victim to disaster; on September 13 he drowned while trying to swim across the Salt River. Exacerbating matters, the operation experienced financial setbacks, and at some point early in its history controlling interest passed to Swiss investors.

Despite these tragedies and difficulties, workers completed excavation in November 1888, at a cost of approximately $60,000, and the canal received its first supply of water. While developers pictured grand plans for the finished Highland, the canal proved to be a bit player in the incipient reclamation efforts in the Salt River Valley. Over its 21-year existence, the Highland never continuously served the large acreage that Carrington anticipated, and operators let it fall into disrepair. Although local newspaper accounts from the early twentieth century boasted it irrigated "10,000 acres of very fertile lands," that figure is almost certainly inflated. When Judge Edward Kent ruled in the legal case *Hurley v. Abbott* on March 1, 1910, establishing water rights for land in the Salt River Valley, he listed the decrepit Highland Canal as serving only 7,000 acres at one time or another during its life.

In the decade following the completion of the Highland Canal, residents of the Salt River Valley began to concern themselves more with creating a water storage reservoir than with new canal enterprises. When Congress passed the Reclamation Act on June 17, 1902 and the Secretary authorized the Salt River Federal Reclamation Project the following year, work at last began on the construction of just such a reservoir in the Tonto Basin. To facilitate the repayment of construction costs, the Water Storage Committee presented a plan for the formation of an association of all landowners in the Valley based on land tenure. The Association was formed to represent the interests of area farmers, as well as to guarantee repayment to the federal government and provide an organization to operate and maintain the finished system. Most local farmers approved the articles of incorporation and the document was filed with the county recorder's office on February 7, 1903.

One of the first moves the USRS made in transforming the Project into reality, aside from beginning construction of Roosevelt Dam in Tonto Basin, involved securing and expanding the Valley's canal distribution system. Prompted by the flood of 1905, which destroyed the Arizona Dam on the north side of the river and deprived area farmers of irrigation water, the USRS purchased the north side system in 1906. Over the course of the next two years, the USRS designed and constructed Granite Reef Diversion Dam downstream of the damaged Arizona Dam to channel water into canals on both sides of the Salt River. In addition, between 1908 and 1909, the USRS either built or acquired several canals on the south side, including the South Canal, the Eastern Canal, and the Consolidated Canal.

With the flurry of activity in the Valley that succeeded passage of the Reclamation Act, farmers under the Highland Canal began to grow optimistic that their fields would finally receive a steady supply of water. Indeed, speculation abounded in mid-1905 that the government would purchase the structure as part of the Project's distribution system, and operators set to cleaning and repairing the canal in anticipation of

that event. But by 1908, this initial confidence faded to uncertainty and discouragement. Although rumors circulated that the USRS had discussed purchasing the Highland and replacing it with a new government ditch in the vicinity, nothing concrete had been finalized.

As people from Tempe and Mesa gathered on June 13, 1908, to witness the first diversion of water to north side canals at Granite Reef Diversion Dam, word spread that the Highland would not be among the first south side canals to receive water, even if it did become part of the Project's network. Homesteaders under the canal remained confident they would receive irrigation eventually, but federal officials could not even provide an approximate date for when that might happen. Concerned by the government's indecision and the impact it might have on their lives, several landowners under the Highland pressed the Project's supervising engineer, Louis C. Hill, for a more definitive statement. Hill divulged that the government did not have enough money to construct a new Highland Canal and probably would not for at least another year or two. In his opinion, area residents had two choices: either thoroughly clean and repair the existing canal, or better yet, form an organization to build a new one entirely on their own. Although the latter scenario meant that Highland landowners would personally bear the expense of digging a new structure, Hill promised that the government would reimburse them with federal script. Under this "cooperative plan," the paper issued by the government could then be used like money to pay assessments once the loan on dam construction costs came due. Furthermore, Hill assured the contingent that if they decided to pursue his plan, not only would it place them in line for immediate water deliveries, he would also run all necessary surveys to connect the finished structure with the South Canal.

On June 20, several days after the meeting with Hill, approximately 40 landowners under the Highland gathered at the Mesa Opera House to discuss their options. The conversation focused specifically on the feasibility of repairing the old canal versus building a new one in its place. Because segments of the existing structure were nearly filled with sand, most in attendance believed it would take as much work to clean as simply to start afresh. They also realized that if they proceeded in that direction, the government would probably delay construction of a new canal for at least five years. In addition, many argued that a new canal built slightly further to the east than the existing one would allow more land to be served within the boundaries of the reservoir district. By the end of the meeting, the landowners had agreed to form a temporary organization to negotiate particulars of building a new canal with the Association.

Plans for constructing the new Highland Canal came together gradually during the summer of 1908. On July 21, government engineer Stephen Baker, along with a crew of eight men, established camp near the head of the Consolidated Canal and began surveying the line for the replacement structure. The USRS, anticipating the irrigation of 20,000 acres from the Highland, originally conducted surveys for the canal in 1906 while planning Granite Reef Diversion Dam, and the final drawings Baker completed in September followed much the same path as this earlier study. Rather than tracing the exact course of the Highland, Baker placed the new canal approximately 0.25 to 0.5 miles to the east, thrilling homesteaders that staked late claims in the area following approval of the Project. Two weeks later, on August 3, 1908, the Association’s Board of Governors voted to proceed with construction under the cooperative plan, pledging its credit to back the enterprise, and formed a committee to coordinate work between the federal agency and Highland landowners.

With formal approval secured, supporters of the project focused on making the canal a reality. Within days of the Association’s Board of Governors accepting the cooperative plan, the "Highlanders," as local newspapers called landowners under the original ditch, organized the Highland Canal Construction Company, appointing W. A. Tway, C. A. Baldwin, and George Dorman as directors. The primary purpose

of the company was to raise capital for the new structure, but in the event that no independent contractor would undertake physical construction of the canal because of the cooperative plan, which only reimbursed labor and materials with government script, the company would also bid on the job and use its members to perform the work.

In the month following its formation, the company worked with USRS officials to understand the specifics that construction entailed, and proceeded to explore a variety of ways to finance the canal. At a meeting on September 16, 1908, with B. A. Fowler, Joseph Kibby, and engineer Hill, the Highlanders learned that to complete the job approximately 215,000 yards of material, mostly gravel, would have to be removed. In Hill's opinion, the "work would be comparatively easy" and could be accomplished with ordinary scrapers and teams. When talk turned later in the afternoon to funding plans, one local resident suggested assessing a 25 percent valuation of all lands served by the ditch. After spirited debate in which a minority of those present voiced opposition to subscribing money for construction, preferring small contracts instead with each person receiving script for removal of a specified amount of dirt, company leaders settled on an alternative idea: each farmer would pay $5.00 per acre for land served by the canal. By the end of the meeting, 4,500 acres of land had been pledged to affect this cause.

Despite momentum that seemed to indicate the start of construction would be imminent, little activity occurred through the late fall and early winter of 1908. In November, final federal approval of the canal, which appeared to be a mere formality, ran into bureaucratic red tape, delaying commencement. Federal officials informed the Association that before the government could authorize the use of script, Highland landowners first had to file a petition with the Association, which would then be channeled through the USRS hierarchy for approval. By December, local leaders cleared this final obstacle and the Association began to solicit bids to build the Eastern Canal, renamed in the meantime by Highland farmers to reflect the structure's location at the Project’s eastern edge.

The Association received two bids by the closing date of December 23, but accepted neither as both had been drafted improperly. Bids for construction reopened in early January 1909. This time, the Association received bids from three companies. In addition to the anticipated one from the Highland Canal Construction Company, local Mesa resident W. S. Dorman threw his hat into the ring, as did San Francisco contractor R. A. Moncure, who already had teams and equipment in the area. On January 16, ten days after receiving the proposals, USRS engineers announced that the Highland company submitted the lowest figure and referred the matter to Association officials for final acceptance. On March 6, the Association and Highland Canal Construction Company signed a contract to build the canal, stipulating that work begin immediately and be completed by November 1, 1909, providing farmers enough time to prepare the land for fall planting.

After months of planning and preparation, construction of the Eastern Canal finally came to fruition on March 13, 1909. Working under the supervision of federal engineers, sub-contractor Tom Smith and his crews began to excavate the large boulder formation at the canal's headwaters. USRS officials believed this would be the only hard digging along the entire course. After just 10 days on the job, Smith confidently reported that work was progressing quickly, without difficulty, and ahead of schedule. The combination of Fresno scrapers and slips his men used to remove the top layer of sand and underlying sediment, appeared to have little problem cutting through the earth. With "reasonable good luck," he predicted, the canal would be finished by July 1, four months before the contracted deadline.

Smith's remarks, however, proved to be premature. By early April, work slowed considerably as crews encountered increasing amounts of boulders mixed with cemented granite. While the Fresnos worked well with some of the looser material, this larger, compacted matter-reportedly harder than solid rock-required blasting before it could be removed. Although the government accepted the first mile of Smith's work on April 23, excavation of the next three miles continued well into the fall of 1909. While Smith and his crews trenched the upper portion of the canal, work also progressed along other segments of the planned 19.75 mile waterway. Two other subcontractors labored on the middle and lower reaches of the structure respectively, together employing over 100 teams. At the same time, farmers began to construct the lateral system to carry water from the canal to their fields. In addition, USRS force account crews deepened the canal at its head, leveled the banks for a suitable roadway, and performed all structural work as the ditch took shape, including immediate construction of a bridge across the Roosevelt Road. By May 23, 1909, a third of the canal stood completed, with three inverted siphons and five culverts marking the first two miles.

Other than the problems Smith encountered, actual construction of the Eastern Canal remained relatively trouble-free from an engineering standpoint. Weather conditions proved favorable throughout and contractors had little difficulty with materials. This did not mean all went smoothly, however, or according to schedule. In the midst of construction, questions about the legality of the cooperative plan suddenly surfaced at the federal level. In September 1909, U.S. Attorney General G. W. Wickersham, acting upon inquiry from Secretary R. A. Ballinger, ruled that the plan violated the spirit and authority of the Reclamation Act. He vigorously maintained the legislation provided for reclamation only through the sale of public lands. If the government did not have funds available to build additional irrigation features, it could not grant credit for work performed by outside contractors to offset construction costs due to the United States for reclamation projects. As a consequence, Ballinger suspended any further use of script.

Wickersham's ruling placed the Association and Tom Smith in a difficult position. By September, much of the canal had been completed, more than the USRS had issued script for, but without the guarantee of further payment, Smith found it difficult to purchase materials or hire extra laborers to finish the contract on time. Although government officials assured him they would devise an alternative way of paying the contract, this situation caused unexpected delays as Smith searched for temporary funding. Combined with the difficulties crews encountered excavating the boulder formation, Smith was forced to request two contract extensions past the November 1 deadline. Crews finally finished the structure six weeks late, on December 15, 1909, and after the Comptroller of the Treasury agreed to redeem certificates under existing agreements, Smith turned the canal over to the Association. In February 1910, Association personnel opened the Eastern's intake gates at the South Canal, and area homesteads began to receive water for cultivation.

As originally completed, the Eastern Canal comprised five sections of varying dimensions. Section 1, which included the first eight miles, had a bottom width of 16 feet, a depth of four feet, and a capacity of 200 cfs. From there, it gradually tapered down to section five, or the 2.5 miles, with a bottom width of six feet, a depth of two feet, and a capacity of 40 cfs. All told, contractors removed 243,031 cubic yards of material during construction and built 58 water structures and six bridges, including one between Warner and Ray roads for the Arizona Eastern Railroad crossing. Total cost to complete the canal amounted to $123,000, double what initial estimates predicted. Today, the canal’s upper reach, stretching from approximately two miles south of Granite Reef Dam to the power plant, is known as the South Canal.

By 1915, the Eastern Canal had become a prominent structure in the Project. That year, it delivered the fourth largest amount of water of the Project's 10 canals, serving approximately 18,000 acres. Despite ranking just behind the Arizona, Grand, and Consolidated canals in those categories, however, the six years following its construction had taken its toll on the waterway's carrying capacity. In mid-1915, a group of landowners under the Eastern petitioned the Association's Board of Governors, requesting the canal be enlarged to compensate for reduced flows. According to a report prepared in response by Association Engineer W. R. Elliott, excessive silting in the structure's first five miles (from its head in the South Canal to lateral 2.5) had changed the canal's grade, making it too flat to carry sufficient water. He determined that while engineers designed the canal to carry 8,000 miner's inches in that area, the 1915 flow only approximated 6,350 miner's inches. To correct the problem, Elliott recommended widening the canal for 12 miles to allow for a future loss by silting of 25 percent. On November 1, 1915, the Board passed a resolution endorsing his recommendations.

The plan for enlarging the Eastern Canal received added impetus in 1916. That January, winter floods washed out 1,500 feet along the north bank of the Consolidated Canal in Section 28 of Township 1 North, Range 6 East and the Board of Governors contemplated abandoning a portion of the structure exposed to Salt River overflows. Instead of rebuilding that stretch, they suggested widening the Eastern to a capacity sufficient to carry water for both canals. This expansion would extend 4.5 miles from the South Consolidated Power Plant to a point near the south line of Section 31, where the power plant would be relocated. At that location, water for land under the Consolidated would be passed through the power plant, returned to the canal, and sent downstream. Figures prepared by the Association's engineer estimated the cost of this improvement to be just over $96,000.

Because that expense appeared to be low for the amount of work involved, the Board of Governors directed the Association manager to make a separate estimate. Throughout the summer and into the winter of 1916, crews ran a complete profile and prepared cross sections every few hundred feet. The results of these efforts showed that such an undertaking would probably total over $209,000. Based upon that estimate, Association leaders decided to shelve plans for widening the canal and repair the Consolidated instead.

This issue did not remain suspended for long, however. Floods in February 20 again tore away a part of the Consolidated Canal adjacent to the Salt River, and this time the Board of Governors decided to remedy the situation regardless of cost. In the days following the break, General Superintendent and Chief Engineer W. R. Elliott submitted plans to the Board with an estimated cost of $323,570, which also included moving the powerhouse and making a cross cut to the Consolidated Canal. Working from the original proposal, Elliott designed expansion plans for the Eastern to insure that lands under the Consolidated would not be deprived of water if the river again topped its banks. He also proposed enlarging the canal wasteway to achieve that purpose. The Association obtained all necessary rights-of-way and easements from landowners along the path of the enlarged Eastern, and Association shareholders approved an assessment of $1.14 per acre to pay for the work.

Crews using two draglines removed 18,103 cubic yards of dirt during widening of the Eastern Canal. Horse and mule teams moved an additional 13,248 cubic yards during September 1920, while also having to move part of the dirt left by the dredging machines. In addition, the Association used the Lidgerwood 0.5 Dragline excavator, which had been abandoned on the Consolidated Canal in 1915 after engineers thought it outlived its usefulness. Association personnel rebuilt the machine at a cost of $6,311, and, after May 1921, placed it in constant use widening the Eastern.

Work expanding the Eastern proceeded rapidly until December 1920, when lack of funds suspended further activity. Money again became available in May 1921, and crews returned to their jobs. The canal continued to carry water throughout the widening process. To serve shareholders continually, engineers concentrated on widening one bank of the canal at a time. They accomplished this by starting on the south side and digging out to the center of the canal, where they left a core of material between that point and the north bank. While workers excavated the south side, water flowed through the old section of the canal. After working down a certain distance in this manner, the machines crossed to the opposite bank and continued in the same fashion, with water now flowing through the new portion. Crews repeated this zigzag pattern, crossing back and forth at predetermined intervals, for the entire project. Not only did this enable machines to work within their capacities, it also required less frequent removal of waste material than would have otherwise been the case. As this excavation continued, other workers used the Ruth Dredger to berm the canal.

During enlargement, crews of varying sizes worked on the canal, performing a variety of functions. In October 1920, teams averaged 26 men and 60 head of stock per day. In November and December, this number fluctuated between 12 and 17 men, and six and 23 head of stock per day. Work performed by crews included adding three additional eight by eight inch barrels to a five by five feet siphon where the canal passed under a desert wash, and lengthening a four by five feet concrete culvert. These culvert improvements required substantial form work, and while part of the team engaged in that endeavor, the remainder hauled sand and gravel from the Salt River, about 2.5 miles from the construction site. Completed in June 1923, the total cost for widening the Eastern amounted to $189,853, with part of the expense attributed to unexpected drilling workers had to perform, as well as removing the bulk of excavation material.

About the same time the Association began to revisit pans for enlarging the Eastern Canal, a group of landowners holding acreage outside Project boundaries began to explore ways to get irrigation water to their fields. In January 1920, these individuals formed an organization called the Auxiliary Eastern Canal Landowners Association to pool their resources. Auxiliary Eastern plans called for irrigating approximately 35,000 acres of land east of the Project, using surplus floodwaters from the Salt and Verde rivers, augmented with pumped groundwater. Following extensive conversation with USRS officials and approval of the Secretary, Auxiliary Eastern landowners negotiated a contract with the Association for delivery of the excess floodwaters through the Eastern Canal. This agreement, signed by leaders from both organizations in June 1920, and approved by the Secretary in August, provided for enlarging the South and Eastern canals, and for building a pumping plant to transfer water from the Eastern to a proposed Auxiliary Eastern Canal.

Before any of these measures could be implemented, however, the 1920 contract required that the Auxiliary Eastern Association form an irrigation district, which it accomplished without much delay in September. Despite this early, rapid progress the new Auxiliary Eastern Canal Irrigation District (later reorganized as the RWCD) soon found it difficult to sell bonds with the limited water resources it had available, and the project came to a standstill. Finally, after some consideration, RWCD officials began negotiating with the Association for a supplemental contract in the hopes of obtaining a larger, more stable water supply, as well as a beneficial power agreement. To provide increased water, while protecting Association shareholders, the newly renamed Bureau of Reclamation suggested, in 1923, lining Project canals to reduce loss through seepage.

Early in 1924, Association Chief Engineer, C. C. Cragin requested that Reclamation conduct a water supply availability study for the RWCD. Cragin had already concluded his own examination, but wanted confirmation from another source. Between January and April of that year, Reclamation engineer Charles P. Williams investigated the Project's canal system to gauge, in part, the amount of water that could be saved by lining the distribution structures. In his report, Williams argued that "in most irrigation systems, where water is carried in unlined canals and laterals, the greater part of water losses occur before the water reaches the land. This, in some cases, amounts to as much as 50 percent of the amount diverted." Although water loss was not that high, Williams concluded that the Project system annually lost about 30 percent of its water. More specifically, he determined the amount wasted by the Eastern alone to be 10 percent. Lining the full extent of both the South and Eastern canals, Williams concluded, would result in a yearly water savings of 49,000 acre-feet which could be put to beneficial use by the RWCD.

Based upon these findings, the Association and RWCD singed a new contract in October 1924. According to the agreement, the RWCD would pay the costs of lining the South, Eastern, and Consolidated canals, estimated to total $750,000, in exchange for the saved water. In December, the Secretary approved the contract, and by June 1925, the RWCD was moving forward with a $1,000,000 bond issue to finance the work. While legal problems arose from interpretation of the contract, both organizations initiated preliminary work. In mid-1925, the Association proceeded to gather information on how best to undertake the project, while the RWCD began constructing a pump house on the Eastern in Section 33, Township 2 North, Range 6 East, to divert water into its own canal. After studying criteria for several months, which included visiting other canal lining projects and assessing materials to be used, The Association developed its own specifications. Final guidelines called for the lining to be reinforced concrete gunite (1.5 to two inches thick, with a mixture of one part cement to 4.5 parts sand. The sand had to be fine enough to pass through a 0.5 inch screen, and the allowable silt content could not exceed 10 percent. Reinforcing wire had to be 14 gauge, galvanized electric welded mesh reinforcing steel, with wires four inches center to center, both ways. Upon application, crews needed to keep the gunite moist for 15 days.

As the Association prepared to begin work, another issue about the project came to the fore. In late 1924, consulting engineer Howard Reed suggested changing the Eastern's course. According to the contract between the Association and RWCD, the Project agreed to deliver water to the RWCD's extension of the Eastern Canal. After consideration, Reed proposed enlarging Lateral 12 south of the canal to fulfill that provision. In his opinion, that change offered the best method for delivering the water while still serving Project lands in the vicinity, but it also made the far southern portion of the Eastern, which ran parallel to Lateral 12, an "unnecessary duplication." As an alternative, Reed recommended abandoning the stretch of the Eastern Canal south of Ray Road in Gilbert, and using Lateral 12 as the main waterway in that area. Although he initially called for digging a 0.25 mile extension in the canal to run it straight into the lateral, the Association scrapped that idea and opted instead to cut the Eastern at the turnout to Lateral 12. The peculiar east-west jog in the canal adjacent to Ray Road, which stands in sharp contrast to its general southerly course, is a result of this change. Following completion of the 1925 enlargement, the original portion of the structure and Lateral 12 South became known, respectively, as the "old" and "new" Eastern.

Actual lining operations commenced in the fall of 1925. Among the first tasks Association crews focused on was establishing a 250-man camp near the dam by the old Consolidated Canal. Nearby, they also erected a screening plant and a narrow gauge industrial railroad, graded and connected to gravel beds in the river. The Association purchased a 22 ton locomotive and eight dump cars from Magma Copper Mine

at Superior, Arizona, and, later, an additional engine to haul sand and gravel to the plant. There, crews transferred the material to a revolving sorter, which sifted the rocks, separating those of proper size from larger ones that could not be used. All equipment used on the job, with exception of the two steam engines and gasoline driven P. & H. Dragline, were electrically operated, with power provided by the Association's own system. Power crews installed transmission lines for lights at strategic locations so they could become part of the Valley's permanent electrification system.

Before spraying gunite, crews dressed the canal bank and bottom. Draglines operated from the banks if surplus material needed to be removed from the bottom, and the Ruth Dredger set to work cleaning the canal while it still had water. After the water was turned out, workers enlarged at least one siphon, and mechanical equipment smoothed the surface. Two Best Caterpillars pulled plows and graders to level the bottom, followed by a steamroller that compressed the area. The Association also used Fresnos and employed over 300 laborers to finish the banks manually with shovels. On November 23, 1925 crews began applying gunite and 10 days later, they completed the first mile of the Eastern.

Throughout the lining process, the Association did all it could to ensure farmers did not have to go without water for long. It instituted two, nine-hour shifts, using lighting to continue night operations. Eight cement guns, working in pairs, operated continuously, which required four complete setups. Each of these four units consisted of two cement guns, one compressor, transformers, water pump, and portable cement mixer. This also required the use of several gunite machine setups for each compressor so that progress lining 1,800 to 2,800 feet of canal could occur at the same time. Trucks delivered sand and cement from the screening plant to canal banks, where portable mixers blended it in two cubic foot batches. Laborers then transported the material in wheelbarrows to the gunite machines. These guns, operating under 60 pounds of pressure, sprayed gunite directly through a hose with a stream of water. In addition to the nozzle man, who operated the gun, a second employee held the wire mesh in place until firmly embedded with the substance. Despite the rapid pace with which lining proceeded, however, the Association interrupted work every six weeks to supply lands with water. All told, crews installed approximately 4,500,000 square feet of gunite the first winter at a cost over $600,000, including camp and plant construction.

On January 26, 1926, the Eastern Canal transported the first delivery of water to the RWCD. Work on lining the canals was suspended during the planting season of 1926, but resumed again that fall and continued through the spring of 1927. During this second phase of the project, crews labored on the Main Consolidated Canal from the new power plant to the division gates, and finished lining the Eastern, advancing from Lateral 10 (just north of Elliott Road) to Lateral 14.5 (south of Pecos Road). The 1.5 inch lining placed on the canal sides the previous year proved more than sufficient and project managers reduced the thickness to one inch. In addition, crews also built numerous structures to connect Laterals 12.5, 13, 13.5, and 14 with the new canal section, including 15 concrete drops and seven bridges.

After three years of seasonal labor, work on the southside lining project finally ended in 1928. Canals lined during this last year of operations included the east branch of the Consolidated and the Tempe Cross-cut, raising the total amount of gunite applied to project structures to 7,772,814 square feet. Final cost for the entire project amounted to over $884,000, or $0.114 per square foot, paid entirely by the RWCD except for the portion near the South Consolidated Power Plant.

The Great Depression of the 1930s had a paradoxical effect on the Eastern Canal. Despite the Project's limited funds to maintain its irrigation system during that period, the canal received several new features

and repair work as needed. These improvements and general upkeep resulted from the Association's use of CCC laborers, a New Deal agency created by President Franklin D. Roosevelt to provide jobs for unemployed Americans. Between 1935 and 1938, when trade union complaints finally caused the Association to quit the program, the CCC completed over 700 jobs at the Project.

The work that CCC forces completed on the Eastern during their stay in the Salt River Valley varied. Soon after their arrival in the fall of 1935, Association leaders used them to raise the canal's banks by two feet along the first four miles of the waterway. The canal, like other ditches in the Project, was carrying less water than peak demand required and this modification increased capacity. Throughout the early part of 1936, CCC workers also built two check structures, one at Lateral 5 (near University Drive) and another at Lateral 6.5 (near 9th Avenue). Finally, following flood damage to the canal on July 24, 1936, CCC crews helped remove broken lining and accumulated silt, and dressed the banks in preparation for new gunite. The contracting firm of Vinson and Pringle completed this latter work in November and December of that year.

Regardless of the work performed by CCC crews in the 1930s, many Reclamation projects suffered from neglect during the Great Depression era through World War II. Lack of finances combined with manpower losses meant that routine maintenance on irrigation structures could not be performed. As a consequence, important water distribution systems deteriorated, wasting the vital resource and creating a substantial decrease in efficiency. On the Project leaking canals and laterals, some which had been lined less than 25 years before, resulted in water losses of 25 percent. The federal government, in recognition of these problems, enacted the Rehabilitation and Betterment Act in 1949, which authorized Reclamation to offer interest-free loans to reconstruct and improve aging Reclamation structures.

Seizing upon this opportunity, SRP signed a series of R&B contracts with the government between 1950 and 1980, obtaining more than $27 million in federal aid to modernize its system. During that time, SRP crews working under this program replaced wooden gates with concrete and metal structures, repaired and replaced siphons, bridges, and other facilities used for water delivery and transmission, and lined canals and laterals that experienced weed growth and seepage problems. One of the first jobs they completed involved building a new concrete bridge across the canal at Main Street in Mesa. Work on the Eastern Canal throughout the R&B program consisted primarily of replacing obsolete gates and structures with more modern equipment. Between 1950 and 1960, SRP crews replaced numerous worn redwood checks with concrete versions. They also installed at least six radial gates, used to back water up for delivery to laterals, at various points along the Eastern Canal, including the head. In addition, workers mounted two, 90-inch Sabin gates at the point where the "old" Eastern meets the "new" at Ray Road. These friction gates allowed field workers to raise or lower the opening easily by fractions of an inch. Other installation work throughout the 1950s included the addition of a stilling well and differential recorder at the head of the canal, and a skimmer wall at Lateral 5 (University Drive) to block sand entry.

The Eastern further benefited through the R&B program by receiving canal-lining repair. This component concentrated on fixing areas where erosion and scouring had occurred over the years, particularly below canal structures. Before applying new gunite, workers generally reshaped and formed the canal by excavating accumulated sand and debris from the bottom and placing compacted gravel along the sides for reinforcement. In 1956, crews first patched a small portion of the Eastern's lining near the South Consolidated Powerhouse. That work expanded in the late 1960s to encompass a total of 4,435 square feet, far less than what other Project canals received during the same period. Finally, in 1980, the last year for which SRP received R&B funds, the Water Construction and Maintenance department lined 3.25

miles of the canal between Pecos and Elliot roads.

The Eastern Canal has changed little physically in the 20 years since the R&B program ended. While the canal has continued to receive periodic repair work and minor improvements, such as replacement lining and new structures, these modifications have been more the result of societal changes than inherent problems with the structure itself. Indeed, population trends and new environmental concerns have combined to affect the way the canal is maintained and used. One of the major changes to influence the Eastern Canal during this time has been the on-going evolution of the Salt River Valley from an agricultural community to an urban center. This trend started in the post-World War II era, when large numbers of people began moving to the Phoenix area, but it has mushroomed in recent years. Construction of numerous housing complexes and streets to accommodate the new demographics has transformed expanses of desert and farmland that once surrounded the Eastern. With this movement, area residents have come to view the canal as a source of recreation, using its banks as paths for bicycling, jogging, and horseback riding, as well as favorite fishing spots. Crews trim trees and remove brush and other vegetation along the canal to make it more attractive to community members, and SRP has taken measures to provide safety for recreational users. As part of a four-year program completed in 1984, the SRP installed steps and ladders at points along the canal to provide quick exit for people and animals that accidentally enter the system.

The transformation of the Valley has impacted the Eastern in other ways as well. In the past 10 years the decline in farmland has recast the significance of the structure from purely an irrigation feature. With more residences and businesses doffing the landscape around the canal, the Eastern has become a conduit of domestic and industrial water. In 1994, the Town of Gilbert began constructing a water treatment plant south of Guadalupe Road to serve its growing nonagricultural users. Three years later, the first year of plant operations, Gilbert received 7,816 acre-feet of water through an intake in the Eastern Canal, more than half of the town's domestic supply. By 1999, that number had grown to 12,344 acre-feet.

Aside from changing demographics, ecological concerns have also figured into recent modifications and uses of the Eastern. Among these, SRP has made it a priority to develop an alternative method for keeping canals clear of aquatic weeds and moss without using harmful pesticides or costly mechanical equipment. In 1989, SRP instituted a pilot program of stocking canals with White Amur fish which can eat nearly three-quarters of its body weight in one day. Following two years of successful experimentation, SRP expanded the program in 1991 and began stocking the Eastern with these weed-eaters. To prevent them from migrating to natural waterways and into the lateral system, crews installed a series of fish grates along the canal from its head to Houston Avenue. In 1995, more White Amur were added to the canal and additional grates were placed south of Guadalupe Road extending to Ray Road.

The future of the Eastern Canal portends to be much like its past-based upon function change and evolution. Over the canal's 90 year history, it has grown from simply an engineering structure designed to irrigate lands at the eastern edge of the Project to part of the South Canal and one of the first Project ditches to be lined. As urbanization continues to transform the Salt River Valley, the Eastern Canal will most likely increase in importance as a carrier of domestic water, slowly moving away from its agricultural roots. However the canal is used in coming years, given central Arizona's dependence upon a developed water supply, it is sure to remain a significant and lasting feature of the built landscape.

Tempe Canal

Source: *Tempe Canal, South Side of the Salt River, Tempe/Mesa/Phoenix Vicinity, Maricopa County, Arizona*. HAER No. AZ-16. Fred Anderson, 1989.

The Tempe Canal, from which the City of Tempe takes its name, is situated in the center of the Project in central Arizona. From its present-day heading at the South Canal diversion gates, it runs generally west and southwest 9.3 miles to its terminus at the Tempe Water Treatment Plant, where it meets the Western Canal. Private interests began construction of the Tempe Canal in 1871, and over the next several decades it grew into a series of interconnected laterals and divisions. The Tempe Canal today consists of a south extension constructed in the early 1880s, while the upper-most section of the current canal, which was once called the Tempe Crosscut Canal, was constructed in 1892. The oldest continuously operating canal in the Project, the Tempe Canal serves as a vital source of domestic water for the City of Tempe and provides urban irrigation water to lands between it and the Western Canal.

The origins of the Tempe Canal are inextricably linked with Tempe founder Charles Hayden, his flour mill, and the development of the City of Tempe itself. Legend has it that sometime between 1866 and 1870, Tucson trader Charles Trumbull Hayden was on a trip to Prescott when he found himself unable to cross the flooding Salt River. While waiting for the river to subside, he climbed a nearby butte and looked down at the flowing river and flat alluvial valley. Allegedly Hayden decided then and there that he would move to this place and establish a water-powered flour mill at the base of that very butte, afterwards known variously as Hayden Butte and Tempe Butte. However, it was not until November of 1870 that Hayden filed a claim for water rights and land on the south side of the Salt River. There is some uncertainty as to whether the Hayden ditch was the same as the Kirkland-McKinney ditch (probably named for W. H. Kirkland and J. B. McKinney), which some sources believe was dug in 1870 or before. The fact that this ditch would be known alternatively by both names for many years lends credence to the theory that they were one and the same. This ditch became the northern branch of the Tempe Irrigating Canal probably no later than the fall of 1871. J. T. Priest later stated that he bought a share in the Kirkland-McKinney ditch and went to work on the Tempe Canal in the winter of 1871–72.

Meanwhile a small group of farmers had also been attracted to the possibilities of the south bank. On December 6, 1870, at a meeting "on the south bank of the Salt River," the Hardy Irrigating Canal Company was formed by B. W. Hardy, Jack Swilling, J. E. Ingersoll, J. O. Sherman, J. L. Mercer, and John Olvaney. In January, the name was changed to Tempe Irrigating Canal Company. This unincorporated association of irrigators would last more than 50 years. The goal of the company was to take out a canal which would be used for milling, farming, and other purposes. The head of the canal was in the southeast corner of Section 34, Township 2 North, Range 5 East, or the northeast corner of Section 3, Township 1 North, Range 5 East, about six or seven miles upstream from the Tempe Buttes. The company claimed 20,000 miner's inches of water for their canal.

The founding partners each invested $200 for two shares, and agreed to furnish all tools and provisions for the digging of the canal and building of a dam. Additional shares could be acquired by anyone in exchange for 100 days labor, and a half-day extra credit would be awarded for animals brought to the job. From early March to the end of April 1871, a small ditch was dug under the supervision of Captain Nathanial Sharp. During this time the meetings of the company directors were held at the construction camp. Water was diverted by a small crib dam, and the entire length of the canal and ditches dug that spring probably was not much more than five miles. On April 28, on a motion by Swilling, work was

suspended until July. No more than 300 acres were irrigated that summer. The following October, bids were solicited for someone to extend the canal to the southern line of Section 19. There is no notation whether such a contract was let.

The Tempe farmers in these first several years were living on the edge of civilization, and many were also on the bare edge of poverty. The sense of isolation and limited availability of funds created a necessary sense of community among the settlers, underscoring the importance of the company's large shareholders in financing the initial work. The company's founders each acquired two shares at $100 per share, and had an option to buy up to eight additional shares at that price. All other shares sold for $200 or for labor. Some of those with capital invested a great deal in this undeniably speculative venture. During 1871, Swilling bought a total of 23 shares, Hayden bought 17 shares, and C. A. Carpenter acquired 19 shares.

During the winter and spring of 1871–1872, the canal system was expanded considerably, taking on the general proportion that it would maintain for many years. The headgate in the river bed was a wooden structure, 14 feet wide. What the farmers considered the "Tempe Canal proper" was about a mile long, ending at a gate which was 20 feet wide. Extending below this for about 0.5 miles was the "Trunk Ditch," from which most or all of the branch canals diverged. In the early years there were two main branches. The Hayden branch ran southwest from the Trunk Ditch for approximately 1.5 miles, then turned due west to the Tempe Buttes, where it curved around the southern and western slopes to Hayden's Mill before dumping into the river for a total length of five to six miles. The Western Branch ran about nine miles from the foot of the Trunk Ditch to the Niels Petersen homestead and was completed in 1872. These branches were built by the individuals or small groups of farmers who would be served by them, not by the Tempe Canal Company. The main canal and Trunk Ditch were built on public lands, and the branches ran through and over the homesteads of the owners.

In the summer of 1872 the first permanent rock and brush dam was built, 100 yards long and five feet high. Like all such dams it had no control works. Excess flow rolled over the top, and in a large flood the dam would began to give way, so repair and maintenance work was nearly constant. The canal headgate was built of wooden timbers supported only by earth. The framework was made of timbers one foot square, in which two gates "opened up and down the same as a window" in grooves formed by cleats attached to the framework. During the winter of 1873–1874, a large flood washed around the headgate, leaving it standing in the middle of the stream. After that the headgate was moved "further down, into the cut," and the height of the dam was increased from seven feet to eight feet.

Sometime in the 1870s, a second dam was built about a mile above the headgate, the purpose of which was to divert the river into its southern channel and toward the lower dam and headgate. Through the decade, additional Tempe Canal branch ditches were built and more acreage came under cultivation. In 1873 the Hayden Branch was widened from eight feet to 12 feet in preparation for supplying the Hayden mill, which began taking water in 1874. By 1877, the Carley (or Carley & Beach) Ditch had been dug from the foot of the Trunk Ditch to the west about 1.5 miles. It was five or six feet wide and irrigated four or five farms. The Spanish Ditch started 1.5 miles down the Western Branch and ran to the northwest, crossing the Hayden Branch on a flume. It probably ran to the Mexican settlement, known as San Pablo, located east of Hayden's Ferry. The Miller Ditch ran from the Western Branch about two miles to the south. The Oury Ditch also branched off the Western Branch and ran about three miles. It was built in approximately 1876 and was about eight feet wide at the bottom. The Petersen Ditch was the longest offshoot of the Western Branch. About a mile north of the Peterson Ditch, the Double Butte Ditch left the

Western Branch in Section 25 and ran west to the northern part of Section 29. It was about eight feet wide, and three to four miles long. The Morrow Ditch also departed the Western Branch in Section 25, running northwest about four miles to Section 20. These big ditches usually served several farms, narrowing as the water was drawn off by laterals.

The expansion of Tempe's ditch system was accompanied by an increase in irrigated acreage. In 1875 it irrigated between 3,500 and 3,800 acres. By September of that year, 109 of the original 200 shares of stock in the Tempe Irrigating Canal Company had been subscribed, and the sale of stock ended. Each share was intended to irrigate 160 acres. Although 20,000 miner's inches of water had originally been claimed, the canal had a capacity of only about 11,000 miner's inches. Using the rule that 100 inches would irrigate 160 acres, 109 shares would irrigate 10,900 acres. These 109 shares were subdivided, consolidated, sold, rented, and exchanged throughout the company's existence. C. A. Carpenter, G. H. Oury, J. L. Mercer, and many other shareholders both large and small farmed little or not at all, selling their water rights on an annual basis, yet the irrigated acreage continued to grow. During the second half of the 1870s acreage increased by an average of 1,000 acres per year, to approximately 8,000 acres in 1879.

A southern branch of the canal was dug in the 1880s. Construction may have begun as early as 1878, but it was definitely a major branch of the system by 1887, 20 feet wide and supplying both the Wormser and Kyrene extensions. The southern branch is the major part of the Tempe Canal to survive into the modern period. It terminated in Section 12, where it split into four branches. The Wormser extension ran due west along the southern borders of Sections 1, 2, and 3, then turned northwest, following the contour of the land along the northern slopes of the Salt River (South) Mountains for another 10 miles. Three ditches, the Great Eastern, Jones, and Goodwin, continued to the south, with the Kyrene Extension taking out of the Goodwin about 0.5 miles south of the Wormser. The Kyrene ran west and followed the contour of the mountain range to the southeast, with an ultimate length of some eight miles, ending near the boundary of the Gila River Indian Reservation. The system also contained two waste gates, both off the Hayden branch. The first turned out of the ditch about five miles below the main canal, east of the buttes. The second ran into the river below the tail race of Hayden's mill. Sometime after 1872 the water from Hayden's ditch was delivered to the head of the San Francisco Canal and became the main supply for that canal.

In 1886, the Tempe Canal was widened to 30 feet to reduce dam rebuilding. The wider mouth allowed a three-foot high dam to divert as much water as the previous seven-foot high dam. It was hoped that the shorter dam would be less likely to wash out. Dam maintenance was a constant concern as the dam washed out during any big flood, often several times a year, and had to be rebuilt by company farmers. As more dams were built upstream, the flow of the river diminished. The Tempe farmers tried to capture all the available flow by packing the upstream face of the dam with hay and manure to try to capture more of the reduced flow during the critical late spring and early summer months.

By the mid-1880s the Tempe's basic system had been built and the expansion of irrigable land had leveled off between 8,000 and 10,000 acres. The settlement around the buttes had grown from a few scattered camps to a small town known as Hayden's Ferry until 1879, after which it was called Tempe. The town was, in a sense, named after the canal, which had adopted the name Tempe in 1871. The farmer-citizens of Tempe faced additional challenges that grew out of the growing settlements in the Valley, and the increasingly complex legal and technological problems associated with this growth.

In the years after 1870, numerous other diversion dams and canals were built on the river, many of them above the Tempe heading. The prevailing custom for obtaining irrigation water was based on the concept of prior appropriation rights; however this system had not been officially codified into law. Tempe farmers' water rights should have been secure because their appropriation in 1870 was preceded only by the appropriations of the Salt River and Maricopa Canals in Phoenix (branches of the Swilling Ditch), but the claims were not enforced, and there was no accurate way of measuring the water in the river. This resulted in upstream diverters taking as much water as they needed, without regard for older water rights downstream. As upstream diversions increased, many of the downstream diverters believed that their water supply was being pre-empted by junior appropriators upstream. This sentiment became especially keen after the Arizona Canal Company made a claim for 50,000 miner's inches of water and built a diversion dam above all the other dams.

In February 1887, most of the canal companies joined in a lawsuit to prevent the Arizona Canal Company from diverting their claimed water. Over the next three years the Arizona Canal Company bought a controlling interest in each of the north-side canal companies, and most of the south-side companies dropped out as plaintiffs. By the time the trial began in March 1890, only the Tempe Canal Company and Michael Wormser, sole owner of the San Francisco Canal and a major stockholder in the Tempe Canal, were left as plaintiffs, while all the other companies had become defendants. The case of *M. Wormser et al. v. Salt River Valley Canal Company et al*. was heard by Judge Joseph H. Kibbey in the Third Judicial District Court, Maricopa County. The judge rendered his decision in April 1892, which became the first important water rights case in Arizona Territory. The Kibbey Decision established the principle that water was appurtenant to the land it irrigated and upheld the custom of priority of rights based on date of appropriation and more or less continuous use.

This decision had the immediate result of assuring the water supply of the Tempe and San Francisco canals against all the other major canals. Before the decree had even been entered, all the defendant companies had entered into a contract to share and divide all the water not required for the Tempe and San Francisco canals. The Tempe Canal was assured of a water supply for 117 quarter-sections in times of plentiful supply, and 95 quarter-sections had an appropriation date prior to 1885, when the first appropriations under the Arizona Canal were recognized. Meanwhile, the operating conditions of the Tempe Canal during the 1890s were described as being "as satisfactory as under any large canal of the Valley, and much more satisfactory than under most of the other canals."

For the next 30 years the shareholders of the Tempe Canal Company would consistently operate in an independent fashion, asserting their own concerns and jealously protecting their rights while most other Valley farmers increased the level of mutual cooperation and joined the Salt River Valley Water Users Association. This assertion of independence is the most important theme related to the Tempe Canal in this period.

In March 1892, the Consolidated Canal Company was incorporated by A. J. Chandler and his partners to deliver water to his ranch south of Mesa, where he planned to develop a town and farmlands. Under contract with the Mesa Canal Company, the Consolidated Canal Company enlarged the Mesa Canal and rebuilt the headworks, then extended a canal (the Eastern Branch of the Consolidated Canal) south toward the Chandler lands. However, the late priority date of these lands made the water supply from the river uncertain, so Chandler planned to increase the supply by pumping groundwater beneath his lands. To obtain electricity for pumping, the company created a plan to use the Tempe Canal Company's water. They would carry water in their Mesa/Consolidated Canal sufficient to supply the Tempe Canal, and

would build a crosscut canal to carry the water approximately two miles due west to intersect the Tempe Canal in Section 9. Before joining the Tempe Canal the crosscut canal would drop off a mesa some 35 feet. A hydropower plant, later named the Chandler Falls Plant, would be built at this point to generate electricity, which would be transmitted to the Chandler lands. Because of the very early priority date of the Tempe water, a continuous flow through the plant was much more likely than using Chandler's own much later appropriation.

The Consolidated Canal Company, unable to reach agreement with the Tempe Canal for this use of its water, proceeded with its plans to construct the Tempe Crosscut Canal. When the bank of the Tempe Canal was breached in June of 1892, and water turned in from the Tempe Crosscut Canal, the Tempe Canal Company obtained an injunction in district court to prevent this use of its water, describing it as a trespass on their property, a blockage of their main canal, and an "unskillful" joining which threatened the reliability of supply. However, in the case of *Austin v. Chandler* (1895), the Arizona Territorial Supreme Court reversed the district court ruling, finding that this use of the water did not interfere with the rights of the Tempe farmers as long as the water was conveyed to their canal above the ditch heading of the first user. Tempe farmers apparently obstructed the interconnection even after the Supreme Court decree in November 1895.

The Chandler Falls Plant was an advanced concept for the Salt River Valley at this period. Within three years the plant was providing power for street lights, homes, and shops in Mesa and Tempe. Persistent drought in the late 1890s meant that even the Tempe Canal Company's venerable water rights were frequently unfilled, so Chandler built an oil-fired steam generator at the Falls site to provide improved reliability, although power generated in this manner was much more expensive than by hydropower. By 1901, Chandler had completed construction of transmission lines to his lands and began pumping from wells which eventually irrigated several thousand acres. In 1908, the federal government acquired the Consolidated Canal, including the Tempe Crosscut and substantially all the features of the Chandler Falls site, except the hydropower plant itself, which it finally purchased 1916, only to rebuild it in 1919.

Tempe farmers voice stringent objections to the hydropower plant, arguing that debris would come down the falls and the rush of water would blow out the banks of their canal. These complaints were spurious, and their stance short-sighted. The opposition of the Tempe farmers toward Chandler's power development fit the emerging pattern of Tempe Canal users as independent, bordering on intransigent, people who stubbornly defended their water rights in the face of other opportunities. Despite actually receiving superior water delivery through the Tempe Crosscut, the Tempe Canal Company would maintain its original headworks to capture flood flows as long as the company existed.

By the late 1890s, irrigation had reached the limit of its expansion without federal aid and a pernicious drought was demonstrating that dependence on the natural flow of the Salt River was a risky proposition. The answer to both concerns was water storage and river flood regulation by means of a major storage dam located in the canyons on the upper Salt. The enactment of the Reclamation Act in 1902 and the subsequent authorization of the Salt River Valley Federal Reclamation Project promised some relief to Valley farmers. To facilitate the repayment of construction costs, the Water Storage Committee presented a plan for the formation of an association of all landowners in the Valley based on land tenure, which became the Salt River Valley Water Users' Association. This Association was formed to represent the interests of area farmers, as well as to guarantee repayment to the federal government and provide an organization to operate and maintain the finished system. Most local farmers approved the articles of

incorporation during a meeting on January 17, 1903, but a minority report which was read at the same meeting indicated that controversy on the executive committee had not been solved. The three signatories of the minority report were Ethelbert Wilbur of the Mesa Canal, James W. Woolf of the Tempe Canal, and Dwight B. Heard, successor to the Wormser interests in the San Francisco Canal and a large stockholder in the Tempe Canal. Minority members offered a number of amendments to the articles, which were rejected and the unedited articles were filed with the County Recorder's Office on February 7, 1903.

The key principle of the minority opposition was the desire to maintain the independence and autonomy of the existing canal companies. The minority report suggested that each canal form a division in the new Association with its own three-man board of water commissioners. This board would both operate the canal and collect assessments. Most importantly, improvements in each division would be paid for only by the members of that division, and prior rights under the older canals would be protected from dilution. The minority position reflected the concerns of many of the older water rights holders in the Valley, which of course included the Tempe farmers. These farmers were essentially satisfied with the water delivery system and feared any expansion of irrigated acreage would lead to a reduction of the amount of water available for prior appropriators. They also felt that their well-established and very valuable farms would be the principal security for the project, while land speculators and new homesteaders would be the principal beneficiaries.

The minority interests tried repeatedly to press their demands on the Secretary and representatives of the USRS, but were told that any changes in the articles would have to come from the Association. As part of this effort, Heard's business partner Adolphus C. Bartlett expressed, in a letter to an associate, some of the reasons why the minority was so strongly opposed to the articles. The primary reasons were economic. Farmers under the Tempe Canal were paying about $0.50 per acre per year for water, while "less favored" areas of the Valley paid three times that much. There was also resentment against George Maxwell, who had been brought to the Valley as an expert in reclamation law, and who the minority saw as the principal person responsible for overriding the district system approach. Maxwell, wrote Bartlett, had set himself up as a stand-in for the Secretary: His oft repeated question from the platform had been "Do you want water storage? If so you must do thus and so, or, in my opinion, the Secretary will never build the reservoir." Bartlett continued, “Every one wants water storage at all hazards and a majority of the Committee has been secured for the present Articles by this ‘whipping in’ process.”

For the next several months, as the Association was trying to sign up farmers, the Tempe farmers continued to try to carry the minority arguments to the Secretary. For these efforts the company, and especially Bartlett and Heard, were alternately vilified and cajoled by Valley civic leaders and editorialists. But the Tempe landowners were pursuing an independent course to assure their water supply. On May 30, Tempe Canal shareholders approved a petition seeking to have its water stored in the reservoir and distributed to them when needed, and even to join the Association, if the Secretary agreed to the conditions which had already been rejected. Several weeks later they attempted unsuccessfully to file on a power site on the upper Salt River, in the vicinity of Mormon Flat, the idea being that hydropower could be generated to run pumping plants in the Tempe district as an alternative to the reservoir.

When the signup deadline passed on July 13, 1903, only a few of the Tempe farmers had joined the Association (the Mesa and Utah canal companies also declined to join the Association). The Tempe farmers were forgotten in the excitement over the beginning of dam construction, but the mutual resentment between the Tempe Canal Company and the Association would color the relationship

between the groups for years to come.

During the construction of Theodore Roosevelt Dam, water rights for almost all land in the Valley were adjudicated as a result the *Hurley v. Abbott* lawsuit. The Tempe Canal Company filed motions early on attempting to obtain a separate trial and a change of venue, which were denied. The resultant legal decision known as the Kent Decree of March 1, 1910, reaffirmed the principle that water rights were appurtenant to land and divided Valley irrigable lands into three classes based on when they had begun receiving irrigation water. Of the lands under the Tempe Canal, 24,380 acres were decreed to have Class A rights, that is, rights to the normal flow of the river, or water that would have come down the river if there were no storage dam. Class B rights were given to 1,045 acres, which meant that these lands had a right to surplus flow of the river. The Kent Decree reaffirmed early appropriation dates of almost all the lands under the Tempe Canal, and though the duty of water to the lands was somewhat reduced (from 64 to 48 miner's inches per quarter section), the government and the water commissioner were instructed to ensure that the water for Tempe would continue to flow down the river and through the Consolidated Canal just as it had before the decree.

That same year some Tempe landowners made an attempt to incorporate the Tempe Canal to the Project. The primary goals of these landowners were to obtain storage water rights from the reservoir and government resources for drainage of their lands, which were becoming waterlogged. The landowners met with Project Engineer Louis C. Hill several times to explore the possibilities. After the meetings Hill estimated that 17,000 of the approximately 24,000 acres in the district would vote to come into the Association, and that the remainder would be willing to buy water through government canals for a fee of $1.80 per acre. He proposed to the Secretary that the entire Tempe system be purchased for $156,800.25. Two factors caused many Tempeans to question the government's proposal. First, their current irrigation costs were remarkably low. In the 1910 fiscal year, the Tempe Irrigating Canal Company served 22,510 acres for a total assessment of $8,696, or about $0.40 per acre. Second, there was adamant opposition of many, if not most shareholders to joining the government system. All the shareholders knew that some of their neighbors would never sell their interest to the government, and that the government would insist on complete ownership. In the end, the United States was unable to reach an agreement with the Tempe Canal for the use of its canals, although individual farmers were free to give up their Tempe Canal shares and receive stored water if there was any feasible means of conveying it to their land.

In late 1910, Hill made an offer to buy the Wormser Branch alone. This canal extended from the Southern Branch of the Tempe Canal along the section line between Sections 1 and 12, and ran west approximately 2.5 miles before turning north and west another 10 miles along the base of the Salt River Mountains. The government planned to dig a feeder from the Consolidated Canal in Mesa west to where it would join the Wormser. In December, the owners of the Wormser responded with a counter-offer that they would retain the canal, but allow the government to expand it to carry Association water. Instead of accepting this offer, the government began surveying a parallel canal (the Western Canal) in February 1911. During the spring of 1911, the Western canal was dug from both ends toward the terminus of the Tempe Canal, with the south Phoenix section of the Western Canal running parallel to the Wormser. Meanwhile the USRS continued negotiations to purchase the Kyrene Branch (also known as the Orange Belt Canal) of the Tempe Canal, which ran parallel to and 1.5 miles south of the Wormser Branch until it turned south and west to water south Tempe lands. Finally, when the USRS was unable to secure the purchase of the Kyrene, it condemned a right-of-way on the north side of the Kyrene and piped under the Southern Branch of the Tempe Canal into the Western Canal.

After the construction of the Western Canal, the operating relationship between the USRS and the Tempe Canal Company ran smoothly and was unaffected by the transfer of Project operations to the Association in 1917. However, as the Project increased the irrigable area of the Valley, the rising water table became an increasing threat to both Tempe Canal Company and Association farmers. Despite the fact that both the Tempe Canal Company and the Salt River Project pumped water to increase their irrigated acreage, or as a backup supply to river water, thousands of acres were so poorly drained that salts and alkali were not being leached out of the root zone. Eventually such land would be unfit for any farming activity.

The geology of the Salt River Valley is characterized by deep alluvial fill, through which flows a substantial underground river. When sufficient lands on either side of the river are irrigated, the size of this underground flow is augmented by return flow of the irrigated water. The flow of this underground river is constricted by an underground ridge extending across the middle of the Valley from the eastern end of the Salt River Mountains north to Camelback Mountain, which breaks the surface as the Double Buttes and Tempe Butte, as well as the Papago Buttes north of the river. The ponding effect from this ridge was the reason why Tempe lands were the first affected by waterlogging when extensive irrigation in the East Valley caused the water table to rise nearly to the surface.

In 1905, members of the Tempe Canal Company had built a battery of pumps along the Hayden Branch in the northwest corner of Section 24 to supplement the supply of river water. The Hayden Branch battery consisted of 10 pumps, each 16 inches in diameter and 200 feet deep. They operated by means of a branching 10-inch suction pipe, which was inserted into the top 30 feet of each well. A single Byron Jackson 750 rpm pump provided suction to the system, which fed a 42 inch steel discharge pipe that dumped water into a concrete flume. Power was provided by a Murray Corliss tandem compound 250 hp engine driven by two Kewanee boilers. The entire plant cost $56,000, and produced 1,100 miner's inches of water. The company also owned a smaller pumping plant, known as Heard's Pump, located in the southeast corner of Section 30. This plant consisted of six wells with 18 inch diameters, 100 feet deep, also operated by a single suction pump. The two pumping plants presented a possible solution to the drainage problem, but this was ignored by the Tempe farmers.

By 1910, the drainage problem had become serious enough to elicit an inquiry from a representative of the Tempe Canal Company as to the legality of setting up a bonding district for drainage. By 1912, with statehood achieved and a drainage district law on the books, an attempt was made to establish a drainage district which substantially overlaid the Tempe Canal Company lands. Although this organization was not authorized, a subsequent attempt to form a drainage district in the Tempe Canal service area was authorized in an election on October 3, 1914. The Drainage District had two alternative methods to drain the lands. The more expensive method was to drill wells to pump out ground water, which would have made it possible to lower the water table to any desired level, and would coincidentally have generated enough water to irrigate, by one estimate, 3,000 to 5,000 acres of land. The benefits of this method were already being demonstrated by the Tempe Pumping Plant, where the battery of pumps had lowered the water table over an area one mile in diameter.

However, the District chose to drain the land by digging a seepage ditch that would drain the water off toward the Gila River Indian Reservation. An unusual feature of the drain was that it crossed from the Salt River watershed into that of the Gila River. This factor, combined with the failure to use pumps, ensured the failure of the project. At its upper end, the ditch was six feet deep, which increased to 15 feet as it crossed the divide between the watersheds, but there was still virtually no flow from the upper end, where the water was about three feet deep but had no perceptible velocity. Drainage was so poor that

water was standing in the fields and along the road near the ditch. By 1920, the water table in the Tempe Canal service area had not declined significantly, if at all. An Association report on groundwater and drainage showed the average depth to groundwater in the Tempe Canal area was less than 10 feet.

The prospect of the Tempe Canal Company joining the Project had been a topic of discussion since 1903 and there had been negotiation attempts ever since the Company's initial refusal to join the Association. By late 1919, however, the idea of joining the Project had reached the point where the two organizations were holding meetings and exchanging correspondence on the subject. While the tone of these exchanges sometimes suggested that there were still some serious differences, negotiations proceeded rather smoothly. In December of 1919, Association President J. M. Wilkinson wrote to E. W. Hudson, chairman of the Tempe Canal committee on consolidation, that "we do not seem to be very far apart in our views unless it be on the question of making immediate compensation to you for (your) irrigation and drainage works." The Association was not in any position to pay for the property in cash, said Wilkinson, but would allow the Tempe farmers credit against the Project construction assessments they would be paying as Association members.

In January 1920, an Association committee on the merger proposed three basic principles for an agreement. First, 90 percent or more of the Tempe shareholders must join the Association and they would be on equal terms with current members. Second, all back assessments on the Tempe lands must be paid. Third, Tempe shareholders would be allowed fair value for the "physical property" that was taken over for use by the Project, which would be determined by a three-man board of engineers. The primary interest of the Tempe landowners was to secure drainage for their lands, so they insisted that their back assessment payments be used to help pay for drainage pumping in the Tempe area; however, the Association committee wanted no strings attached to the use of the money. This issue was resolved when the Association membership voted in an April 1920 election to assess themselves a $2.04 per acre to construct a drainage pumping system on the Project, and another $1.80 to construct waste ditches. Thus, if Tempe joined the Project they would immediately begin to benefit from the drainage program.

Despite the favorable assessment election results, the defeat of the incumbent Association President, F. M. Wilkinson, by F. A. Reid in that same April 1920 election set back the merger for another two years. There are some indirect indications that Reid's election was the result of concerns about efficient operation of the Project, but there was no reporting either in Association documents or the press that such an issue raised during the election. At the time, the farmers were profoundly affected by the postwar depression and were falling behind in paying their assessments. As a result, the Association was in danger of defaulting on its construction repayments to the federal government. Upon taking office, Reid immediately abrogated the previous understanding by insisting that Tempe entry into the Project would be on terms of no compensation whatsoever for the canal company's property, either in cash or in credit against assessments. In a letter dated June 1920, he quoted the terms of contracts which the Association was negotiating with the Auxiliary Eastern Irrigation District and the Paradise Verde Irrigation District as examples of lands coming into the Project without compensation. He concluded the letter by saying that if the Tempeans cared to continue negotiations on those terms, the Association would do so. Hudson replied immediately that he did not see the relevance of the examples cited, because they were both outside the Project boundaries, and were prospective projects with no water rights or existing facilities, whereas the Tempe lands were in the middle of the Project, had highly developed facilities, and good water rights. He called attention to the fact that all the other developed canal companies that had joined the Association had been compensated in some way. Ten days later, Reid responded that the major item of compensation was not negotiable, and there would be no further discussion until such time

as the Tempe Canal Company was prepared to concede that point.

The Tempe Canal Company did not reply to Reid's ultimatum for fully three months. After the Tempe shareholders met in October, Hudson wrote that they were prepared to enter the Project on the terms previously outlined, but would not enter without compensation. There the matter died. There can be no doubt that Reid's actions constituted a summary repudiation of the previously negotiated understanding, but whether the reasons were economic, ideological, or personal is unknown. Certainly they fit the established pattern of nonnegotiable principles and stubborn rhetoric that had characterized relations between the two companies over the years.

No further action took place on the merger of the two systems until July 1922, when the Association Board of Governors passed a resolution that "all negotiations with the Tempe Canal Company shall be carried on with the understanding that the Tempe Canal District shall be admitted to the Salt River Project on the same basis as the present shareholders of this Association." While this was essentially identical to a resolution passed in the spring of 1920, it indicated the merger idea had returned to the fore.

Drainage continued to be the outstanding motivation for both parties. During the wet winter of 1921–1922, an alarming rise in the water table on the south side of the river was attributed to over-watering by Tempe farmers, who had been "dumping water into their land all winter." This caused a rise in the water table on Project lands in Mesa, and it may have been the reaffirmation of the need for a regional solution to the groundwater problem that led to the new negotiations. By August 1922, the general principles of an agreement had been approved by the leaders of both organizations. The mechanism for the merger was the creation of an Agricultural Improvement District which would take over operation of all the works and properties of the Tempe Irrigating Canal Company and Drainage Districts No. 1 and No. 2, the power plant for the Hayden Mill, and the Tempe and the Heard pumping plants. The Agricultural Improvement District would convey these properties to the United States, and they would be operated by the Association. Thereafter the District would issue bonds to finance the building of a drainage system for the Tempe lands.

Through the fall and winter of 1922–1923 negotiations continued on the fine points. On June 16, 1923, the presidents of both organizations signed the contract whereby the Tempe Irrigating Canal Company went out of existence, and the canal which it had built in 1870 and jealously guarded over the succeeding 53 years passed to the ownership of the federal government under Association management. The Tempe landowners were assured in their water rights, and would benefit from the Association drainage program and the increased financial stability of belonging to the Project. The Tempe Canal owners were required to pay $25 per acre in back construction assessments, but these were spread out over a 30 year period. They were also vindicated in their dispute with Reid over credit for their property, receiving credits up to $100,196 for the canal system, pumping plants, and other properties. Hydropower generation at Hayden Mill was ended, and the mill signed a contract to buy power from the Association.

The Tempe farmers did not simply recede into the background, however. In 1924, the extended wet period which had aggravated drainage problems was succeeded by an extended dry period. In 1925, Association landowners voted overwhelmingly to begin using drainage water for irrigation. Previously, it had been sold to off-Project users or run back into the river. Because the Tempe area was among those with the worst drainage problems, and because it was not economically feasible to transport drainage water for long distances across the Project, Tempe lands began to receive a large proportion of the drainage water as irrigation water. There was at that time a strong belief among farmers that pumped

water was inferior to river water because it contained a higher concentration of salts, and the Tempe farmers began to feel that their natural flow water rights were being subverted by the substitution of pumped water. They began to complain of this, and in the face of their threats, their payments of back assessments were postponed for several years. The Association and the Tempe landowners were unable to reach a compromise, and in September 1934, a group of 106 Tempe landowners representing 10,000 acres sued the Association, seeking to be assured delivery of river water, and to limit the pumping of their lands to that necessary for drainage.

The suit was resolved in favor of the much more powerful Association. The decision stated that the Association was the best judge of how to operate the Project, and could make necessary adjustments to the irrigation system within the limitations imposed by the location and condition of each area of land it served. For example, while pumped water might be inferior to river water, this deficiency could be corrected by increasing the amount of water in each irrigation application, to wash any excess salts out of the soil. Furthermore, other Project lands received no benefit from drainage pumping which saved the Tempe lands from ruin, but all lands in the Project paid for it equally. The decision was appealed to the Arizona Supreme Court, where it was affirmed in 1939. From that date it may be said that the Tempe landowners, as well as the physical property of the Tempe Canal, were finally consolidated into the Salt River Project. It became part of the Southside Irrigation Division of the Project, and its Wormser and Kyrene extensions were incorporated into the existing parallel canals. As Tempe became increasingly urbanized, the original Hayden and Western branches of the Tempe system, which dated from the early 1870s, were both reduced to laterals and replaced with underground pipes. Soon the term "Tempe Canal" referred only to the main canal from the Tempe Crosscut to the junction with the USRS-built Western Canal.

Following the end of World War II, the Project participated in a federal loan program to rebuild and modernize its irrigation delivery system. The R&B program funded concrete lining of canals and laterals, underground piping of some laterals, and replacement of earthen and wooden headgates and control structures with concrete and steel components. These measures saved water loss due to seepage and weed growth, reduced erosion, and improved the regulation and measurement of water delivery. In addition, underground piping of laterals improved the safety and traffic flow of an increasingly urbanized area. R&B funds were used to build a concrete slip-formed ditch on the Hayden Ditch, now called Lateral 5, east of McClintock Drive. After being piped for several hundred yards, the water emerges into a broad and shallow unlined ditch not very different from that originally dug by the pioneer shareholders in 1871.

The R&B program and other improvements by SRP's Water Construction and Maintenance division also sought to increase efficiency of water delivery by improving the routing and operation of the system. Improvements to the lower reaches of the Hayden Branch of the Tempe Canal, which was the most historic section of the canal, exemplify these efforts. The Hayden Branch had provided water for hydropower generation at Hayden Mill, and supplied water to the San Francisco Canal. Hydropower generation at the mill ended in 1924, yet the canal still ran behind the mill and along the south bank of the Salt River for approximately three miles before reaching any farm gates. Besides resulting in a large loss of water through seepage and plant growth along the sandy river bank, this section of the canal was frequently used by Project zanjeros as a handy waste ditch to dump excess water into the riverbed. By removing this ditch, Project engineers hoped to eliminate the seepage losses, avoid further maintenance on the Hayden tailrace, and make use of the water being dumped into the river bed by the zanjeros.

Therefore, the Hayden Branch was eliminated north of a point known as Continuation Gate 70, at about

5th Street and College, in downtown Tempe. Those lands in north Tempe that had relied on the Hayden Branch would continue to be served by the lateral which ran more or less down 5th Street to 52nd Street. Laterals 6 and 7 of the Western Canal were expanded to carry water north to the south Phoenix lands formerly served by the Hayden Branch. At the same time, these laterals were converted to underground pipe. The realized water savings in eliminating this section of the Hayden Canal, combined with the savings of losses due to seepage and evaporation in Laterals 6 and 7, was estimated to amount to 8,825 acre feet of water per year.

As Phoenix and its suburbs grew, more and more of the farmlands within the Project were converted to residential neighborhoods. These lands still retained water rights, however, and many homes, schools, and parks continued to receive flood irrigation through Project canals and laterals. Urban irrigation has given large areas of the Valley a distinctive landscape comprised of ditches, standpipes, ditch gates, and bermed lawns. Of course, the most imposing structures are the canals and large laterals. As the urban area grew, the streets and blocks, with their rectilinear orientation, ran up against the canals, which were oriented to the slope of the land. The canals were not only physical barriers, but legal ones, because their rights-of-way are owned by the federal government. Therefore the layout of streets and neighborhoods was forced, in most cases, to conform to that of the canal system where they met. For example, the Tempe Canal also serves as the border between the Cities of Tempe and Mesa from University Avenue to the Western Canal.

While many ditches have been abandoned or piped underground, SRP has long had a policy of retaining the federal ownership of canal and ditch rights-of-way, whenever possible, for future use. This has created subtle aberrations in the urban landscape. The Western Branch of the Tempe Canal, dating from about 1872, ran only through farmland until the mid-1960s, when the southward expansion of the City of Tempe reached and passed it. From 1965 to 1974 most of this ditch, now known as Lateral 6, was piped in conjunction with the development of residential subdivisions in the neighborhood. Although no longer visible, the Western Branch left a permanent imprint on the development of the city because the streets to the north of the ditch, such as Concorda and Broadmor, had already been laid out parallel to the ditch. SRP continued to retain ownership of the right-of-way, which can be seen on the surface as a grassy median running down the middle of Alameda Drive, and as unusually wide alleys along the route of the ditch. The Hayden Ditch is similarly marked along its piped sections by set-back buildings and wide sidewalks and streets. Another remnant of the Tempe Canal which is still visible in the layout of urban development is the old Trunk Ditch, which was superseded by the Tempe Crosscut in 1895 as the main delivery canal for the Tempe system. Though seldom used thereafter, the Trunk Ditch was maintained by the Tempe Canal Company until its transfer to Reclamation upon purchase by the Association, and continued to be represented on canal maps up to that time. The original headworks in the river have apparently been covered by a landfill.

While the alignment of Alameda Drive and other streets is an example of the city conforming to the canal system, there have also been cases when the changes to the irrigation system were requested or implemented to conform to urban development. Dobson Ranch, a 1,600 acre planned development just east of the Tempe Canal, approached the Project in 1971 to consolidate the water rights and water delivery of all the land in the development to create a system of lakes as its centerpiece. The initial proposal was to reroute the Tempe Canal and divide and curve it in picturesque ways. SRP rejected this plan but eventually approved an alternate plan by which the development diverted approximately 700 miner's inches of water at a single point on the Tempe Canal to supply the lakes. SRP refused to accept and credit return water from the lakes, because of the fear of setting an unworkable precedent in crediting

return flow. The water is lost through seepage and evaporation and replaced as needed.

While SRP declined to relocate the canal for the Dobson Ranch development, it was realigned in 1977 because of the construction of the Superstition Freeway. SRP originally hoped to run the canal under the freeway along the same alignment, but ended up routing it approximately 0.5 miles due west, then running across the freeway in a flume with service roads on both sides. In 1989, work began on another realignment and piping of the same section of the canal. This was necessitated by the planned construction of the Price Freeway, which overlaps the Tempe Canal right-of-way for approximately two miles, from the Western Canal to the Superstition Freeway. The canal goes underground on the north side of the Superstition in two 10-foot diameter pipes, crossing under both the Superstition and Price freeways and running south under the west access road of the Price before spilling into the Western Canal. This was the first time a long stretch of a major SRP canal had been piped, and it eliminated the flume over the Superstition Freeway.

The Tempe Canal is the oldest canal in the Salt River Valley in continuous use. The oldest part of the main canal still in use is the reach below Chandler Falls, which was constructed in the spring of 1871. This is one of the few sections on the upper reaches of the canal that still ran past farm fields in 1989. The Hayden, or McKinney-Kirkland ditch, which in one place runs between Hayden Lane and Kirkland Lane in Tempe, is largely piped, but was still open ditch in some small sections. Remnants of the abandoned tail race were still visible along the north bank of the Salt River in 1989. This reach, the first extension of the Trunk Ditch, dates from no later than 1872, and is now a supply source for urban irrigation in north Tempe. The Western Branch, which also dates from 1872, is now entirely piped and supplies urban irrigation water to central Tempe. The Southern Branch dates from the early 1880s, and is the branch which is today known as the Tempe Canal.

Western Canal and Highline Canal/Lateral System

Source: *Western Canal, South Side of the Salt River, Mesa/Tempe/Phoenix Vicinity, Maricopa County, Arizona*. HAER No. AZ-22. Fred Anderson, 1990.

The Western Canal, so named due to its location on the west side of the Project, was constructed in part between 1911 and 1912 by the USRS and finished between 1912 and 1913 by the Western Canal Construction Company. It originates at the terminus of the Tempe Canal and runs due west for 9.5 miles before turning north to run about 14 miles around the north side of South Mountain to 23rd Avenue and Dobbins Road, where it terminates near 18th Avenue. The Highline Canal laterals are fed by the Western Canal, and wind north and south through Tempe, Guadalupe, Awahtukee, and southwest Phoenix. The Highline system was constructed in 1913 by the Highline Canal Company and consists of a pumping plant and two laterals that carry water around the base of South Mountain. The open North Branch Lateral extends about 10 miles north and then west until 10th Avenue south of Guadalupe Road, and the primarily open South Branch Lateral travels about 4.5 miles south and then west ending near 44th Street, south of Chandler Boulevard. Both the Western and Highline canals were constructed to provide water to farmers on the southwest side of the Salt River Valley.

Although they became an important part of the Project, and fundamental to operations on the south and west sides, the Western and Highline canals were relatively late-comers to the Valley irrigation system. The Tempe Canal, begun in 1871, was the first permanent canal taken out on the south side of the Salt

River. Over the next three decades, the Tempe system gradually extended to the south and west, serving much of the area that would eventually come under the Western Canal. The Wormser and Kyrene branches of the Tempe Canal were precursors of the Western Canal, located in approximately the same place, and irrigating many of the same lands. The Wormser Branch of the Tempe Canal ran west, and then followed the contour of the land to the northwest around the base of the Salt River (South) Mountains. It may have been built as early as the mid-1870s, and by the late 1880s most of the lands in this area were irrigated by the Wormser Branch. The Kyrene or Orange Belt Branch of the Tempe Canal ran west about 0.5 miles south of the Wormser Branch, then turned to the southwest and followed the contour of the land in that direction. New lands under this canal opened up in the late 1880s through 1907. The farmers served by the Wormser and Kyrene branches formed companies to dig and maintain these canals and also held shares in the Tempe Irrigating Canal Company, the unincorporated association that maintained the Tempe Canal and its dam on the Salt River.

Between 1890 and 1891, large-scale flooding of the Salt River washed out the primitive dams and headgates of Valley canal companies. The floods were followed by a 15 year-long drought that was interrupted by the occasional destructive flood event. The solution to controlling the flows in the river and increasing the water supply to Valley residents was the construction of a storage dam. The passage of the Reclamation Act in June 17, 1902 and authorization of the Salt River Federal Reclamation Project the following year, promised relief from unpredictable flows to many Valley farmers. To facilitate the repayment of construction costs, a plan was presented for the formation of an association of all landowners in the Valley based on land tenure, which became the Salt River Valley Water Users' Association. This Association was formed to represent the interests of area farmers, as well as to guarantee repayment to the federal government and provide an organization to operate and maintain the finished system. Draft articles of incorporation were drawn up, and while a majority report recommended passage, a minority report backed by the Tempe and San Francisco canal companies offered a number of amendments to the articles. The articles of incorporation were approved without the amendments and the document was filed with the County Recorder's Office on February 7, 1903. Landowners and canal companies were given until July 13 to enroll under the Project.

The minority Tempe and San Francisco canal interests tried repeatedly to impress their demands on the Secretary and USRS representatives, but were told that any changes in the articles would have to come through the Association. For the next several months, as the Association was trying to enlist Valley farmers, the minority interests continued to try to carry their arguments to the Secretary; however, the government insisted that it would deal only with the Association. When the enrollment deadline passed on July 13, 1903, only a few of the Tempe farmers had joined the Association. Mutual resentment between the Tempe Irrigating Canal Company and the Association would color the relationship between the groups for years to come.

As time passed, the Project grew to include much more than the storage dam, later named Theodore Roosevelt Dam. Granite Reef Diversion Dam was completed in 1908 and became the single point of diversion for all the canals on both sides of the river, including those canals like the Tempe that had not joined the Association. The USRS also bought or appropriated all major Valley canals except for the Tempe, Mesa, and Utah, and made many enlargements and improvements to the system, including the development and transmission of hydropower.

The construction of the Western Canal originated in a failed attempt by the USRS to obtain control of the Tempe Canal. By 1910, Tempe Irrigating Canal Company shareholders were looking to improve the

drainage of their lands, which were becoming severely waterlogged. Approximately 12,000 acres of Tempe Canal land had serious drainage problems, and while some believed that drainage ditches would be sufficient to carry the water away, others thought that pumping would be necessary, which was a task that would require the extensive resources of the federal government.

USRS Project Engineer Louis C. Hill surveyed the canal properties to determine their value and to gauge the drainage problem. He also polled Tempe landowners and concluded that the owners of 17,000 acres were "willing" to sign up under the Project. The government made an offer of $157,000 for the entire Tempe system including all branch canals, and promised to begin a drainage project as soon as title was transferred. The offer specified that at least 70 percent of the Tempe district's 24,000 acres would have to join the Association or the offer would be withdrawn. While the Tempe shareholders considered this offer, some farmers in the southern part of the district independently joined the Association so that they could receive stored water. The government was eager to incorporate Tempe farmers. The early priority of most Tempe water rights meant that they would add considerably to the stored water because their water had to "pass through" the dam if ordered. Their land would add thousands of acres to the assessment rolls of the Project as well. Furthermore, the Tempe system represented a barrier to the delivery of water to valuable project lands west of it, in south Phoenix. If the government could not acquire the Tempe system, or at least the Wormser extension, it would be faced with digging parallel canals to reach south Phoenix.

Many Tempe shareholders questioned the government's proposal because it would increase their irrigation costs from $0.40 cents per acre to about $1.80 per acre. They also believed that joining the Association amounted to forfeiture of their substantial investment in the Tempe Canal and its works. In September 1910, the Tempe Canal Company declined to join the Project and decided to pursue its own solution to the drainage problem. Despite the government's best efforts, just 1,850 acres of Tempe Canal land had independently enrolled with the Association by the end of July 1910, and only 160 more acres were incorporated over the next 5.5 years. All the lands that joined the Project were in the southeast corner of the Tempe district, which could be served by laterals off the Consolidated Canal.

Frustrated in his attempt to buy the whole Tempe Canal, Hill made an offer to buy the Wormser and Kyrene branches, which were the most crucial of the Tempe system branches for reaching south Phoenix. The government's plan was to widen both canals and dig a feeder from the Consolidated Canal in Mesa west to where it would join either or both of them. The government's offer for the Wormser amounted to about $10,000. The owners of the Wormser immediately made a counter-offer to retain the canal, but allow the USRS to expand it to carry Association water. Hill wrote to the Director of the USRS, asking if the department would still "care to consider a proposition" of owning either of these canals "in common with a few other individuals," with the government retaining ownership of about 0.75 percent of the stock. Hill knew that to construct a canal across the low-lying and waterlogged lands of south Tempe would involve building a ditch "high out of the ground," and urged the government to "exhaust every means to acquire possession of these canals, or either of them, rather than be compelled to build a new ditch in this locality." The government declined the Wormser's counter-offer and by the first of February there was a crew in the field surveying for a new canal. During the spring of 1911, government crews began digging the Western Canal from both ends toward the middle, while negotiations continued with the Kyrene Canal owners.

On the west end (Division 2), the government began construction at the west line of Section 32, Township 1 North, Range 4 East, and worked upstream, paralleling the Wormser Canal on its south side. From this

footing, the canal would not serve south Phoenix without a further extension or a crosscut to the San Francisco Canal. On the east end digging began on Division 1, working from the east, and extending and widening the Peck and Pine feeders, which ran west from the Consolidated Canal to the west line of Section 9, Township 1 South, Range 5 East. The Eureka Ditch off the Mesa Canal also contributed to the system, joining the Peck Feeder near its lower end. By midsummer, the government had given up its attempt to buy the Kyrene Branch, and had secured right-of-way for its parallel canal on the north side of the existing one. In conformance with its general upgrading of the irrigation distribution system which it owned, the USRS engineered all the major structures on the Western Canal, such as drops, turnouts, bridges, and siphons, and constructed them of concrete.

Construction of the Western Canal was complicated by the need to go over or under the Tempe Canal, and its Wormser and Kyrene branches, as well as their two separate lateral systems and connected roads. In June 1911, there were 170 men and 165 head of stock at work on the construction project. In a single week in June, working eight-hour days, this force excavated 11,808 cubic yards of dirt at a cost of $0.09 per yard, which was "said to be the least expensive work of the sort ever done in this valley." In contrast, a separate account describes the difficulties of blasting out or working around rows of cottonwood trees, and of building up the canal banks along the north side of Kyrene Branch. As Supervising Engineer Hill had foreseen, it was necessary to build up the banks to 7.5 feet above ground level, the dirt being taken from a borrow pit on the north side of the right of way.

The Western Canal was nearing completion in October 1911 when funds ran out. The sudden shortfall in funding was exacerbated by a complex dispute between the Association and the USRS. Since 1904, the government had been building and operating the Project, charging fees only for operation and maintenance. Repayment would not begin until the Project was officially completed and turned over to the Association. While everyone knew that the Project had grown considerably in scope since the original estimate of $3 million, the total Project costs were not yet finalized. By 1911, it became apparent that the cost would probably exceed $9 million, or an assessment of over $50 per acre. Almost all of the initial Project work had been completed, except for several of the power plants and canals, including the Western Canal. As the end of the Project construction period neared, the farmers were faced with beginning the 10-year repayment period prescribed by federal law. Many of these farmers had bought their land from large landowners at inflated prices after the Project began, and would have great difficulty in making the payments on the Project assessment, for which their land was pledged as security. This impending disaster produced two responses among Association members. One was to seek an extension of the repayment period from 10 to 20 years, which would require an act of Congress. The other was to accuse the USRS of fraud and inefficiency that unnecessarily increased costs. Accusations of fraud were partly the result of local and national controversy over the way the USRS managed the entire reclamation program, as well as its relationship with Congress, other federal departments, and the settlers who were its nominal clientele.

These accusations led to a number of investigations of the USRS. A March 1912 report of local USRS officials noted that there were, "floating about the valley many indefinite charges of waste and extravagance." One of the rumors was that three canals had been built and abandoned on the south side, which while untrue was a reference to the unfinished sections of the Western Canal. While many Association members perceived that their interests were served by petitions and complaints against the USRS, the farmers of south Tempe and south Phoenix who were sitting on unpatented homesteads awaiting the completion of the Western Canal had different interests. USRS Chief Engineer A. P. Davis wrote that the completion of the Western Canal was the "most urgent work for which no provision has

been made." Overall, the USRS estimated that the canal system was then sufficient to serve 160,000 acres of the potential 240,000 irrigable acres of the Project. Director F. H. Newell, however, ordered that in the existing climate "all further expenditures (on the Salt River Project) should be made out of the returns from the Project," a policy which "should be kept prominently in sight."

USRS construction on the Western Canal was not resumed until September of 1912, and was completed a few months after that. The necessary funding to complete the USRS work came from applying a refund of Association freight costs to the project. The funding issue that resulted in a year's delay in finishing Divisions 1 and 2 of the Western Canal inspired South Phoenix farmers and residents to form their own company to extend the canal farther west to serve their lands. In February 1912, the Association's Board of Governors requested that the Secretary devise a plan by which farmers could construct canals and laterals under the supervision of USRS engineers. An agreement was signed on August 19 that allowed the newly formed Western Canal Construction Company, Inc., to supply all labor and materials for the western extension of the canal, including laterals, turnouts, and bridges, in return for credit on water deliveries for a maximum of three years.

The Western Canal Company was responsible for the acquisition of rights-of-way and construction of Divisions 3–6 of the canal, which included eight miles of main canal beginning at the end of the government's Division 2 on the west line of Section 32, Township 1 North, Range 4 East, and running west along the highest possible gravity line before turning southwest and terminating in Section 1, Township 1 South, Range 2 East. The canal ran parallel to and just south of the Wormser Canal.

Western Canal Company work on Division 3 began September 28, and proceeded concurrently with the USRS' completion of Divisions 1 and 2 and the feeder canals. Government surveyors ran center lines and cross sections of the canal bed, and staked grades and bridges. Survey work was completed by the first week of December and excavation was finished several weeks after that. The first delivery of water took place on February 16, 1913. Structural work was completed in March. During the 1913 and 1914 irrigation seasons it was determined that the supply through the Peck and Pine feeder canals was approximately 160 cfs short of what was needed to satisfy the requirements of the Western Canal. It was decided to build a third feeder following the line of the Wallace Ditch, which ran parallel to the Peck and Pine, and between them.

The initial plan was to have government forces build the entire feeder, but the Association "strenuously" objected and insisted that most of the work be contracted out. The contract was awarded to S. J. Rhodes for $14,132 and construction began September 26, 1914. The contractor had considerable trouble with drainage on this canal, which was aggravated by the fact that he dug from the head (east end) of the canal to the foot, so that he was always digging in the lowest part of the canal. If Rhodes had gone the opposite direction, the water would have drained into the completed section of the canal. In the end, Rhodes estimated that he lost $6,000 on the construction of the feeder due to water accumulation. He completed construction of the Wallace Feeder on January 26, 1915.

In January 1916, as the construction water credits were about to expire, Western Canal Company shareholders sought an extension of the three-year credit period. They maintained that their investment in the canal far exceeded the three years water service credit required by the contract for several reasons. First, the irrigable area under the Western Canal had been reduced from 13,000 acres to 9,000 by the Board of Survey which, in 1914, determined the official boundaries of the Project. The Western Canal Company maintained that it had incurred unnecessary expense in building the canal to irrigate

13,000 acres. Second, it was contended that for the first two years of service, the water supply had been inadequate, due to the small size of the feeder system from the Consolidated Canal. In the 1912 –1913 irrigation season, the 7,545 acres cultivated under the Western Canal received a total of 11,900 acre feet of water, with a duty of only 1.58 acre feet per acre. In the Salt River Valley at that time, a duty of 3.5 to four acre feet was considered the minimum for successful cultivation. In the 1913 –1914 season, the duty on the 8,924 acres cultivated was 1.89 acre feet, and in the 1914 –1915 season, after completion of the Wallace Feeder, the duty on 9,061 acres finally reached an acceptable level of 3.53 acre feet per acre. On this basis the Western Canal Company calculated that the water they actually received in return for the canal cost them $1.38 per acre foot, as opposed to a typical cost of $0.50 per acre foot on the rest of the Project. The USRS refused to alter the Western Cana Company's contract unless petitioned by the Association. At the time Association President John Orme was not in favor of a credit extension, so none was given.

While the construction of the Western Canal brought water to some residents in south Phoenix, it did little initially to assist farmers living on the north and south slopes of the Salt River (South) Mountains. Between 1909 and 1910, when it appeared that the Tempe Canal system might join the Project, farmers situated above the high line, then marked by the Wormser Canal, on the slopes of the Salt River Mountains were meeting to discuss how to obtain water for the approaching irrigation season. They were bolstered by the hope that water pumped from Tempe Canal lands, in an effort to relieve their drainage issues, might soon be available for their use. The Arizona Republican stated that "it has always been firmly believed by those who have taken up land in that locality that the government would eventually come to their rescue and supply pumped water for the irrigation of their lands."

The water that was clogging Tempe fields was coveted by those above the high line who had no water at all. Upon the advice of Supervising Engineer Hill, the meeting elected one of its members, Roy S. Goodrich, to go to Washington D.C. to press the highliners' case before the Secretary. It was thought at the time that there were as many as 15,000 irrigable acres on the east, north, and west slopes of the Salt River Mountains, and the soil was ideal for citrus trees. However, nothing was accomplished toward constructing a Highline Canal until February 1912, when the Association made an appeal to the government to allow farmers to construct their own ditches. In March, Goodrich and Dwight B. Heard met with Hill and members of the Association Board to discuss the Highline and Western canals. A few days later, on March 29, the Highline Canal Construction Company was incorporated with Goodrich as President, Walter Strong as Vice-President, John J. Gould as Secretary, and C. P. Mullen as Treasurer. The capitalization of the company was $100,000, and sale of stock was limited to members of the Association or homestead entrymen under the proposed canal. The purpose of the company was to acquire all land and rights-of-way for a canal, laterals, and a pumping plant to service farmers above the high line.

A preliminary estimate made by USRS Chief Electrical Engineer O. H. Ensign put the cost of a pumping plant at $75,000, including the pipeline, two pumps, the electrical motors and transformers, and a pump building. On August 22, the company entered into a contract with the USRS, which was almost identical to the contract that the Western Canal Construction Company had signed just three days earlier. However, unlike the Western Canal, the Highline Canal was not a simple matter of surveying and digging a ditch. The principal feature of the Highline Canal would be the electric pumping plant and pressurized pipe that would raise water 40 feet through a single 54-inch diameter pipe over a mile long. The water would be drawn from a forebay in the Western Canal and pumped by three (rather than two) horizontal, direct-connected pumps through a steel manifold into the concrete pipe. Each pump would supply 9,000

gallons per minute (20 cfs). Check valves at the bottom and top of the pipe would prevent water from flowing back when the pumps were stopped. Each pump was powered by a 150 hp, 2,200 volt, 25-cycle motor. Power would be supplied through Project transmission lines from the newly completed Roosevelt Dam Power Plant.

Through the fall of 1912 USRS engineers spent a good deal of time preparing drawings and specifications and advertising for bids. In December 1912, contracts were awarded to General Electric Company for the electrical apparatus, and Perrine Machinery Company for the pumps. That same month Martin & Gillis started pipeline construction. Construction of the Highline Canal went forward on two branches. The northern branch ran about 10 miles along the east and north side of the Salt River Mountains, from 0.5 to one mile above the Western Canal. The southern branch ran toward the southwest for about 4.5 miles. About 92,000 cubic yards of material was excavated by Toohey and Sons Contractors at a cost of $17,500. The structural work was conducted by Arizona Engineering and Construction Company. Construction of the pump building was begun February 1913 by Martin & Gillis. At the same time the Highline Construction Company was erecting an 11,000 volt electrical line from the closest Project line, located at Southern Avenue and Mill Avenue, to the pumping plant. This line was completed March 19, just as installation of the machinery was underway.

Regular water service to the Highline Canal began on June 16, 1913, and it was estimated that at least two pumps would be required to satisfy demand, with each unit pumping 20 cfs. Pumping was aggravated by the fact that the newly dug canals consumed considerable water in excess seepage during the first few weeks of operation. The flywheel was first tested the same day, but it was a disappointment because it failed to materially lengthen the stopping time of the pump. This may have been due to the fact that the centrifugal-type pump, by its design, had a sharp drop-off in output below its critical speed range. Although flywheels were ordered for the other two motors, it was soon decided that the only thing left to do was build the standpipe. The local engineers must have felt that their design and execution of the plant was in some way lacking, for they tried to obtain approval to spend government funds for the work, but this request was denied.

The Highline Canal Company did not agree to pay for the standpipe until October 1, and the engineers were fearful of running more than one pump at time, so the first summer the entire system was supplied by one pump producing 20 cfs. In the meantime, problems had also developed with the efficiency of the pump. A test in early June seemed to indicate that the pumps had an efficiency of 55 percent, far less than the 78 percent required by the machinery contract. Tests of pump efficiency also revealed problems with the very process of testing. In the first place, the farmers were now well into the irrigation season, trying to stretch the output of the single pump to as many acres as possible, so any interruption in service was unwelcome. Second, the engineers were having problems obtaining properly calibrated instruments for testing electrical current, water pressure, and water flow, which limited their ability to make fairly fine judgments of efficiency. One engineer expressed the wish that he could have the use of rated meters that were not "knocked around the country on motorcycles as are the ones we have to depend on."

Even when the testing equipment was available and operating, there was some question whether or not the engineers knew exactly what they were doing. There were some obvious design errors, for example it was necessary to chip out the pump house wall to fit the 48 inch flywheels on the motors. Other problems simply revealed a lack of experience in making water move uphill. These engineers were familiar with the building of hydropower generating plants, groundwater pumps, and even cableways, but references in their correspondence to past problems encountered and solved lacked attention of the

pumping of water through a pressurized pipe. After the engineers had concluded that the pumps were delivering at only 65 percent efficiency, a representative from the manufacturer, Kingsford Foundry & Machine Company, was summoned from Oswego, New York, at Kingsford's expense. The representative turned down the tips of the impeller vanes, the results of which were inconclusive. He also suggested that the entire problem was caused by air in the pump, which happened because the suction pipes were not submerged deep enough in the intake canal. Although the engineer in charge of the Power Division, Irving C. Harris, disagreed, later tests confirmed that the manufacturer's representative was probably correct. The Kingsford man also contended that the engineers were measuring the pressure and vacuum in the wrong place, which accounted for their low readings. Although this was briefly disputed, the engineers finally decided that they could not clearly show that the pumps were not meeting the contract specifications for efficiency.

The standpipe was completed in January 1914, and thereafter the performance of the plant was considered satisfactory. The total cost of the plant was $56,990, considerably less than the USRS' original estimate of $75,000. Within a few years, however, the capacity of the pumps was found to be inadequate at the height of the irrigation season. In 1918 another pump was added that had a higher horsepower and output rating (200 hp and 33 cfs), but was otherwise identical to the other pumps. The pump building and manifold pipes were extended to include the new pump. Total cost of the new installation was $11,670, which was paid for by the Highline Canal Construction Company. Despite these improvements, the water supply remained insufficient, and a new pipeline was considered briefly. During the summer of 1920, two temporary pumps were added to pump additional water into the surge chamber, which brought the water supply to a satisfactory level.

In 1921, new improvements on the Highline system were undertaken to permanently eliminate supply problems. The delivery capacity of the Western Canal to the pump plant was increased by enlarging several siphons. In addition, three air vents were installed at intervals in the pipeline. The three older pumps were rebuilt to provide 28 cfs, and given new 250 hp motors. The rebuilt equipment delivered a total of 100 cfs when all pumps were operating. The rebuild cost $23,140 and paid with Association funds. For the first time in the summer of 1921, all irrigation demands were met without complaint; therefore, this should be considered the completion date of the Highline Pumping Plant. The total cost of all three major phases of work (1913, 1918, and 1921) was $91,800.

In 1952 a new Highline Pumping Plant was built on the west side of the Western Canal as part of a Project-wide, federally-financed R&B program. The new plant had a short concrete feeder ditch and eight freestanding pumps attached to an above-ground steel manifold. The installation of equipment was begun in September 1952, and completed by June 1953. The new pumps had a total capacity of 125 cfs and were 30 percent more efficient than the old ones, which resulted in yearly savings of $24,000 in power costs. The cost of the new plant was approximately $200,000. The Western and Highline canals also underwent considerable renovation during the R&B program. Typical improvements included concrete lining of the canals, lining or piping of many laterals, replacement of wooden control structures with concrete, and the installation of telemetry equipment on many pumps and gates for instant, centralized control.

Since the late 1940s, the Salt River Valley has experienced rapid and almost continuous population growth, during which many of the most productive farmlands of the Project were converted to residential neighborhoods and commercial developments. This led to a change in the purpose of some Project canals, as the delivery of water to city water filtration plants for municipal water systems became more

important. In addition, large parts of the urbanized area still receive flood irrigation through a system of laterals which, though largely piped, follows the same lines as the original farm laterals. Those lands, though now residential, retain their water rights, which qualify them for relatively inexpensive water delivery from SRP. The Highline and Western canals still flow for the most part in the same banks dug with such trouble out of the water-soaked land before World War I.

Current Photographs

Name of Property: Salt River Project Water Diversion and Conveyance System Historic District
City or Vicinity: Phoenix Metropolitan Area
County: Maricopa
State: AZ
Photographer: Jim Bailey, Bureau of Reclamation; Salt River Project
Date Photographed: March 2010; Salt River Project 2009
Location of Original Digital Files: Bureau of Reclamation, Denver, CO; Salt River Project, Phoenix, AZ
Number of Photographs: 57

Photo 1. Granite Reef Diversion Dam aerial, 2009. Photo courtesy of the SRP.

Photo 2. Granite Reef Diversion Dam crest looking north.

Photo 3. Granite Reef Diversion Dam north side turnout looking north.

Photo 4. Granite Reef Diversion Dam north side turnout structures looking east. Photo courtesy of the SRP.

Photo 5. Granite Reef Diversion Dam south side gate structure looking west.

Photo 6. Granite Reef Diversion Dam south gate structure and South Canal turnout looking northeast.

Photo 7. Granite Reef Diversion Dam dam tenders house looking east.

Photo 8. Granite Reef Diversion Dam dam tenders house looking south.

Photo 9. Arizona Canal at Arizona State Route (Loop) 101 looking east.

Photo 10. Arizona Canal at Scottsdale Road and Camelback Road looking north.

Photo 11. Arizona Canal at Old Arizona Falls power plant looking east.

Photo 12. Arizona Canal at Central Avenue looking northwest.

Photo 13. Arizona Canal west of Metrocenter looking east.

Photo 14. Arizona Canal west of Metrocenter looking west.

Photo 15. Arizona Canal toe looking northwest.

Photo 16. Crosscut Canal turnout at Arizona Canal looking west.

Photo 17. Crosscut Canal at Arizona Canal looking south.

Photo 18. Crosscut Canal check at 64th Street and Thomas Road looking north.

Photo 19. Crosscut Hydro Plant looking north (see site drawing).

Photo 20. Crosscut Hydro Plant looking northeast.

Photo 21. Crosscut Hydro Plant looking southwest.

Photo 22. Crosscut Hydro Plant roof detail.

Photo 23. Grand Canal (foreground) at Old Crosscut Canal toe looking north.

Photo 24. Grand Canal at Hohokam Expressway looking west.

Photo 25. Grand Canal at 40th Street and Van Buren looking southeast.

Photo 26. Grand Canal at Central Avenue looking east.

Photo 27. Grand Canal check at 75th Avenue and Camelback Road looking southeast.

Photo 28. Grand Canal west of University of Phoenix (Cardinals) Stadium looking northeast.

Photo 29. Grand Canal toe drain looking northwest.

Photo 30. South Canal turnout at Granite Reef Diversion Dam.

Photo 31. South Canal at Thomas Road in Mesa, looking northeast.

Photo 32. South Canal “horsesteps” detail (same location as Photo 33).

Photo 33. South Canal near McDowell Road looking northeast.

Photo 34. South Canal at Tempe/Consolidated/South canals juncture looking north.

Photo 35. Consolidated Canal at 8th Street, Mesa looking northwest.

Photo 36. Consolidated Canal at Lindsey Trail, looking north.

Photo 37. Consolidated Canal at Arizona State Route (Loop) 202 looking north.

Photo 38. Consolidated Canal at Ocotillo Road looking south.

Photo 39. Consolidated Canal check at Ocotillo Road looking north.

Photo 40. Consolidated Canal toe at Arizona State Route 87 looking north.

Photo 41. Eastern Canal at turnout from South Canal looking northeast.

Photo 42. Eastern Canal at Val Vista Road looking north.

Photo 43. Eastern Canal check at Williams Field Road, looking south.

Photo 44. Eastern Canal at Williams Field Road looking north.

Photo 45. Eastern Canal toe at Pecos Road looking north.

Photo 46. Tempe Canal at Tempe Draw gates looking northwest.

Photo 47. Tempe Canal at Dobson Road looking northeast.

Photo 48. Tempe Canal at Broadway Road looking northwest.

Photo 49. Tempe Canal just north of piped section looking north.

Photo 50. Tempe Canal piped section intake looking south.

Photo 51. Western Canal at Tempe water treatment plant looking east.

Photo 52. Western Canal at Tempe water treatment plant looking west.

Photo 53. Western Canal at Guadalupe Road looking north.

Photo 54. Western Canal check at 16th Street, Phoenix, looking east.

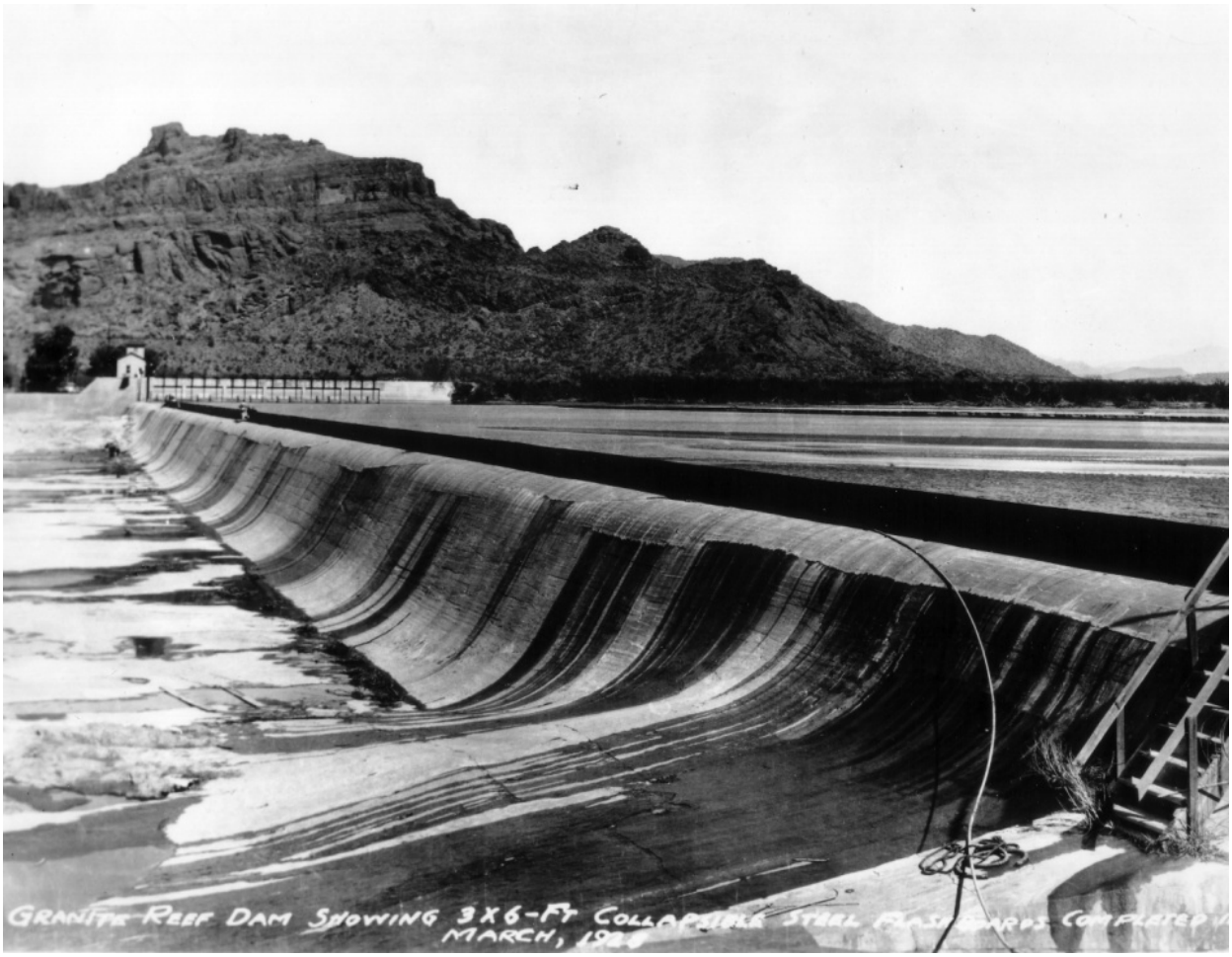
Photo 55. Western Canal toe at 23rd Avenue and Dobbins Road, Phoenix looking north.

Photo 56. North Highline at Central Avenue looking west.

Photo 57. South Highline at Grove Parkway looking north.

Historic Photographs

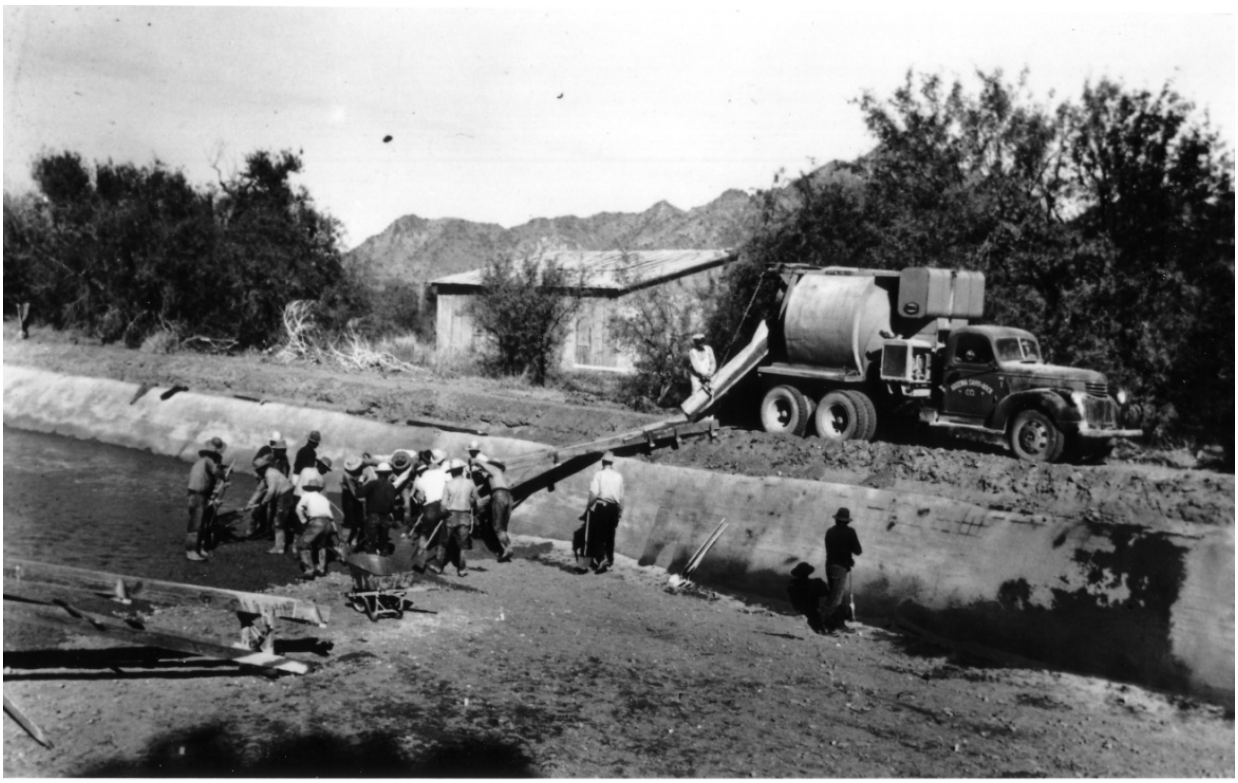
Name of Property: Salt River Project Water Diversion and Conveyance System Historic District
City or Vicinity: Phoenix Metropolitan Area
County: Maricopa
State: AZ
Photographers: Salt River Project
Date Photographed: unknown, 1901, 1902, 1913, 1916, 1928, 1937, 1938, 1943, 1960
Location of Original Digital Files: Salt River Project, Phoenix, AZ
Number of Photographs: 12



Historic Photo 1. Granite Reef Diversion Dam facing north, March 1928. Photo courtesy of the SRP.

Historic Photo 2. Arizona Falls on the Arizona Canal, facing east, prior to power plant construction in 1901. Photo courtesy of the SRP.

Historic Photo 3. Arizona Canal excavation, eight miles northeast of Phoenix. Undated photo by Walter J. Lubken.



Historic Photo 4. Workers lining the Arizona Canal with concrete, December 1943**.** Photo courtesy of the SRP.

Historic Photo 5. Italian prisoners of war working on the Arizona Canal, December 1943. Photo courtesy of the SRP.

Historic Photo 6. Arizona Dam facing east, c. 1902. Photo courtesy of the SRP.

Historic Photo 7. Crosscut Hydro Plant under construction, 1913. Photo courtesy of the SRP.

Historic Photo 8. CCC rubble paving in the Grand Canal near 83rd Avenue and Bethany Home Road, January 18, 1938. Photo courtesy of the SRP.

Historic Photo 9. Taintor gates on the Grand Canal at 7th Avenue, 1937. Photo courtesy of the SRP.

Historic Photo 10. Grand Canal reconstruction looking east toward Tempe Butte, circa 1916. Photo courtesy of the SRP.

Historic Photo 11. Grand Canal facing north on Central Avenue, circa 1960. Photo courtesy of the SRP.

Historic Photo 12. Children playing in the Grand Canal lateral near 7th Avenue. Photo courtesy of the SRP.

United States Department of the Interior
National Park Service

National Register of Historic Places Continuation Sheet

Salt River Project Diversion and Conveyance System Historic District
Name of Property
Maricopa, AZ
County and State
Salt River Project
Name of multiple property listing

Section number 10 Page 1

UTM Coordinates

Structure	Zone	Easting NAD83 (meters)	Northing NAD83 (meters)
NORTH SIDE			
Granite Reef Diversion Dam	12N	435768	3708688
Arizona Canal			
Head	12N	435787	3708847
Toe	12N	387233	3721617
New Crosscut Canal			
Head	12N	412394	3706070
Toe	12N	412058	3700390
Crosscut Hydro Plant	12N	412067	3700386
Grand Canal			
Head	12N	412058	3700390
Toe	12N	381146	3709961
SOUTH SIDE			
South Canal			
Head	12N	435817	3708505
Toe	12N	424140	3700028
Consolidated Canal			
Head	12N	424146	3700029
Toe	12N	421656	3674325
Eastern Canal			
Head	12N	427588	3703288
Toe	12N	428041	3683528
Tempe Canal			
Toe	12N	424132	3700027
Head	12N	416723	3691188
Western Canal			
Head	12N	416723	3691188
Toe	12N	396810	3692083
Highline Canal North			
Toe	12N	397841	3692117
Head	12N	410976	3691208
Highline Canal South			
Head	12N	410976	3691208
Toe	12N	407237	3685520

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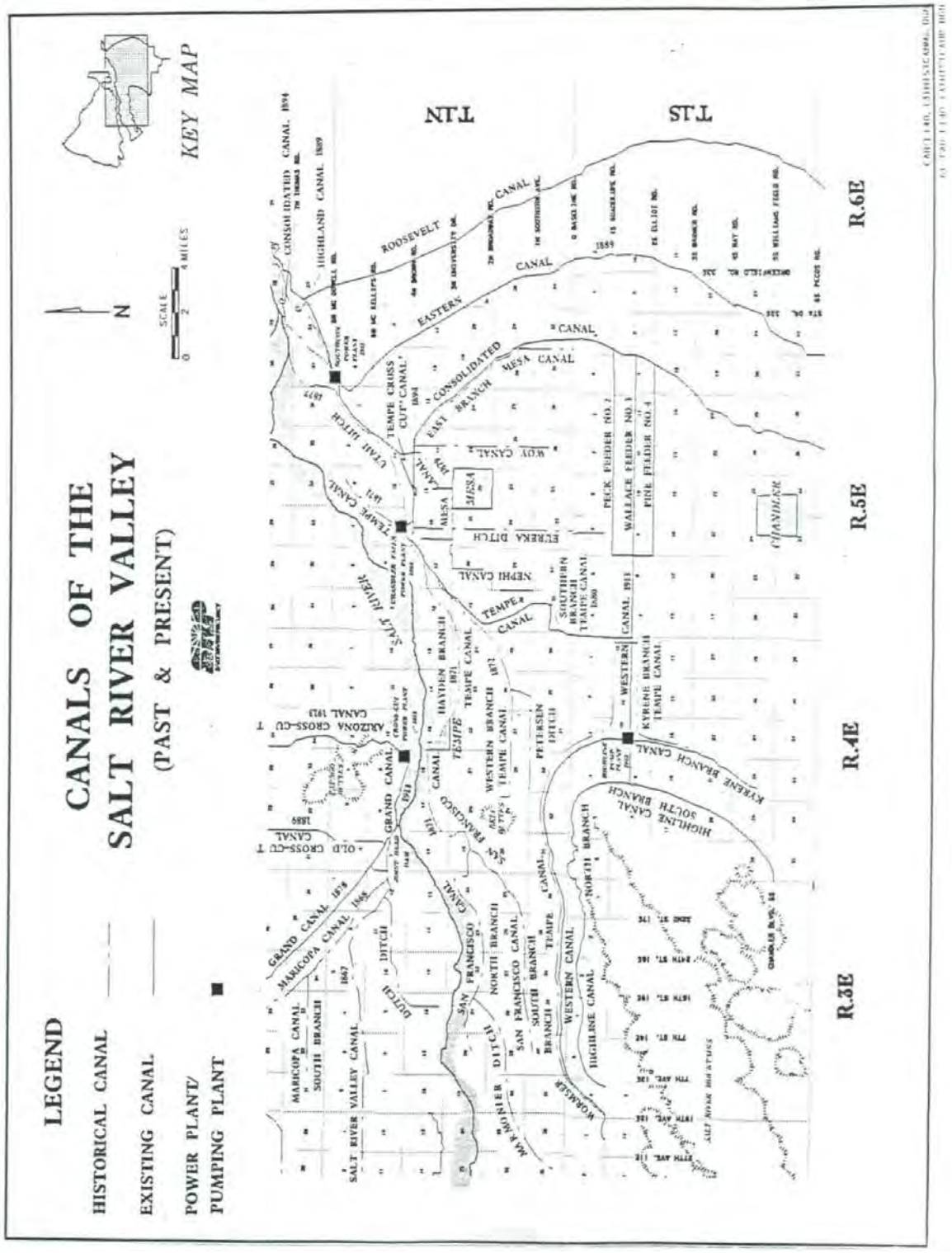
National Park Service

National Register of Historic Places Continuation Sheet

Salt River Project Diversion and Conveyance System Historic District
Name of Property Maricopa, AZ
County and State Salt River Project
Name of multiple listing

Section number 11 Page 1



Map 1. Canals in the Salt River Valley (Anderson 1990).

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National Park Service

National Register of Historic Places Continuation Sheet

Salt River Project Diversion and Conveyance System Historic District
Name of Property Maricopa, AZ
County and State Salt River Project
Name of multiple listing

Section number 11 Page 2

Map 2. Boundaries of the Granite Reef Diversion Dam.

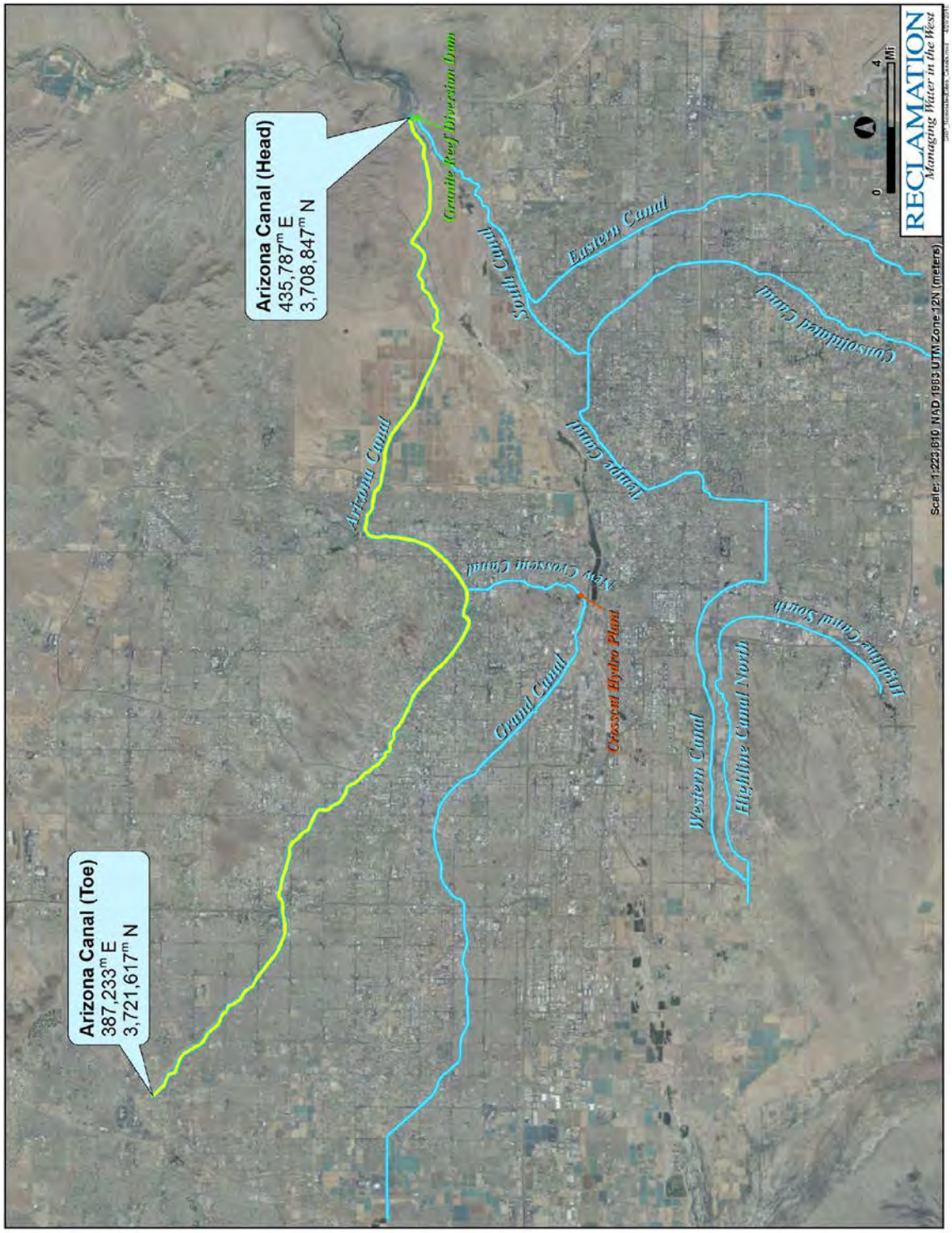
Map 3. Granite Reef Diversion Dam showing the orientation of photos taken by Jim Bailey.

United States Department of the Interior
National Park Service

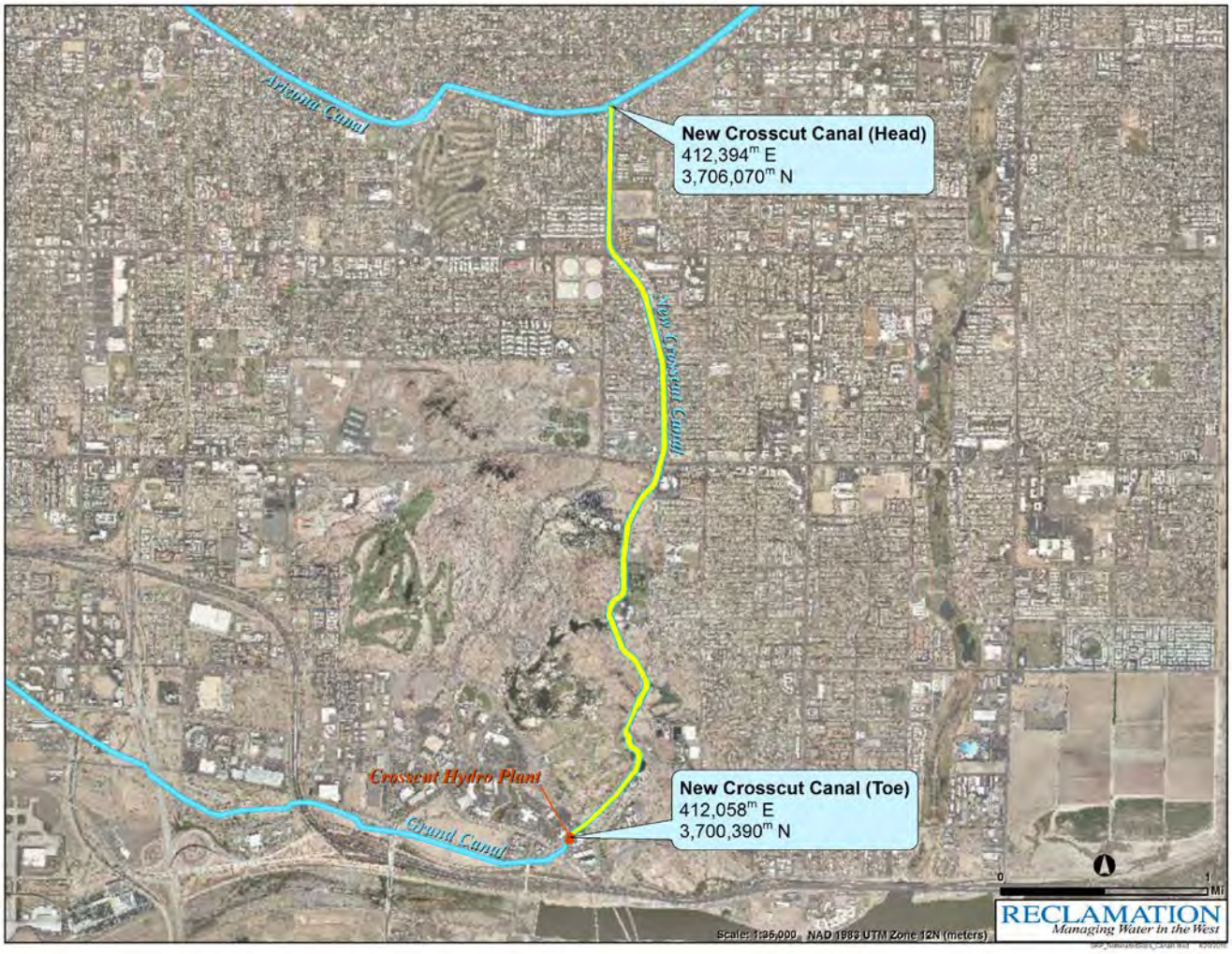
National Register of Historic Places Continuation Sheet

Salt River Project Diversion and Conveyance System Historic District
Name of Property Maricopa, AZ
County and State Salt River Project
Name of multiple listing

Section number 11 Page 4



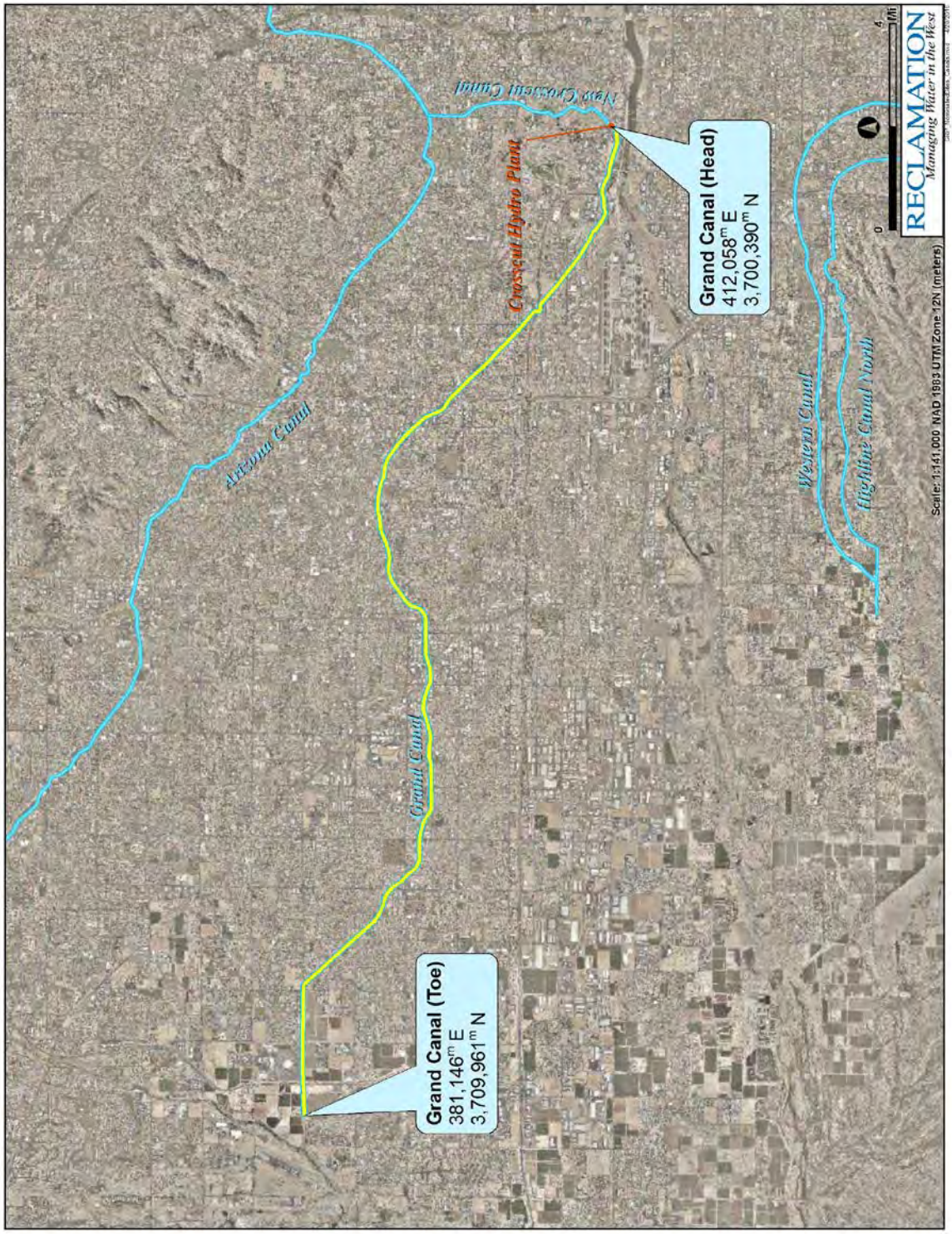
Map 4. Boundaries of the Arizona Canal.



Map 5. Boundaries of the New Crosscut Canal.

Map 6. Boundaries of the Crosscut Hydro Plant.

Map 7. Crosscut Hydro Plant showing the orientation of photographs taken by Jim Bailey in 2009 and 2010.



Map 8. Boundaries of the Grand Canal.

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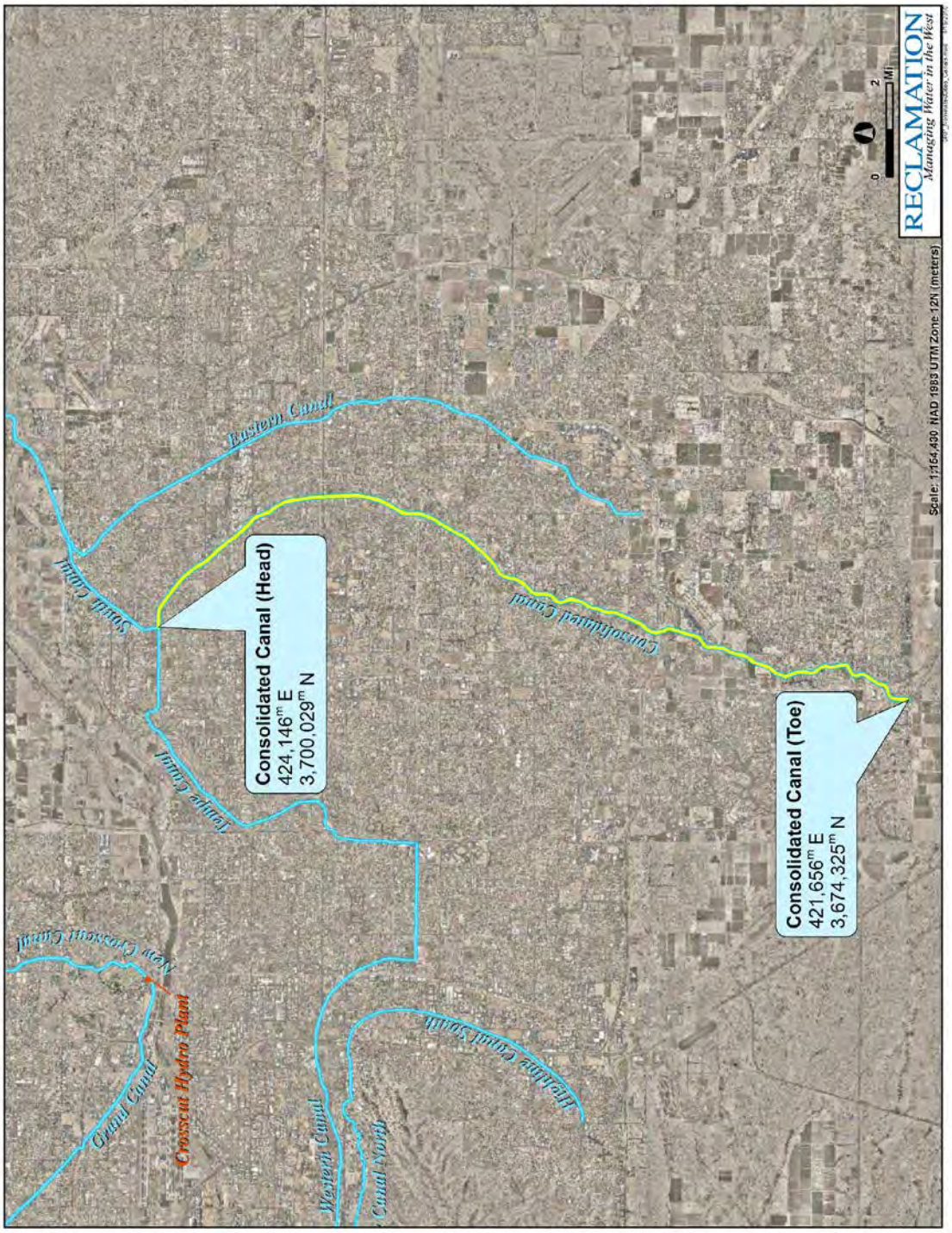
National Register of Historic Places Continuation Sheet

Salt River Project Diversion and Conveyance System Historic District
Name of Property Maricopa, AZ
County and State Salt River Project
Name of multiple listing

Section number 11 Page 9

Map 9. Boundaries of the South Canal.



Map 10. Boundaries of the Consolidated Canal.

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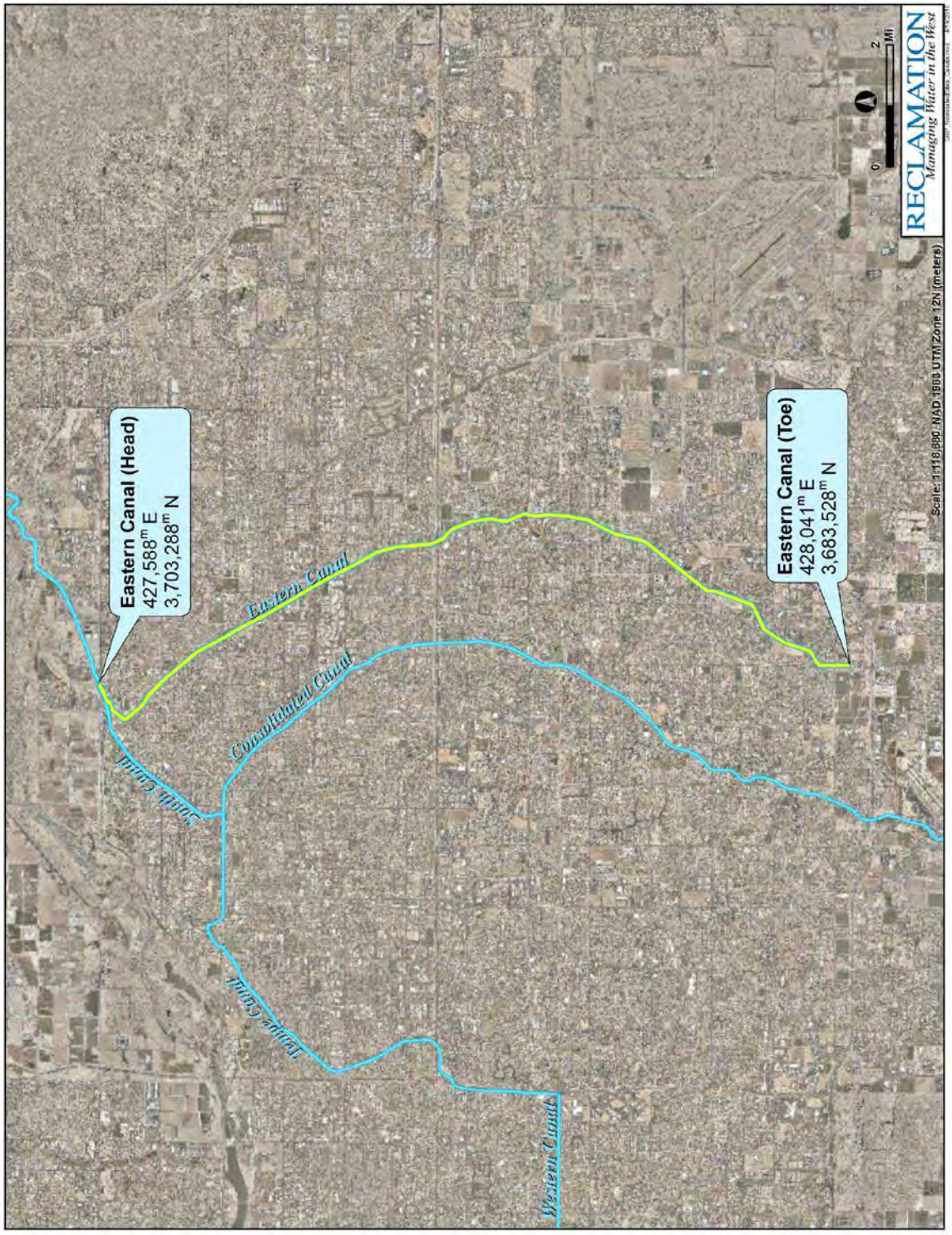
National Register of Historic Places Continuation Sheet

Salt River Project Diversion and Conveyance System Historic District
Name of Property Maricopa, AZ
County and State Salt River Project
Name of multiple listing

Section number 11 Page 11



Map 11. Boundaries of the Eastern Canal.

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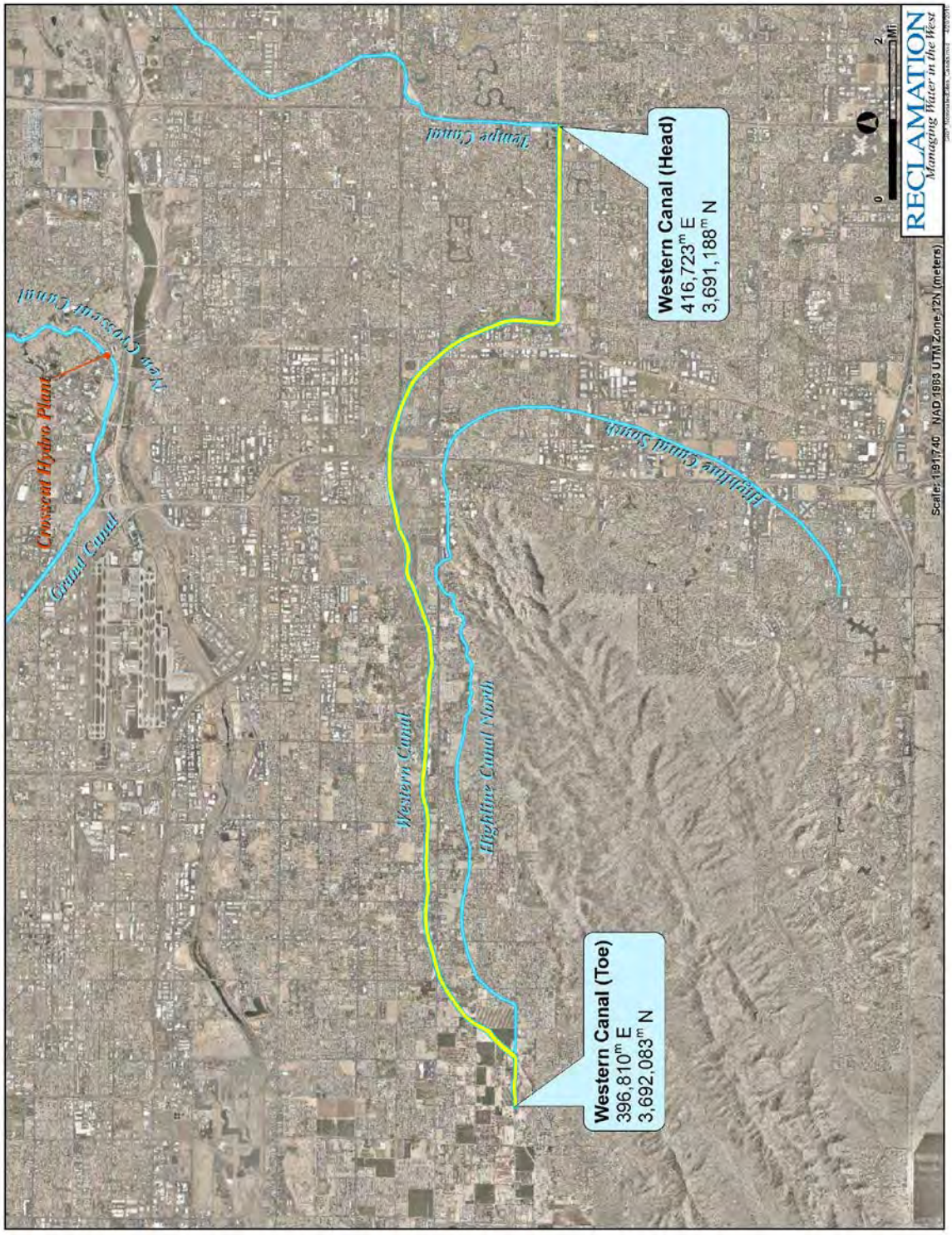
National Register of Historic Places Continuation Sheet

Salt River Project Diversion and Conveyance System Historic District
Name of Property Maricopa, AZ
County and State Salt River Project
Name of multiple listing

Section number 11 Page 12

Map 12. Boundaries of the Tempe Canal.



Map 13. Boundaries of the Western Canal.

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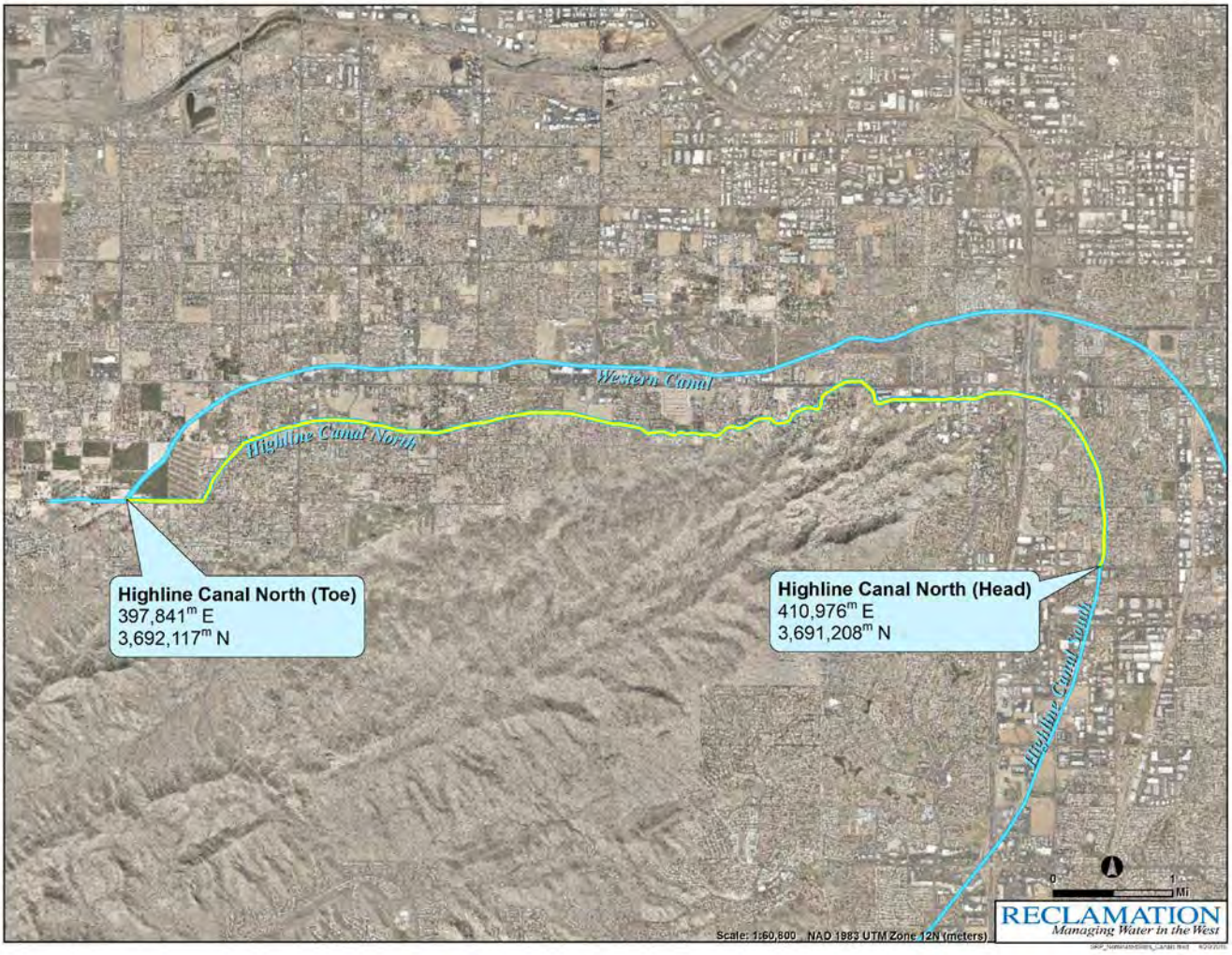
National Register of Historic Places Continuation Sheet

Salt River Project Diversion and Conveyance System Historic District
Name of Property Maricopa, AZ
County and State Salt River Project
Name of multiple listing

Section number 11 Page 14



Map 14. Boundaries of the Highline Canal North.

United States Department of the Interior
National Park Service

National Register of Historic Places Continuation Sheet

Salt River Project Diversion and Conveyance System Historic District
Name of Property Maricopa, AZ
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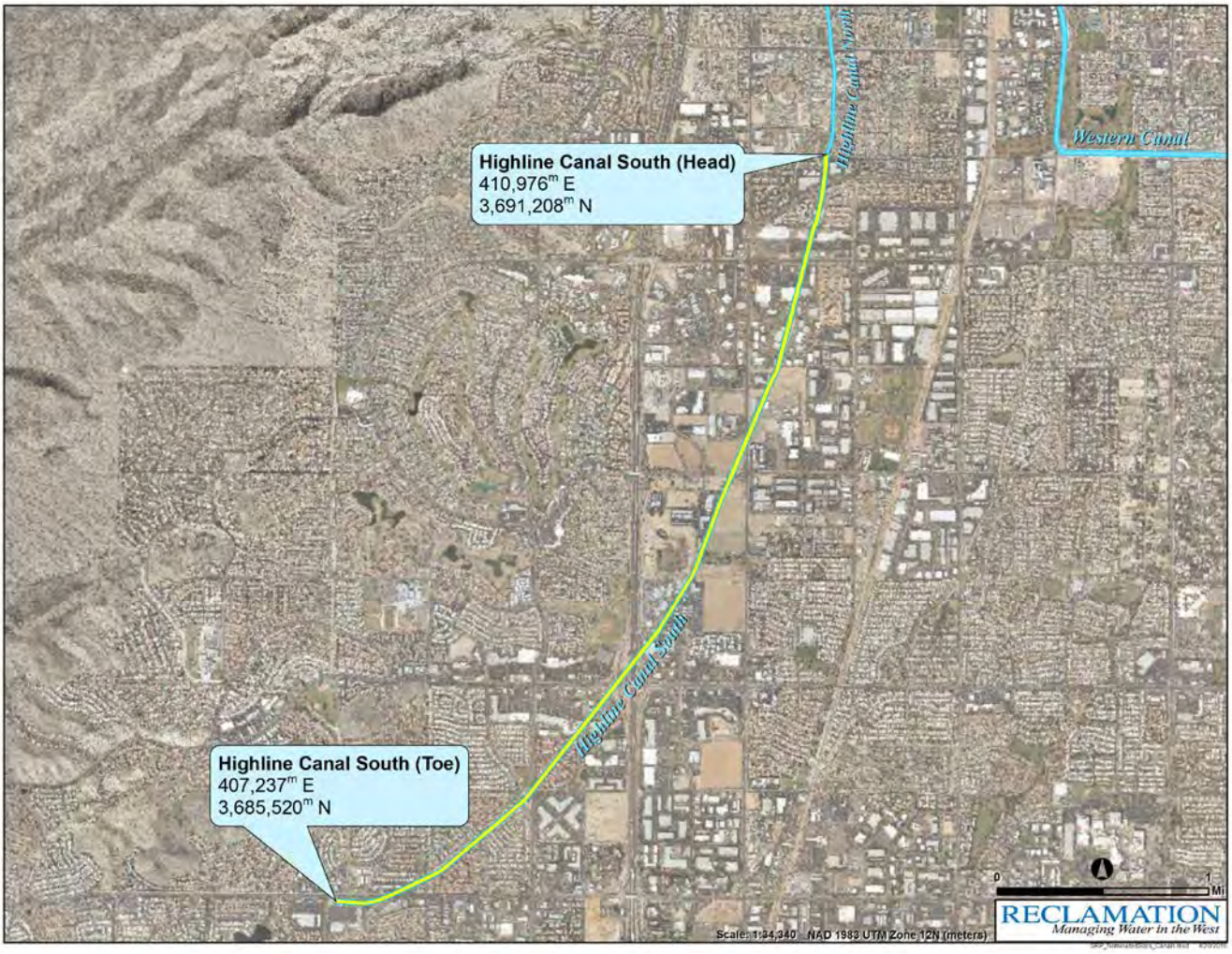
Section number 11 Page 15



Map 15. Boundaries of the Highline Canal South.


American Apparel


BICYCLES
YIELD TO
PEDESTRIANS
THE PASEO
Chandler · Arizona
CONSOLIDATED CANAL
1912

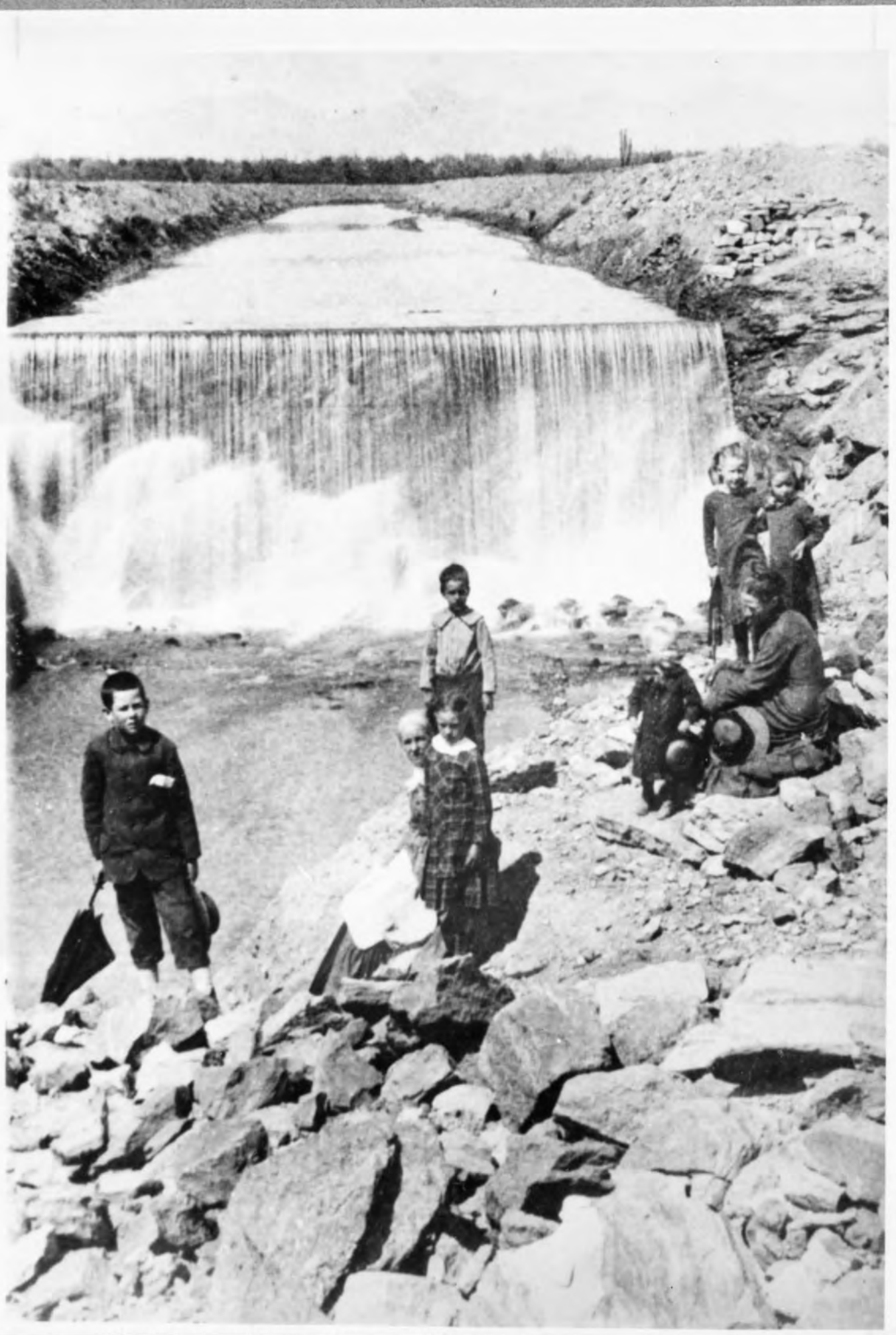

DANGER


SRP
Mechanical Services
Bldg. 9
SRP
Building
9


SPEED
LIMIT
35

GRANITE REEF DAM SHOWING 3X6-FT COLLAPSIBLE STEEL FLASHBOARDS COMPLETED IN MARCH, 1925

HAER NO. AZ-19-13



HAER NO. AZ-19-1

HAER NO. AZ-19-4

TIGER NO. AZ. 19-17

HAER NO. AZ-19-19

HAER NO. AZ-19-2

HAER No. ~~AZ-11-37~~ AZ-30-1

Rubble paving job in Grand Canal at 4E - 10N - January 18, 1938

HAER No. AZ-17-12

HIGH WATER PRIVATE DITCH
20E-35 1-2-35

36" TAINTOR GATES GRAND CANAL LAT. 12
1937

HAER No. AZ-17-10

Grand Canal Reconstruction
Excavating Earth Section

HAER No. AZ-17-7

HAER No. AZ-17-1

HAER No. AZ-17-9


McDowell Rd
EXIT 3
EXIT 4


WARNING
SECURITY DOG


WARNING
SECURITY DOG


SPEED LIMIT 45

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES
EVALUATION/RETURN SHEET

Requested Action: Nomination

Property Name: Salt River Project Diversion and Conveyance System Historic District

Multiple Name: Salt River Project MPS

State & County: ARIZONA, Maricopa

Date Received:	Date of Pending List:	Date of 16th Day:	Date of 45th Day:	Date of Weekly List:
6/23/2017	7/18/2017	8/2/2017	8/7/2017	

Reference number: MP100001454

Nominator: State

Reason For Review:

__X__ Accept _____ Return _____ Reject __8/7/2017__ Date

Abstract/Summary Comments: The Salt River Project Diversion and Conveyance System Historic District meets National Register Criterion A at the statewide level of significance in the areas of Politics/Government, Agriculture, and Community Planning and Development. As one of the first five federal reclamation projects authorized by the Secretary of the Interior under the National Reclamation Act of 1902, and with many features constructed by the USRS, the Salt River Project (SRP) Diversion and Conveyance System is directly associated with the beginnings of federal intervention in the planning and building of large-scale water storage and irrigation delivery systems in the arid regions of the western United States. The SRP system was instrumental in the explosive physical and economic growth of the Phoenix metropolitan area in the twentieth century, initially providing water to support the agricultural industry that was the economic foundation of local communities, and later delivering water for urban and industrial uses as the Valley transformed and its economic base changed. The development of the physical infrastructure of the diversion and conveyance under the USRS/Bureau of Reclamation began in 1906 with the incorporation of earlier private canals and construction of new resources to create the eventual 1300-mile integrated system of canals, laterals and drains (131 miles of main canals). Updated improvements through 1938 resulted in the current extant property. [In counting resources the Bureau of Reclamation considered each canal and its attendant features as a single structure. The nominated resources include, but do not count as separate resources, individual features such as sluiceways, drains, culverts, siphons, checks, grates and measuring devices. All such features represent component elements of their respective contributing resources.]

Recommendation/ Criteria: Accept National Register Criterion A.

Reviewer Paul Lusignan Discipline Historian

Telephone (202)354-2229 Date 8/7/2017

DOCUMENTATION: see attached comments : No see attached SLR : No

United States Department of the Interior

BUREAU OF RECLAMATION
P.O. Box 25007
Denver, CO 80225-0007

JUN 20 2017

IN REPLY REFER TO:

84-53000
ENV-3.00

MEMORANDUM

To: J. Paul Loether, Chief, National Register of Historic Places Program, National Park Service, 1201 Eye Street, NW (2280), Washington, DC 20005
Attn: Mr. Paul Lusignan

From: Roseann Gonzales
Director, Policy and Administration

Subject: Nomination of the Salt River Project (Project), Maricopa County, Arizona, as a Multiple Property Listing (MPL) in the National Register of Historic Places (National Register), and Nominations of Associated Properties under the MPL

The Bureau of Reclamation is pleased to nominate the Salt River Project as an MPL on the National Register. We are concurrently individually nominating five associated Project dams, and nominating the Project's diversion and conveyance system as a historic district. The multiple property documentation (MPD) form and associated property registration forms, with supporting information, are attached. All forms are submitted in electronic format on the two enclosed compact disks, with the required hard copy of the original signature sheet for each of the six property nomination forms. In order to provide an original signature for both the Federal Preservation Officer (FPO) and the State Historic Preservation Officer (SHPO), two copies of each signature page is attached. As is also required, I confirm that the enclosed compact disks contain the true and correct nomination forms for the Salt River Project MPD; for the Salt River Project Diversion and Conveyance System Historic District; and for Bartlett Dam, Horse Mesa Dam, Horseshoe Dam, Mormon Flat Dam, and Stewart Mountain Dam.

The nomination forms were submitted for review to the Arizona SHPO and the SHPO signed the forms without comment. In Arizona, the State Review Board does not review Federal nominations. Reclamation provided all seven forms to Maricopa County for review by their Board of Supervisors, who are the chief local elected officials. The 45-day comment period closed on May 25 without Reclamation receiving comment from the County. Although not required for Federal nominations, Reclamation also provided the MPD and historic district forms to the six Certified Local Governments (CLG) established within the greater Phoenix metropolitan area; they were not provided with the dam nomination forms because the Project dams lie outside of the jurisdictional boundary of a GLG. The comment period closed with only the City of Glendale responding to say they had no comment at this time, and that they found the "materials were very well put together."

The Project and the associated properties are important pieces of Western reclamation history. Although some modifications have occurred to keep the structures operational, in large part the nominated properties retain levels of design, materials, workmanship, feeling, and overall integrity sufficient to convey their historic character and function. They demonstrate the historic importance of this irrigation and hydropower system that was instrumental in the transformation of the Phoenix basin into one of the great regional centers of the West.

If you have any questions, please contact Mr. George Herbst, FPO, at 303-445-3311, or gherbst@usbr.gov, or Ms. Lynne MacDonald, cultural resources specialist, at 303-445-3206, or lmacdonald@usbr.gov.

Attachments - 14

cc: Archeologist, Bureau of Reclamation, 500 Fir Street, Boulder City, NV 89006-1470, Attn LC-2633 M. Slaughter
Archeologist, Bureau of Reclamation, 6150 W Thunderbird Road, Glendale AZ 85306-4001 Attn: PXAO-1500 D. Gifford
Supervisory Environmental Protection Specialist, Bureau of Reclamation 6150 W Thunderbird Road, Glendale AZ 85306-4001 Attn: PXAO-1500 S. Heath
Archeologist, Bureau of Reclamation, 6150 W Thunderbird Road, Glendale AZ 85306-4001 Attn: PXAO-1500 L Jelinek,
(all w/o att)