

All-American Canal:

Boulder Canyon Project

Eric A. Stene
Bureau of Reclamation
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Table of Contents

Table of Contents	1
List of Tables	1
All-American Canal System:	
Boulder Canyon Project	2
Project Location	2
Historic Setting	3
Project Authorization	5
Construction History	6
All-American Canal	7
Imperial Dam	11
Coachella Canal	16
Post Construction History	21
All-American Canal	21
Imperial Dam	25
Coachella Canal	27
Settlement of the Project	28
Uses of Project Water	30
Conclusion	32
About the Author	33
Bibliography	34
Manuscripts and Archival Collections	34
Government Documents	34
Books	35
Articles	35
Interviews	35
Index	36

List of Tables

Table I. Contractors on the All-American Canal and Its Features.....	7
Table II. Crops Grown in the All-American Canal Region–1943.....	31

All-American Canal System: Boulder Canyon Project

For many years in the nineteenth and early twentieth centuries, Californians searched for ways to bring water from the Colorado River to southern California's Imperial Valley for irrigation purposes. The most natural route involved moving the water through Mexican territory. Early private interests recognized this and accepted it, building canals over the border in Mexico, delivering water to the Imperial Valley. Later, water users from the Imperial Valley requested Reclamation's involvement in building a canal lying entirely in the United States, eventually leading to construction of the All-American Canal.

The All-American Canal System of the Boulder Canyon Project is closely related to Reclamation's Yuma and Gila Projects as well as Hoover Dam, the flood control and storage structure of the Project. Imperial Dam, the only diversion dam in the system, diverts water to the All-American Canal from the Colorado River. The dam also diverts water to the Gila and Yuma Projects, and led to the abandonment of the latter project's Laguna Dam as an active diversion dam.

Project Location

The All-American Canal System is located in Imperial County, California. Imperial Dam lies 303 miles south of Hoover Dam, and eighteen miles north of Yuma, Arizona. The All-American Canal travels west from Imperial Dam about eighty miles to a point ten miles past Calexico, California. The Coachella Canal branches off from the All-American Canal sixteen miles west of Pilot Knob and travels northwest 123 miles to the Coachella Valley in Riverside County. Imperial Dam also diverts water to the Yuma Main Canal of the Yuma Project, California and Arizona, and the Gila Gravity Main Canal on the Gila Project, Arizona. Temperatures recorded in the area range from 16 to 125 degrees Fahrenheit. The annual precipitation averages 3.14 inches a year, and the valleys receive most of their water in the form of runoff from snow in the San Bernardino Mountains and Mount Jacinto. The resort city of

Palm Springs, at the northern end of the Salton Sink, is the most famous community in the area.¹

Historic Setting

The Gulf of California once stretched 150 miles northwest of its current position, covering the Imperial and Coachella Valleys. The Colorado River gradually built its delta across the gulf from Pilot Knob, near Yuma, Arizona; to the Cocopah Mountains, south of Calexico, California. The delta created a natural dam across the gulf, leading to the evaporation of water from the Salton Sink. As a result most of the Imperial and Coachella Valleys lie below sea level.²

The California Legislature first proposed development and irrigation of the Imperial Valley, using water from the Colorado River, in the 1850s. The proposal involved diverting the Colorado to the Alamo River drainage area in Mexico. Then using natural channels the water would flow through the Alamo river back into California, for distribution by a canal system. The project required a Federal grant of three million acres of government land. The California Legislature approved the grant, but the bill failed to pass the U.S. Congress in 1862. In 1876, Lieutenant Eric Bergland of the U.S. Army Corps of Engineers investigated the feasibility of a canal route traveling entirely through the United States. Bergland's report proved unfavorable, but he recommended the natural route through Mexico.³

After the failure of state and Federal government plans for the Imperial Valley, private concerns entered the competition. Oliver Wozencraft, a physician from New Orleans, first considered the possibility of irrigating the Salton Sink in the 1850s. Unable to finance his plan, Wozencraft abandoned the idea. John Beatty's establishment of the Colorado River Irrigation Company (CRIC) in 1892, plunged private business into Imperial Valley irrigation. The CRIC surveyed a route and planned to deliver water from the Colorado, in California, across the border

1. Water and Power Resources Service, *Project Data* (Denver: Government Printing Office, 1981), 72; Homer J. Gault, "All-American Canal to Serve a Million Acres: A Review of Report on All-American Canal Investigations," *New Reclamation Era*, July 1931, 146; Bureau of Reclamation, "Report of Repayment Ability: Coachella Valley, California," Project Reports, Record Group 115, August 1946, Box 4, 1. Hereafter Record Group 115 cited as RG 115.

2. Leeds, Hill, Barnard and Jewett, consulting engineers, "Survey of Conditions in Imperial Irrigation District," Project Reports, RG 115, May 3, 1943, Box 4, 1.

3. Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All American Canal," 1934, RG 115, 8; Water and Power Resources, *Project Data*, 69.

to a short canal in Mexico. The canal would divert water into the Alamo River for transport north into the Imperial Valley. The CRIC failed to achieve its ambitious plan, and Beatty renamed the company the California Development Company (CDC) in 1896.⁴

Beatty brought in two partners and Charles Rockwood, to act as engineer. One of the new partners was George Chaffey, who already attained a reputation as an irrigation entrepreneur in Los Angeles and on the Murray River in Australia. The CDC built the Imperial Canal, extending diagonally from the Colorado River, with the headworks 500 feet north of the U.S.-Mexico border. Silt deposits at the headgates halted the flow of water to the canal. The stoppages caused water shortages in the Imperial Valley in 1903 and 1904. Mexico allowed the CDC to divert water from the Colorado in Mexico. The company cut a heading four miles south of the border. In 1905, the river washed out the heading and turned inland away from its normal course to the Gulf of California. For two years the Colorado flowed through the heading, flooding and eroding farm lands in the Imperial Valley, before entering the Salton Sink. Early trailblazers reported infrequent salt pools in the sink in 1853. The Colorado River made the Salton Sea permanent. Before the Southern Pacific Railroad Company closed the breach, the surface elevation of the Salton Sea increased from 275 feet below sea level to 201 feet below sea level. The water rose seven inches a day in 1906, and engulfed a salt refining works in sixty feet of water. The increasing size of the Salton Sea submerged an additional 298,240 acres of land. The Southern Pacific found itself obligated to close the breach because the flooding inundated the company's tracks across the Valley, and the California Development Company's resources proved too few to deal with the problem.⁵

California Development Co. reorganized in 1905, and as a result of its settlement with the Southern Pacific for repairing the breach in the canal and re-directing the river, control of the

4. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1934, 9; Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York: Pantheon, 1985), 195-6; "Imperial Valley, California," *The Reclamation Era*, February 1936, 45.

5. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1934, 9-10; David Lavender, *California: A Bicentennial History* (New York: W.W. Norton and Company, 1976), 177; Water and Power Resources, *Project Data*, 70; Leeds, Hill, Barnard and Jewett, "Survey of Conditions in Imperial Irrigation District," 3; Worster, *Rivers of Empire*, 196; Remi A. Nadeau, *The Water Seekers* (Santa Barbara, California: Peregrine Smith, 1974), 152; Erwin Cooper, *Aqueduct Empire: A Guide to Water in California, Its Turbulent History, and Its Management Today* (Glendale, California: Arthur H. Clark, 1968), 70.

company's affairs went to the Southern Pacific Land Company, a subsidiary of the Southern Pacific Railroad, that included the CDC's Mexican corporation. CDC's property was in a receivership from 1910 until 1916. In the meantime the Imperial Irrigation District (IID) organized in 1914, and in 1916, the Irrigation District obtained the CDC's property, including all the company's stock in the Mexican corporation that managed all the CDC's property in Mexico. The Coachella Valley County Water District (CVCWD) organized on January 16, 1918, under the County Water District Act of California. The CVCWD soon became part of the drive to irrigate the Imperial Valley with a canal located entirely in the United States.⁶

Project Authorization

During the summer of 1904, Imperial Valley water users asked Reclamation to consider purchasing the California Development Company's works for \$3 million and complete the system under the auspices of the Reclamation Act of 1902. The U.S. Attorney General asserted the project's international features legally prohibited Reclamation's involvement. Furthermore, the Reclamation Service considered the asking price excessive.⁷ The roadblocks to Reclamation, however, failed to stop future considerations of a project in the area.

In 1918, the U.S. government appropriated \$15,000, and the Imperial Irrigation District appropriated another \$30,000 to begin surveys and estimate the cost for a canal situated entirely in the United States. Elwood Mead, W. W. Schlecht, and C. E. Grunsky submitted the first report on July 22, 1919. Congress, felt the need for more information, and authorized Secretary of the Interior Franklin K. Lane to examine conditions of the Imperial Valley and major features of the project. The resulting "Fall-Davis Report" recommended a highline canal from Laguna Dam, on the Yuma Project, to the Imperial Valley. The report also endorsed construction of a storage reservoir at or near Boulder Canyon on the lower Colorado River. As a result, Congress approved the Boulder Canyon Act on December 21, 1928, providing for construction of present day Hoover Dam. The act further authorized a main canal, traveling entirely in the United

6. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1934, 9; Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal," 1939, RG 115, 127; Leeds, Hill, Barnard and Jewett, "Survey of Conditions in Imperial Irrigation District," 3; Bureau of Reclamation, *Boulder Canyon Project Final Reports: Part IV--Design and Construction; Bulletin 6--Imperial Dam and Desilting Works*, Bureau of Reclamation, Denver, 1949, 11.

7. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1934, 10.

States, connecting Laguna Dam, or another diversion dam, with the Imperial and Coachella Valleys in southern California.⁸

Construction History

On March 26, 1929, the United States contracted with the Imperial Irrigation District and the Coachella Valley County Water District for investigating and estimating the cost for the type of canal authorized in the Boulder Canyon Act. The contract limited expenditures to \$100,000, to be split equally between the government and the two districts. Two sites were considered. One recommendation proposed a canal from Laguna Dam. The second location started at a diversion dam five miles upstream from Laguna and had an elevation twenty-one feet higher than the other proposal. Reclamation Engineer Homer J. Gault directed the investigation, completing the field work in May 1930. Gault submitted the final report in May 1931, recommending the diversion dam and desilting works five miles upstream from Laguna Dam. The report set the location for the All-American Canal in approximately its final position.⁹

Reclamation also planned to use the All-American Canal to divert water to the Siphon Drop Powerplant, on the Yuma Project, and from there into the Yuma Main Canal, eliminating the need for Laguna Dam. The canal's immediate purpose was to provide an adequate supply of desilted water to the almost 500,000 acres already irrigated by the canal Imperial Irrigation District's system. The Irrigation District contracted with Reclamation on December 1, 1932, for construction of a diversion dam, main canal and structures, and delivery of water. The repayment contract's major provisions specified: construction by Reclamation; a final cost not to exceed \$38.5 million; assumption of operation and maintenance by the Irrigation District; method of repayment; diversion and delivery of water for the Yuma Project; delivery of water from Boulder Dam by Reclamation; and development of hydroelectric power. On October 15, 1934, the Coachella Valley County Water District entered into a repayment contract with Reclamation specifying a diversion dam, main canal and structures, and the delivery of water.¹⁰

8. *Ibid.*, 10-2.

9. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1934, 12; Reclamation, *Boulder Canyon Project Final Reports: Imperial Dam and Desilting Works*, 12.

10. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1934, 12, 14-15; Bureau of Reclamation, "Annual Project History, Coachella Division--All-American Canal System--Boulder Canyon Project," (continued...)

Raymond M. Priest was the first Construction Engineer for the All-American Canal. After Priest’s death on July 6, 1934, Roy B. Williams became the Construction Engineer for the Project. The Yuma Project office handled preliminary clerical work until the All-American construction headquarters could be put in the new Federal building in Yuma. Reclamation established a survey tent camp on the Colorado River about twenty-five miles above Yuma with plans to move it as work progressed.¹¹

All-American Canal

The size of the All-American Canal convinced Reclamation to separate construction into several schedules. Besides the contracts, Reclamation also carried on a significant portion of the work by force account. Sixteen companies received contracts for work on the canal, not including subcontractors or bond companies forced to complete work (see Table. I). Work on the canal started in 1934.

Table I. Contractors on the All-American Canal and Its Features. Source: Reclamation, “Project History, Boulder Canyon Project--All-American Canal”: 1934, 23, 27; 1936, 83, 89, 93, 94; 1937, 111, 124, 132; 1938, 122; 1939, 95; 1940, 98.	
The Griffith Co.	W. E. Callahan Construction Co.
Gunther & Shirley Co.	George Pollock Co.
Peterson Construction Co.	Frazier-Davis Construction Co.
David H. Ryan	Lewis-Chambers Construction Co.
Frank Doran	A. S. Vinnell
V. R. Dennis Construction Co.	Norman I. Fadel
Sharp and Fellows Contracting Co.	Atlas Construction Co.
J. W. & E. M. Breedlove Excavating Co.	Southwest Welding and Manufacturing Co.

The Griffith Company contracted one of the most difficult excavation schedules on the All-American Canal. Schedule Seven ran through two rock ridges on the east side of Pilot Knob. Griffith started excavation on August 8, 1934, experiencing considerable difficulty in drilling the rock because of seams and the irregular condition of the formation. The company managed to excavate over 150,000 cubic yards of rock before the end of 1934. The Griffith Company

(. . .continued)
1947, RG 115, 43.

11. Reclamation, *Boulder Canyon Project Final Reports: Imperial Dam and Desilting Works*, 13, 16-8.

excavated 35,833 cubic yards of common material and 522,582 cubic yards of rock, completing Schedule Seven on August 22, 1935.¹²

In the midst of the Great Depression and severe drought of the 1930s, Imperial Valley farmers and other citizens, like others around the United States, suffered from unemployment and financial difficulties. In an attempt to alleviate the problem, the Board of Directors of the Imperial Irrigation District requested \$1 million for force account labor on part of the Canal in the Imperial Valley. The allotment served as a relief measure for the unemployed and farmers suffering from the shortage of irrigation water during 1934. The force account labor employed 250 men and 1,000 head of horses and mules. All the men and teams were hired through the Federal Re-employment Office in El Centro, California.¹³

In 1935, the Southern Sierras Power Company protested a loan given to the Imperial Irrigation District under the Emergency Relief Appropriation Act of 1935. The loan enabled the Irrigation District to build generating, transmission, and distribution facilities to provide electricity to the Imperial and Coachella Valleys. Southern Sierras argued the proposed works would duplicate adequate electrical facilities in existence and infringe on the power company's market share. Southern Sierras further maintained the power facilities failed to qualify for Public Works Funds because the work would compete with private industry and was not useful, among other lesser reasons. The company said construction of the All-American Canal would furnish ample relief work. The power company's arguments proved to be in vain and the Irrigation District eventually had their power facilities.¹⁴

Continued construction in 1936, required conclusion of right of way negotiations. Reclamation secured contracts with several mining groups to guarantee canal right of way above Laguna Dam. A contract with the Southern Pacific Railroad granted a right of way for the All-American Canal over the railroad right of way at Araz Junction and provided for a bridge at that

12. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1934, 23; Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal," 1935, RG 115, 41, 43, 47.

13. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1934, 33.

14. Southern Sierras Power Company, "Protest of The Southern Sierras Power Company to Application of the Imperial Irrigation District: Filed on May 22, 1935 with the Projects Work Administration at Los Angeles for a Loan and Grant for the Construction of Competing Power Plants and Distribution System in Imperial and Coachella Valleys, California," Project Reports, RG 115, Box 4, 1, 3, 20, 23.

point. The canal right of way crossed the Picacho and Castle Dome cemeteries, forcing Reclamation to relocate the remains from both to Potholes, California.¹⁵

Two contracting companies became financially unstable while working on the canal, forcing their bond companies to take over the work. Peterson Construction Company, already plagued by work stoppages, suffered financial difficulties during 1937, forcing their bond company, Seaboard Surety Company, to take over the contract. Atlas Construction Company became unable to finish its contract for construction of turnouts, checks, culverts, and temporary metal and timber flume crossings on the All-American Canal in 1939. The company's surety, Fidelity and Deposit Company of Maryland, assumed responsibility for the contract. Fidelity and Deposit sublet the contract to MacDonald and Kahn, Inc.¹⁶

Reclamation completed repairs and rehabilitation of the Siphon Drop Powerplant of the Yuma Project in 1938, under the auspices of the Boulder Canyon Project--All-American Canal System. Reclamation rehabilitated the Siphon Drop Powerplant in order to increase its generating capacity. Reclamation's work on the powerplant also linked the All-American Canal to the Yuma Main Canal for supplying irrigation water to the Yuma Project. V. R. Dennis Construction Company and their subcontractors finished a check and wasteway near Pilot Knob on June 27, 1938. Norman I. Fadel contracted to construct a turnout from the All-American Canal to the Yuma Main Canal and the Siphon Drop Powerplant, four drainage outlets, and a turnout from the Siphon Drop Powerplant forebay to an existing lateral serving lands in the Fort Yuma Indian Reservation.¹⁷

Some citizens of Calexico wanted the All-American Canal to travel through the city. Reclamation felt the damage resulting from any breaks in the open canal would not be worth the risk. Reclamation considered two alternatives through Calexico using conduits traveling under the streets of the city, crossing the New River through pipes or conduits. The cost for running

15. Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal," 1936, RG 115, 39, 41, 60.

16. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1936, 93; Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal," 1937, RG 115, 106; Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal," 1938, RG 115, 107; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1939, 95, 99.

17. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1938, 103, 125, 131.

the canal through Calexico would have been \$186,760 to \$382,358 more than the route around the town. Reclamation decided to skirt Calexico with the canal.¹⁸

Sharp and Fellows Contracting Company received the contract to build the combination siphon and wasteway over the New River and started construction of the New River Siphon, carrying the All-American Canal over the New River, on March 8, 1937. Sharp and Fellows poured the inclined barrels at the inlet and outlet of the steel pipe sections monolithically, in one solid section without joints. The company finished the siphon on August 6, 1938. Southwest Welding and Manufacturing Company started finishing, erecting, and painting the 196-inch diameter plate steel pipes for the New River Siphon in October 1938, and finished the next year.¹⁹

Reclamation completed acquisition of rights of way for most of the All-American Canal in 1939, except for some parcels through the more heavily farmed section of the Imperial Valley. Title complications delayed closing the sections. The Act of August 30, 1890 (26 Stat. 391) reserved right of way for canals and ditches constructed under the authority of the United States. As a result, payment for the rights of way only covered damages to improvements, not for the land. Reclamation did purchase three parcels near the Alamo River for borrow pits and building sites.²⁰

In 1939, all contract work on the All-American Canal ended. Final construction on the canal consisted mainly of work on the power drops. Lewis-Chambers started Drop One and the Coachella Turnout on July 24, 1938, progressing slowly during the year, but picked up the pace in 1939. The company finished the contract on July 6, 1939. Work crews completed the other power drops during the same year. The Imperial Irrigation District installed the generating machinery for the powerplants.²¹

Seepage proved a continual concern on the canal throughout construction. In 1937

18. "Canal to Skirt Calexico," *The Reclamation Era*, March 1936, 72; Chad F. Calhoun, Chief Engineer for MacDonald & Kahn, Inc, "Report on Cost Studies: All-American Canal System, California; Giving Estimated Cost for 'C' and 'D' Locations of Canal and Conduit Compared with U.S.B.R. Estimated Cost of the 'R' Location Around the City of Calexico," *Project Reports*, January 1936, Box 4, 5.

19. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1937, 124; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1938, 118, 120, 122.

20. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1939, 47.

21. *Ibid.*, 69, 80, 89, 92.

compacted lining was placed where the canal traversed material too porous to prevent excess seepage losses, and Frank Doran placed clay sewer-pipe drains parallel to the All-American Canal on both sides in the Calexico area. The pipe carried off seepage water which otherwise might flow into adjacent farm lands. In 1940, Reclamation constructed intercepting drains along the All-American Canal through the Reservation Division of the Yuma Project and on East Mesa near the East Highline Canal as needed. The drains prevented canal seepage from settling into ponds on nearby cultivated lands. The drains kept out the accumulation of water which otherwise would damage crops and land.²²

Actual water delivery started in the spring of 1940. An earthquake in May 1940 destroyed some of the Imperial Irrigation District's canal. The District received permission from Reclamation to divert water from the Central Main Canal until repairs could be effected. The All-American Canal continued receiving water from the IID's Mexican canal system until water diverted at Imperial Dam reached the western canals. Official water delivery through the All-American Canal started in October 1940. The inaugural ceremonies took place on October 12, 1940, at the turnout to the East Highline Canal of the Imperial Irrigation District. Reclamation Commissioner John C. Page gave the keynote address at the celebration.²³

Upon final completion, the All-American Canal stretched eighty miles, from Imperial Dam to just west of Calexico, California. The bottom width of the canal averaged 160 feet, with a water depth of twenty-one feet. The canal's diversion capacity reached 15,155 cubic feet per second. Much of the All-American Canal's path skirts the U.S.-Mexico border as it travels west.²⁴

Imperial Dam

Reclamation constructed the government camp site for Imperial Dam one and one half miles downstream from the dam site, starting September 17, 1935. The camp included an air-conditioned office, an air-conditioned twenty-eight man dormitory, four four-room residences,

22. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1937, 111; Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal," 1940, RG 115, 79.

23. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1940, 121, 123, 125, 127; "All-American Canal Celebration," *The Reclamation Era*, November 1940, 314.

24. Water and Power Resources, *Project Data*, 68, 72.

six three-room residences, four two-room residences, seven two-car garages for residences, a dormitory garage, and a combination garage/warehouse/shop. A 100 foot deep, twelve-inch, cased well pumped water to the 30,000 gallon steel supply tank, standing sixty feet high, which held the camp's water supply.²⁵

Reclamation conducted clearing operations on the reservoir site for Imperial Dam. Dense areas of arrow weed, willows, mesquite, and other local plant life covered the site. Reclamation cleared the area prior to construction work to facilitate survey work and allow bidders to better study the dam site. Reclamation employed Native Americans from the nearby Fort Yuma Indian Reservation to clear the site using hand tools.²⁶

Reclamation awarded the contract for construction of Imperial Dam to Morrison-Knudsen Company, Inc., Utah Construction Company, and Winston Brothers, Inc., three of the companies that built Hoover Dam, on December 14, 1935. The three contractors received the notice to proceed January 14, 1936, and started work two weeks later. Orders for Changes, issued shortly after the contract award, required construction of a desilting basin for the Gila Gravity Main Canal, a concrete apron upstream from the units of the headworks, and reinforced concrete sheet piling for the division walls of the inlet channels.²⁷

Morrison/Utah/Winston established a temporary camp east of the All-American Canal, and started constructing a permanent camp 900 feet west of the Canal. They completed fifty buildings by the end of 1936. The structures erected consisted of a eight man dormitory, two sixteen man dormitories, fifteen twenty-four man dormitories, twenty-eight one-family residences, two office buildings, one hospital, and one mess hall/commissary/recreation building. The contractors raised a secondary camp for laborers with families who could not be taken care of in the main camp, or who chose to establish their own quarters. The companies provided electricity, treated water, and bathing facilities. Left to their own devices, the secondary camp residents used trailer, tents, frame buildings, and cabins for living quarters. Initially, Reclamation counted ninety-six families in the camp, but believed there might be more. A later

25. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1935, 41, 43-4.

26. Reclamation, *Boulder Canyon Project Final Reports, Pt. IV*, 171.

27. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1935, 8, 65.

census revealed 253 residences in the area with a population of 812 inhabitants. The contractors provided two police officers and Reclamation provided another, who was also deputized as a county health officer and agriculture inspector. An owner of a quarter section, one mile from the dam site, built some temporary cottages to rent to workers. The contractors supplied electricity and water to the owner under agreement that the granting of any concessions on the property needed the contractors' approval, to guarantee a uniform policy for all residents. Eventually about sixty families lived at the third camp.²⁸

Work on the dam site began with construction of a 3,400 foot long cofferdam to block the river from the diversion works and construction site. Then Morrison/Utah/Winston started work on the desilting basins, driving sheet-piling under the outer banks of the outlet channels on January 26, 1936, and finished the work the following May. The companies began placing the eighteen inch dry rock paving in the desilting basins on May 15, 1936. At first they used rock excavated from Basin One, but after depleting that source, the contractors then opened a rock quarry on the Arizona side of the Colorado.²⁹

Work crews started excavating the California abutment on April 6, 1936. By June 3, they were ready to place the first concrete, completing most of the work by December 3, 1936. Excavation for a footing to some of the All-American Canal headworks extended more than fifty feet and went below the elevation of the river bed. To keep river water out of the excavation, workers drove a line of steel sheet-piling into the rock around the work area. Seepage required three six inch and three four inch pumps to discharge water from 219 wellpoints driven into the sand around the inside of the piling, for eight days before placing the concrete. Seepage continued through the rock itself, causing problems for the work crews. The pumps removed 1,500 gallons per minute from the footing during concrete placement, and a system of tile and gravel drains brought the water to a central point to pump out. After finishing the work, the contractors filled the drains with grout to seal them.³⁰

The Morrison/Utah/Winston contract included the beginning of the Gila Gravity Main

28. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1936, 66-7; Reclamation, *Boulder Canyon Project Final Reports, Pt. IV*, 173-4.

29. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1936, 68, 71, 73.

30. *Ibid.*, 75-6.

Canal. Work started on September 28, 1936. The canal required construction of the left embankment, in addition to canal excavation using material channel excavation and a borrow pit. At the end of 1936, Morrison/Utah/Winston employed 1,035 men on the dam construction, excluding government and company officials.³¹

Morrison/Utah/Winston set up concrete mixing plants on both the Arizona and California sides of Imperial Dam. The contractors placed all the concrete possible before diversion of the river, nearly completing the All-American Canal headworks by the end of 1937. Some of the work completed included installation of the twenty-three foot high, seventy-five foot long roller gates in the headworks during 1937. Work crews finished most of the Gila Gravity Main Canal headworks on June 14, 1937.³²

Morrison/Utah/Winston began closing the downstream cofferdam in late March 1937, using surplus material from excavation to construct it. Excavation of the diversion channels started on May 17, 1937, and the contractors completed them on July 12.

Morrison/Utah/Winston started excavation of sections of the dam on July 17, 1937, and closed the upstream cofferdam at midnight two days later. The contractors completed all of the excavation on October 23, 1937.³³

Two minor floods struck the Imperial Dam site in February 1937, but did no damage. Early warning of the flood conditions allowed sufficient preparation to deal with the problem. During the year, dam construction had an average of 800 workers, from a low of 520 to a high of 1,280 during peak construction. On May 3, 1937, the contractors and the American Federation of Labor (AFL) reached an agreement under which the dam construction would only employ union men.³⁴

Morrison/Utah/Winston finished the concrete on the overflow weir, the section where the Colorado River flows across, with the placement of twelve units. The contractors leveled gravel ballast, stockpiled in the units before final placement of concrete, and graded it to form a fill nine

31. *Ibid.*, 79, 81.

32. Reclamation, "Project History, Boulder Canyon Project--All-American Canal System," 1937, 27, 65, 78, 80, 82.

33. *Ibid.*, 84-7.

34. *Ibid.*, 92, 96.

feet deep. Work crews formed a drainage channel along the downstream weir wall to pass water from the drains in the foundation to the outlets in the downstream surfaces of the weir. Morrison/Utah/Winston maintained stability in the channel by paving the bottom and slope with twelve inch thick, dry rock paving. The contractor placed a massive riprap section downstream from the overflow weir. Excavation for the section reached twenty-eight feet deep. The companies surrounded the area with wellpoints to help dewater the site, but work crews could only remove water down so far, forcing them to place some of the riprap under six feet of water.³⁵

The contractors resumed driving the twenty foot steel sheet-piling for cutoff walls, and placement of concrete and riprap for the sludge pipe outlets in conjunction with construction of the training dike on the sluiceway. Work finished on the influent channel structures in two desilting basins, and concrete work on the transitions from the gate structures for three bypass. Morrison/Utah/Winston lined the desilting basins with rock paving embedded in gravel. Final work included the control structures for the desilting works.³⁶

Heavy rains on the headwaters of the Bill Williams River, a Colorado River tributary in the northeast corner of Arizona, in early March 1938, caused flooding on the Colorado which suspended all construction on the Arizona side. The flood waters threatened the contractors' construction bridges across the diversion channels downstream from the gate structure. The Colorado started rising March 4, reaching flood levels by March 9. Morrison/Utah/Winston removed stop logs from Basin Three's gate structure to pass the flood waters. The contractors replaced the stop logs when the water subsided, having done no damage.³⁷

Work on Imperial Dam finished July 30, 1938. Reclamation completed some construction on the dam by force account because materials and equipment did not arrive before the contract deadline. The contractors began dismantling the construction camp on the right bank, downstream from the desilting works, in the early part of June. Morrison/Utah/Winston left their wood construction bridge, originally meant to be temporary, in place to use for

35. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1938, 70, 72.

36. *Ibid.*, 78, 80, 82.

37. *Ibid.*, 93-4.

maintenance work. Reclamation held dedication ceremonies at Imperial Dam on October 18, 1938. Secretary of the Interior Harold L. Ickes gave the keynote address to the audience. As part of the celebration, Reclamation turned the first water into the headgates of the All-American Canal.³⁸

The central overflow section of Imperial Dam is a hollow section 1,198 feet long and 31 feet high. The hollow sections contain gravel ballast to give it the weight necessary for stability. The overflow weir is a “floating” type, resting on a twelve foot layer of compacted earth on top of the gravel bed of the Colorado. At the end of construction Imperial Dam was the highest concrete or masonry dam built as a floating weir. The non-overflow section of the dam is a concrete slab and buttress weir standing eighty-five feet high, which adds 2,277 feet to the length of the dam. The All-American Canal and Gila Gravity Main Canal headworks sit on either side of the dam, resting on fifty foot concrete pilings.³⁹

The All-American Canal’s desilting works at Imperial Dam consist of six settling basins arranged in pairs. Each basin is about 269 feet wide and 769 feet long, set at a sixty degree angle to the influent channels. The influent channels are concrete and have a diminishing cross-section. The water feeds through vertical slots, tipped with iron which reduce the velocity and turbulence of the water, and distribute it evenly into the basins. The water flows across the basins to the effluent/bypass channels. The water travels across an overflow weir, remaining in the basin for twenty-one minutes, depositing 80 percent of its silt. Seventy-two rotary scrapers with 125 foot diameter, remove the silt into collecting trenches. The silt is then forced into sludge disposal pipes and through a sluiceway channel leading back into the river below Imperial Dam.⁴⁰

Coachella Canal

The Coachella Valley County Water District had over 161,000 irrigable acres in the district, but only 16,000 acres received irrigation water pumped from wells. A lack of runoff and

38. *Ibid.*, 56, 59, 63, 95-6.

39. Reclamation, “Project History, Boulder Canyon Project--All-American Canal,” 1939, 28; Water and Power Resources, *Project Data*, 71; Bureau of Reclamation, “Annual Project History, Boulder Canyon Project--All-American Canal,” 1942, RG 115, 14.

40. D. M. Forester, “The Desilting Works at Imperial Dam,” *The Reclamation Era*, August 1938, 153-4.

increased development of land combined to make well pumping necessary. When construction of the All-American Canal System started the district looked there for a new water supply.⁴¹

W. E. Callahan Construction Company and J. P. Shirley started the first excavation of the Coachella Canal on August 11, 1938. The combined companies finished seven and one half miles, and excavated over two million cubic yards of material before the end of the year. Their work progressed steadily on the first forty-three miles of the canal the following year.⁴²

Reclamation awarded the contract for the second forty-three miles of Coachella Canal to Morrison-Knudsen and M. H. Hasler in 1939. The Morrison/Hasler contract included construction of thirty-one double box siphons, one round barrel siphon, five checks, four automatic spillways, and five drainage inlets. The firms subcontracted some of the work out to various companies. The main contractors started work September 9, 1939.⁴³

Work on the Coachella Canal progressed well in 1940. Callahan-Shirley excavated 1,334,615 cubic yards of material, bringing their total of excavation to over nine million cubic yards. Morrison/Hasler excavated eighteen and one-half miles of the Coachella Canal and another seventeen and one-half miles for diversion channels during the year. During 1940, the companies finished work on fourteen siphons, substantially completed eight more, and started another.⁴⁴

By the end of 1941, the contractors completed over seventy-five miles of the Coachella Canal. During the year Morrison/Hasler excavated twelve miles of their contract. The companies completed concrete work on the contract June 7, 1941. When high temperatures struck in May and early June of the year, the contractors laid the concrete during the night to keep the concrete temperatures below ninety degrees, as per Reclamation's specifications for the Project. Reclamation opened bids on October 27, 1941, for twenty-two miles of concrete lined

41. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1937, 26.

42. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1938, 139; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1939, 111.

43. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1939, 111, 114; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1940, 106.

44. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1940, 78, 110, 112, 115.

canal, but the United States' entry into World War II forced Reclamation to reject all bids.⁴⁵

In 1942, the War Production Board suspended all work on the Coachella Canal, except the Morrison-Knudsen/M. H. Hasler contract already in effect. The firms completed excavation of storm drains and dikes, and placement of rock riprap around the structures and dikes on March 8, 1942. By the end of the year, the contractors nearly finished the contract. Labor shortages caused by the war hindered Morrison-Knudsen/Hasler sufficiently for the contractors to request an extension past the December 24, 1942 deadline. Morrison-Knudsen/Hasler concluded work on the contract March 22, 1943.⁴⁶

In 1944, the scarcity of labor, materials, and repair parts continued hampering work on the Coachella Canal. Nevertheless, Reclamation resumed work largely postponed in 1942-43. John Bohannen received a contract to build thirteen six-room residences and twelve five-room residences for Reclamation employees stationed at Coachella. On March 9, 1944, Reclamation awarded a construction contract on twenty-two miles of the Coachella Canal to J. F. Shea, Inc., who bid low at just over \$1.6 million. Reclamation issued the notice to proceed on May 2, 1944, but labor and equipment shortages prevented the contractor from starting until October 3, 1944. The canal line in Shea's contract started through rough and badly cut up terrain, slowing work considerably. By the end of 1944, Shea had only excavated one quarter of a mile of the canal.⁴⁷

Labor shortages continued to slow construction in 1945. John Bohannen completed construction of the twenty-five residences for Reclamation employees at Coachella. Because the camp lay outside of Coachella, separate water, sewer, and electrical systems had to be constructed for them. The Chicago Bridge and Iron Company built a 50,000 gallon elevated water tank to supply the camp. During 1945, J. F. Shea completed most of the excavation work on the contract, but accomplished none of the concrete work. Delays kept Shea from starting the concrete work until December 14, 1945. Heavy rains struck the Coachella Valley on August 18, 1945. The resulting runoff flooded the lower portion of the valley. The flooding caused some

45. Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal," 1941, RG 115, 32-3, 110.

46. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1942, 40; Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal," 1943, RG 115, 32.

47. Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal," 1944, RG 115, 15, 28-9, 95.

damage to compacted areas of a drainage inlet, canal banks, construction roads, and other structures on Shea's contract. Shea estimated damages at \$25,000, but Reclamation officials considered the firm's estimate excessive.⁴⁸

Reclamation awarded a contract in 1944, to Vinnell-Engineers, Ltd., for a check and a drop. When the contractor completed the work, Reclamation forces installed stop logs and turned water into the Coachella Canal on January 20. M. H. Hasler received a contract to line twenty-three miles of canal and surface about forty-nine miles of road with clay. The company completed the road surfacing and the twelve-inch canal lining January 16, 1945.⁴⁹

In 1946, Reclamation awarded a contract to J. F. Shea for eleven miles of canal with a bottom width of twelve feet lined with concrete. The contract included a nine mile dike to form a detention basin. Shea teamed with Morrison-Knudsen for two Coachella contracts. The two companies acknowledged the notice to proceed on the first contract on March 16, 1946. Reclamation awarded the second contract on April 15, 1946, but Reclamation officials complained the contractors did not accomplish any significant work during the year.⁵⁰

J. F. Shea completed one stretch of canal in 1947, including six wash overchutes. A lack of reinforcement steel initially delayed work, which continued progressing slowly because of the deficiency of skilled labor. On March 20, 1947, flood waters flowed behind the canal's concrete lining at four of the wash overchutes under construction, damaging the canal lining. Shea repaired the damage and completed the cleanup before summer. Reclamation accepted the six overchutes on June 6, 1947.⁵¹

Shea and Morrison-Knudsen concluded work on their first contract of the Coachella Canal on July 14, 1947. Late delivery of materials postponed final completion. Reclamation's Chief Engineer Walker R. (Brig) Young extended the contract an extra 105 days to allow for delayed arrival of construction materials. Slow material transfers further hindered the two

48. Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal," 1945, RG 115, 19, 42-3, 47.

49. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1944, 29; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1945, 48.

50. Bureau of Reclamation, "Annual Project History, Coachella Division--All-American Canal System--Boulder Canyon Project," 1946, RG 115, 38, 43-44.

51. Bureau of Reclamation, "Annual Project History, Coachella Division--All-American Canal System--Boulder Canyon Project," 1947, RG 115, 34, 36.

companies' second contract. The delays forced the contractors to use their own reinforcement steel for the concrete work. Shea and Morrison-Knudsen finished the contract in fall 1947, and Reclamation accepted the work October 3.⁵²

Reclamation awarded the contract for a reach of the canal to Otto B. Ashbach and Sons on January 10, 1947. Continuing negotiations between Reclamation and the Coachella Valley County Water District, for a supplemental repayment contract, delayed issuance of the notice to proceed until May 28, 1947. The negotiations for the new repayment schedule arose because costs had reached the maximum allowed by the 1934 contract. Reclamation studied a proposal on the Ashbach contract to reduce the canal section downstream of the central main turnout, but discarded the idea because of increased cost. Ashbach and Sons progressed slowly on the contract, but by the end of the year, the contractor extended the Coachella Canal past the Palm Springs highway.⁵³

Reclamation forces built a maintenance depot near Coachella Canal. The depot included a large Quonset hut to serve as a garage; two twenty by forty foot tropical huts provided a shop and warehouse; fueling facilities included a 2,000 gallon diesel oil storage tank and a 2,000 gallon gasoline storage tank; a loading dock; sewer lines; a septic tank; and water supply lines at the depot.⁵⁴

Reclamation laid canal lining on the southern end of the Coachella Canal by force account in 1947. Reclamation forces placed a twelve inch layer of uncompacted clay on the banks and bottom between Siphons One and Six. They spread the clay across the slopes and sides with bulldozers.⁵⁵

Water shortages struck the Coachella Valley during construction of the Coachella Canal in 1947. Increasing demands for water and a declining water table combined to create a water shortage in the valley. Some well supplies fell while other wells failed completely. Many

52. *Ibid.*, 37-8, 42.

53. *Ibid.*, 43, 46.

54. *Ibid.*, 49.

55. Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal System--Imperial Division," 1947, RG 115, 49.

farmers deepened their wells to find the ever elusive supply of water.⁵⁶

In 1948, Ashbach and Sons completed the concrete lining on their Coachella Canal contract. The company hauled all the concrete in transit mix trucks from one mixing plant. Wind arose in May and June 1948, hampering final completion of the contract. The wind blew large amounts of sand into the canal, forcing the contractor to clear it. The delay did not prevent Ashbach and Sons from completing the contract in June. Reclamation accepted the work June 26, 1948.⁵⁷

Macco Corporation contracted construction of flood protection wasteways, including lining, earthwork, and structures in 1948. The company finished the protection works within the following year. The contractors on the main section of the Coachella Canal also completed their contracts in 1949. Work on the lateral system for the Coachella Canal commenced in 1949, and finished in May 1954. Contractors also completed an equalizing reservoir on the Coachella Canal on June 10, 1953.⁵⁸

The Coachella Canal travels 123 miles northwest from the All-American Canal at Drop One. Initial capacity of the earth lined section is 2,500 cubic feet per second. The concrete lined section has a capacity of 1,300 cubic feet per second. The earth lined section of the canal is forty to sixty feet wide at the bottom with a water depth of 10.3 feet. The bottom width of the concrete lined section is twelve feet with a water depth of 10.8 feet.⁵⁹

Post Construction History

All-American Canal

Heavy rains struck the All-American Canal in early September 1939, causing some damage to embankments and roadways of the canal. Reclamation began repairs on the damage immediately. Workers repaired the embankments and roadways, and cleaned dirt deposits out of

56. *Ibid.*, 52.

57. Bureau of Reclamation, "Annual Project History, Coachella Division--All-American Canal--Boulder Canyon Project," 1948, RG 115, 20.

58. Reclamation, "Project History, Coachella Division--All-American Canal System--Boulder Canyon Project," 1948, 26; Bureau of Reclamation, "Annual Project History, Coachella Division--All-American Canal--Boulder Canyon Project," 1949, RG 115, 20; Bureau of Reclamation, "Annual Project History, Coachella Division--All-American Canal--Boulder Canyon Project," 1953, RG 115, 35; Bureau of Reclamation, "Annual Project History, Coachella Division--All-American Canal--Boulder Canyon Project," 1954, RG 115, 19.

59. Water and Power Resources, *Project Data*, 68-69, 72.

the canal. To prevent further damage, Reclamation placed rock riprap and side drains at intervals along the embankment. The work started at Imperial Dam and neared Station 1800 at the end of the year.⁶⁰

Reclamation started canal priming operations on the All-American Canal, between the desilting works and Pilot Knob wasteway, on January 26, 1939. The diversion continued until March 11, after 30,000 acre-feet had been turned into the Canal. Afterwards, Reclamation's project lab found the diversion had deposited 1.04 acre-feet of silt into the canal. At the beginning of the priming operation, seepage losses totaled 86 percent. By the end of the operation, seepage was reduced to 17 percent. Reclamation again diverted water into the All-American Canal on September 9, 1939, after floods washed out the Yuma Main Canal. The All-American supplied water to the Yuma Project through the turnout at the Siphon Drop Powerplant.⁶¹

Based on studies of the priming operation, Reclamation decided to line the upper reaches of the All-American Canal, and build a system of intercepting drains, generally parallel to the canal, connected to drains of the Yuma Project. The drains prevented canal seepage from causing ground water conditions, and accumulation of water which otherwise would damage nearby crops and land. J. W. and E. M. Breedlove Excavating Company laid a clay blanket on a section of the canal, completing it July 24, 1940.⁶²

On May 18, 1940, the Imperial Valley experienced a large earthquake. The quake consisted of two major shocks. The first struck at 8:37 p.m. and the second at 9:50 p.m. The initial shock damaged buildings in Imperial, El Centro, Holtville, Calexico, and Mexicali, Mexico. The second shock caused extensive damage to buildings in Brawley, the most serious in the area. The earthquake killed at least nine people in the Imperial Valley and Mexico, five in the Imperial Valley. The earthquake extensively damaged the IID's irrigation system, seriously damaging or totally destroying approximately thirty miles of the Imperial Canal lying in

60. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1939, 80.

61. *Ibid.*, 82-3.

62. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1939, 83, 85; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1940, 79, 98, 104, 130.

Mexican territory.⁶³

The earthquake created a continuous surface fracture which followed a fault from five and one-half miles north of the city of Imperial to a point sixteen miles within Mexico, a total distance of forty miles. The fracture offset fourteen feet, ten inches of canal where it crossed the All-American Canal. The rift destroyed one turnout structure which lay in the path of the fracture. The most serious damage to the All-American Canal occurred at Power Drop Five where the gate structure and powerhouse foundation settled. Both banks of the Canal shattered for a distance of 1,950 feet, and the quake shook 60,000 cubic yards of dirt into the Canal. Reclamation gave the IID permission to divert water from their Central Main Canal into the All-American for delivery of water to lands west of the New River, while completing repairs of the IID canals. The All-American continued receiving water from the IID's Mexico system until water diverted at Imperial Dam reached the western canals. All earthquake damage was repaired by the end of 1941.⁶⁴

As sections of the All-American Canal became operational, the IID severed its connections to Mexico. The IID placed the New Briar Canal in operation in 1941, and it became the water source for the Ash Canal. The Irrigation District abandoned the temporary flume of the Ash Canal crossing the All-American Canal. A large inundated area used as a desilting basin for the Ash Canal was drained and abandoned, to reduce the threat of collapsing the All-American Canal embankment.⁶⁵

In 1941, Reclamation removed the high spoil banks along the All-American Canal near Drop Five, to improve stability of that section. During the year Reclamation awarded a contract to Norman I. Fadel to line the New Briar Canal, connecting All-American with the IID system, with a one and one-half inch layer of gunite. The New Briar Canal was originally designed as an unlined canal, but Reclamation decided to line it to prevent seepage. Possibly because more water would reach its destination through the lined canal, part of the work involved reducing the

63. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1940, 147; "Five Killed as 4 Quakes Shake West," *Rocky Mountain News*, 19 May 1940, p.1; "Quakes Spread Heavy Damage in California Area," *The Denver Post* 19 May 1940, p.1.

64. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1940, 121, 149, 151, 153; Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal," 1941, 29.

65. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1941, 36, 29-30.

size of the canal section.⁶⁶

Flood waters in 1942, overflowed the wash structures at Picacho and Unnamed Washes, overflowing the structures. Reclamation constructed protective dikes adjacent to Picacho Wash that was 2,020 feet long, for Picacho and one next to Unnamed Wash 1,000 feet long. Rock work on the dikes finished at Picacho during 1942 and at Unnamed in 1943.⁶⁷

In 1944, the Mexicali Valley in Mexico suffered a severe water shortage. Early in May 1944, the Imperial Irrigation District formally requested Secretary of the Interior Harold Ickes' consent in temporarily supplying water to Mexicali. The State Department received a similar request from the International Boundary and Water Commission. On July 17, 1944, when the water shortage in the Mexicali Valley became acute, the State Department asked the Department of the Interior and Reclamation to make water available. The State Department said it would make arrangements for payment by Mexico. In 1945, Reclamation diverted 704,008 acre-feet at the Pilot Knob wasteway for delivery to Mexico through the Imperial Canal.⁶⁸

Reclamation started connecting the All-American Canal to the Reservation Division of the Yuma Project by force account on March 12, 1948, finishing the switch of the Yuma Project's source of water from Laguna Dam to Imperial Dam. Reclamation completed the four connections by the summer. They included Reservation Main, Yaqui, Pequod, and Tilsink. Reclamation sealed the outlet works for the Yuma Main Canal at Laguna Dam on June 23, 1948.⁶⁹

Wind erosion and windblown sand continued to plague the All-American Canal. In 1950, As part of normal maintenance, Reclamation laid riprap along some sections of the All-American, where wind and waves eroded the bank. Reclamation and contract forces removed windblown sand from the canal.⁷⁰

66. *Ibid.*, 101, 104.

67. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1942, 43, 45; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1943, 31.

68. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1944, 24; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1945, 59.

69. Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal--Imperial Division," 1948, 37.

70. Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal--Imperial Division," 1950, RG 115, 50-1, 53.

In 1990, seepage continued to be a major problem for the first sections of the All-American Canal near Imperial Dam. Reclamation considered conservation of seeped water important for two reasons. The southern California coast area needed water and predictions indicated that by 2010, water supplies to the coast would fall short of requirements by 1.2 million acre-feet.⁷¹

Reclamation officials developed several options to reduce seepage. The first alternative considered was construction of a new canal, parallel to the All-American, to bypass the problem spots of the main canal. The new canal would start one mile west of Pilot Knob and travel twenty-three miles west to Drop Three. Two alternatives dealt with lining the existing canal, suggesting the placement of a concrete type able to harden underwater allowing Reclamation to line the canal without interrupting service. The first of these would line All-American from Pilot Knob to Drop Three, a distance of 24.6 miles. The other advocated lining the canal to Drop Four, a distance of almost thirty miles. The fourth alternative planned a series of wells along the canal between Pilot Knob and Drop Two to collect seeped water and return it to the canal. Reclamation's fifth alternative was to take no action and let the situation remain the same. The IID and the Metropolitan Water District decided to build a parallel canal, with construction scheduled to start in 1996.⁷²

Imperial Dam

By 1939, silt deposits behind Imperial Dam had already reduced the capacity of the reservoir so much that Reclamation predicted the dam would soon cease to function as a flood control structure. To remove the large amount of silt constantly building up behind Imperial Dam, Reclamation carried out sluicing operations every few months. For sluicing operations in 1949, Reclamation opened the sluice gates at Laguna Dam two hours before opening the gates at Imperial Dam. Opening the gates at Laguna drew the water down to the normal level of the Colorado and increased the velocity of the current. This cut into the silt deposits in the river bed

71. Bureau of Reclamation, "Draft Environmental Impact Statement/Draft Environmental Impact Report: All-American Canal Lining Project," Imperial County, California, Bureau of Reclamation, Lower Colorado Region, 1991, S-1--S-2.

72. Reclamation, "Draft Environmental Impact Statement/Draft Environmental Impact Report: All-American Canal Lining Project," S-1--S-2; Telephone interview with Jim L. Sizemore, Construction Engineer, Yuma Projects Office, Yuma, Arizona, 4 January 1995.

and above the gates. Opening the gates at Imperial two hours later achieved similar results. Even now Imperial Dam requires dredging every two years because of silt buildup.⁷³

The high velocities of water flows in the channels and basins of the All-American Canal desilting works threatened to erode the channels, basins, and dikes at the canal's headworks at Imperial Dam. To prevent such erosion, in 1940, Reclamation applied a gunite lining to the rock paving on the sides and the channels of the desilting works, and to the sides of the dike upstream from the All-American Canal headworks.⁷⁴

Reclamation workers carried out a variety of tasks during the early years of World War II. As a result of the war's outbreak, Reclamation raised a series of barriers on the road near Imperial Dam to control traffic. Most work consisted of operations, maintenance, and repairs. A high salt content in the soil around Imperial Dam corroded pipes where their protective coatings proved defective. Reclamation workers repaired or replaced the pipes as necessary.

Reclamation forces cleared tamarisk and willows which grew in the desilting basins and filled the basins with water to prevent further growth.⁷⁵

Reclamation started operating the desilting works at Imperial Dam in October 1944. In the first year of operation the desilting works suffered several washouts, some caused by shutdowns for repairing the initial damage resulting in unbalanced water flow. Reclamation awarded an emergency contract to M. H. Hasler to stabilize the rock paving. Hasler finished the contract on June 24, 1945, at a cost of \$245,465.⁷⁶

The complexity of Imperial Dam's desilting works and their machinery created problems in maintenance, necessitating frequent repairs. In late 1945, the lack of replacement parts in 1945, delayed necessary repairs on the scraper mechanisms. Reclamation discovered concrete failure in the scraper pedestals. Repairs on the scrapers and damaged concrete finished by the

73. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1939, 37; Reclamation, "Project History, Boulder Canyon Project--All-American Canal System--Imperial Division," 1947, 55; Reclamation, "Project History, Boulder Canyon Project--All-American Canal System--Imperial Division," 1949, 47; Bureau of Reclamation, "Safety Evaluation of Existing Dams: Analysis Summary; Imperial Diversion Dam," Bureau of Reclamation, January 10, 1991, 2.

74. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1940, 81.

75. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1941, 79; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1942, 41.

76. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1945, 52-3.

end of March 1946. Another example of mechanism failure occurred in 1947, twelve two inch high pressure lines failed from corrosion. Reclamation started work on December 5, 1947, replacing them with four inch steel pipes. Reclamation finished the pipe repairs on February 25, 1948. In 1949, Reclamation alternated taking the basins out of operation for maintenance and repairs.⁷⁷

On December 12, 1945, Reclamation awarded a contract to Clyde W. Wood for construction of a check to control the velocity of water flowing from the desilting works, to prevent damage to the outlet channels. Wood started work on January 14, 1946, and finished the 202 foot long check on August 21, 1946.⁷⁸

In 1947, Reclamation abandoned a well, used for an industrial water supply, at Imperial Dam and the desilting works because an excessive amount of sand had seeped into the water. Reclamation dug a new well on the west end of the dam, on the downstream side. The new well was twenty-five feet deep and cased with a forty-two inch concrete pipe. Reclamation installed two pumps, each with a capacity of 125 gallons per minute, over the well. Reclamation officials planned to use only one pump, with the other on standby in case of an emergency.⁷⁹

Coachella Canal

The CVCWD began to realize in the 1960s that the Coachella Canal had severe limitations. The Water District started preliminary investigations to develop an improvement program to eliminate the weaknesses of the original canal system. The CVCWD applied to Reclamation for a loan to start rehabilitation of the Coachella Canal system. The loan was authorized in 1961, under the Rehabilitation and Betterment Act of October 7, 1949 (63 Stat, 74), as amended March 3, 1950 (64 Stat. 11). The program, carried out by the CVCWD, installed a supervisory remote control and telemetering system to operate the canal and

77. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1945, 58; Reclamation, "Project History, Boulder Canyon Project--All-American Canal--Imperial Division," 1946, 66; Reclamation, "Project History, Boulder Canyon Project--All-American Canal System--Imperial Division," 1947, 58, 61; Reclamation, "Project History, Boulder Canyon Project--All-American Canal--Imperial Division," 1948, 61; Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal--Imperial Division," 1949, RG 115, 47-8.

78. Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal--Imperial Division," 1946, RG 115, 60-1.

79. Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal--Imperial Division," 1947, RG 115, 53-4.

distribution system, constructed a regulating reservoir, Lake Cahuilla, at the end of the canal, built two flood control dikes, added ten traveling demossing screens, a new check gate, and rehabilitated an existing check gate. The automated telemetering equipment consisted of microwave and UHF circuits linking the central headquarters to 150 response stations, including the demossing screens. Lake Cahuilla is impounded by an earthen dike 18.6 feet high and 6,276 feet long. The embankment has a top width of 100 feet and a maximum base width of 193 feet. The lake has a capacity of 1,300 acre-feet.⁸⁰

Settlement of the Project

Much of the settlement in the Imperial Valley occurred long before Reclamation started the All-American Canal System. The establishment of the Imperial Canal, the Imperial Irrigation District, and the Coachella Valley County Water District, in the early twentieth century, first brought irrigation to the valley. In a move which some later considered questionable, the lame duck administration of President Herbert Hoover let the Imperial Valley out of the 160 acre limitation required by the Reclamation Act of 1902. In a letter dated February 34, 1933, Secretary of the Interior Ray Lyman Wilbur announced that because the Imperial Valley had used Colorado River water before Federal intervention, the valley did not have to comply with the acreage limitation. According to Wilbur, Reclamation was not selling the Valley new water, the All-American Canal System was simply delivering old water through a new system.⁸¹

The population of the area continued growing before Reclamation entered the picture. The Coachella Valley grew from 3,674 in 1920, to 9,048 in 1930. The Valley had a population of 10,423 in 1940. Of these, 2,296 lived in Indio, Coachella had 1,000, seventy-five lived in Thermal, and fifty resided in Mecca. In the 1940s, the Coachella Valley remained primarily an agricultural area inhabited mostly by farmers, farm laborers and helpers, packers, merchants, and others related to the agricultural industry. The populations of Project towns increased greatly during the 1940s. By the end of 1941, Reclamation estimated the Coachella Valley had 13,000

80. Water and Power Resources, *Project Data*, 75, 77-78; Lowell O. Weeks and Keith H. Ainsworth, "Automation Does Something for Coachella Valley," *The Reclamation Era*, February 1967, 1-4.

81. Worster, *Rivers of Empire*, 212; David Lavender, *California*, 199.

inhabitants. Indio grew to about 6,000 residents in 1946, while Mecca reached 400. Coachella and Thermal grew to 1,400 and 700 respectively. In 1946, the Coachella Valley had an estimated 75,000-80,000 acres of irrigable land with only 18,000 acres irrigated by pumping from wells. Most of the irrigable land was privately owned. Unentered public land comprised about 1,000 acres, and another 8,400 acres consisted of Indian Reservation land. The Southern Pacific Land Company and the Coachella Valley County Water District were the largest landowners. Neither had farming interests and Reclamation officials expected both to liquidate their holdings when Colorado River water became available. By 1990, Coachella grew to 16,896 residents. Indio reached 36,793 inhabitants, and Mecca had a population of 1,966.⁸²

The Coachella Valley had a number of land owners with more than 160 acres. Eighty-one private owners had land in excess of 160 acres, and sixty-two of them did not live in the Valley. Some had mailing addresses as far away as San Francisco, Salt Lake City, Utah, and Madison, Wisconsin. Ten non-resident corporations had large land holdings in the area, and only one resident corporation had more than 160 acres. Private lands totaled 104,080 acres while entered public land only amounted to 962 acres. In 1943, 50 percent of the Project farms in the Imperial Valley were farmed by the owners, and tenant farmers worked the other half. According to Reclamation, most of the farm laborers were Hispanics, Asians, African-Americans, and migrant whites working under white foremen.⁸³

Land values in the Imperial Valley dropped between 1937 and 1940. Land values in the Valley totaled \$40 million in 1937-38, but declined to \$38 million in 1940. The population of the Imperial Valley grew in leaps and bounds for a few decades. In 1910, the Valley had 13,951 inhabitants. By 1920, the population jumped to 43,453. In 1930, Imperial Valley boasted a population of 60,903. The number dropped to 59,740 in 1940, but increased to 62,512 in 1950.

82. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1938, 154; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1941, 145; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1945, 64; Reclamation, "Project History, Coachella Division--Boulder Canyon Project--All-American Canal," 1946, 63; Bureau of Reclamation, "Report of Repayment Ability: Coachella Valley, California," Project Reports, August 1946, Box 4, I, 1, 4-5; Department of Commerce, Bureau of the Census, *Twenty-First Census of the United States, 1990: Population and Housing*, Bureau of the Census, 1990, on CD-ROM.

83. E. R. Fogarty, "Land Ownership; Coachella Valley Division, All-American Canal Project, California," Project Reports, March 1945, Box 16, 2, 5, Appendix I-1; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1940, 22; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1943, 38.

The increase was entirely in the Project towns. Population of irrigated farms stayed at about 27,000. In 1990, Calexico had a population of 18,633, and Brawley had 18,923 residents. Calipatria did not grow as much over the decades. The town had a population of 2,690 in 1990. Holtville had 4,820 inhabitants and Imperial had 4,113. Westmorland remained small with a population of 1,380. El Centro reached 31,384 inhabitants in 1990.⁸⁴

Reclamation signed an agreement with the Imperial Irrigation District on February 27, 1947, for the IID to assume control of the All-American Canal at midnight of February 28. On March 4, 1952, Reclamation and the IID executed a supplementary contract for the operation and maintenance of the canal. In the contract, the Secretary of the Interior would supervise Imperial Dam and the section of the All-American Canal between the dam and Pilot Knob because of the continued water deliveries to Mexico.⁸⁵

Uses of Project Water

The Imperial and Coachella Valleys have a twelve month growing season which can prove a blessing to farmers, in good years. In the 1930s, many farmer grew double crops to increase productivity. Dairy farms also contributed to the area's economy during the Great Depression. Stockmen often transported their herds of sheep and cattle into the Imperial Valley by railroad during the winter for feeding. Alfalfa was the most abundant crop in 1940, averaging seven to ten tons per acre. The annual value of alfalfa varied from \$2-\$3 million per year. Imperial Valley farmers devoted 115,836 acres to alfalfa in March 1942. In the 1940s, poultry and hogs entered the agricultural industry in areas served by the All-American Canal. In addition to alfalfa and livestock the Imperial Valley grows a variety of crops (see Table. II).⁸⁶

84. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1940, 133; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1945, 63; Reclamation, "Project History, Boulder Canyon Project--All-American Canal System--Imperial Division," 1950, 55, 58, 60, 77; Department of Commerce, Bureau of the Census, *Twenty-First Census of the United States, 1990*, on CD-ROM.

85. Reclamation, "Project History, Boulder Canyon Project--All-American Canal--Imperial Division," 1947, 25; Reclamation, "Project History, Boulder Canyon Project--All-American Canal System--Imperial Division," 1952, 7.

86. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1935, 60-1; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1937, 140; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1940, 21; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1941, 129, 135-36; Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1942, 64.

Table II. Crops Grown in the All-American Canal Region–1943. Source: Reclamation, “Project History, Boulder Canyon Project--All-American Canal, 1943,” 42-3.

CROP	ACRES	CROP	ACRES
COACHELLA VALLEY			
Grapefruit	2,443	Tangerines	147
Oranges	121	Dates	3,033
Figs	17	Thompson Grapes	3,193
Malaga Grapes	60	Red Malaga Grapes	47
Green Beans	949	Cabbage	55
Carrots	515	Sweet Corn	1,805
Eggplant	99	Melons/Cantaloupes	223
Okra	48	Onions	460
Peas	135	Bell Peppers	252
Sweet Potatoes	180	Spinach	50
Squash	300	Tomatoes	378
Alfalfa	1,310	Cotton-Acala	50
IMPERIAL VALLEY			
Alfalfa	114,085	Flax	144,618
Barley	32,848	Wheat	540
Cantaloupes	9,662	Honey Dew Melon	967
Honey Balls	740	Watermelons	2,888
Asparagus	261	Peas	5,904
Onions	230	Squash	1,076
Carrots	10,747	Cabbage	1,382
Tomatoes	2,421	Lettuce	17,324
Mixed Vegetables	183	Sugar Beets	7,591
Grapefruit	3,803	Oranges	665
Tangerines	253	Lemons	62
Grapes	691		

Dates comprised a large portion of the crops grown in the Coachella Valley. The U.S. Department of Agriculture first brought dates to the Valley from Asia in 1890. Valley farmers

imported offshoots of Deglet Noor dates from Algeria and near the Persian Gulf between 1912-14. World War I halted the importation of offshoots, but after the war the date industry grew until farmers had approximately 3,000 acres in production in 1945. In addition, Coachella Valley farmers grew Thompson seedless grapes, citrus fruits, and vegetables (see Table. II). In 1946, Valley farmers grew 4,618 acres of dates and 4,243 acres of Thompson grapes. The gross crop value reached \$75,249,859 in 1951, and hit \$93,394,738 in 1952. In 1991, the crop value for the Coachella Division was \$367,019,102. The Imperial Division had a gross crop value of \$605,330,793 in 1991.⁸⁷

The All-American Canal supplies hydroelectric power to the Imperial and Coachella Valleys. The Imperial Irrigation District first started generating electricity in May 1936, using a diesel generating plant at Brawley, and entering into competition with the California Electric Power Company. Using four of the power drops constructed by Reclamation on the All-American Canal, the IID built powerhouses and generating equipment adding to their previous electrical generating capacity. The IID bought all of California Electric's properties in the Imperial and Coachella Valleys in April 1943. This gave the IID sole control of all electric power in the two valleys.⁸⁸

Conclusion

Reclamation faced two major obstacles in building the All-American Canal System. The first problem was the light flow of the Colorado River, about fourteen million acre-feet per year. The second problem was the amount of silt and dirt to remove from the water. About 160 million tons of silt flow down the Colorado each year. In addition the Salton Sink is a desert, in which sand is often blown around, no small portion of which lands in the canals of the system.⁸⁹ In spite of the problems with silt, sand, and the technology required to remove it from the All-

87. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1945, 63-4; Reclamation, "Project History, Coachella Division--Boulder Canyon Project--All-American Canal System," 1947, 53; Reclamation, "Project History, Boulder Canyon Project--All-American Canal System--Imperial Division," 1951, 8; Bureau of Reclamation, "Annual Project History, Boulder Canyon Project--All-American Canal System--Imperial Division," 1952, RG 115, 7; Bureau of Reclamation, *1991 Summary Statistics: Water, Land, and Related Data*, Bureau of Reclamation, Land, Recreation, and Cultural Resources Branch, 1991, 189, 190.

88. Reclamation, "Project History, Boulder Canyon Project--All-American Canal," 1943, 3637; Water and Power Resources, *Project Data*, 72.

89. Worster, *Rivers of Empire*, 194-5.

American Canal System, the Imperial and Coachella Valleys remain a productive agricultural location. Only the increasing threat of water shortages looms over the future of agriculture in the Salton Sink.

About the Author

Eric A. Stene was born in Denver, Colorado, July 17, 1965. He received his Bachelor of Science in History from Weber State College in Ogden, Utah, in 1988. Stene received his Master of Arts in History from Utah State University in Logan, in 1994, with an emphasis in Western U.S. History. Stene's thesis is entitled The African American Community of Ogden, Utah: 1910-1950.

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Index

Agriculture	
cattle	30
crops	30, 31
hogs	30
poultry	30
sheep	30
Alamo River	3, 4, 10
Algeria	32
American Federation of Labor	14
Araz Junction	8
Arizona, state of	15
Army Corps of Engineers	3
Ashbach (Otto B.) & Sons	20, 21
Ashbach & Sons	20
Atlas Construction Co.	9
Beatty, John	3
Bergland, Lt. Eric	3
Bill Williams River	15
Bohannen, John	18
Boulder Canyon	5
Boulder Canyon Act of 1928	5
Boulder Canyon Project	
Hoover (Boulder) Dam	6
Boulder Canyon Project--All-American Canal System	2, 9, 17, 28
All-American Canal	2, 6-13, 16, 21-26, 28, 30, 32
Coachella Canal	2, 16-21, 27
Coachella Turnout	10
Imperial Dam	2, 11, 14-16, 22, 23, 25-27, 30
Lake Cahuilla	28
New Briar Canal	23
New River Siphon	10
Power Drop One	10
Brawley, city of	22
Breedlove Excavating Company	22
Breedlove, J. W. and E. M.	22
Bureau of Reclamation	2, 5, 6, 8, 9, 11, 12, 17, 18, 20, 21, 23, 24, 26-28, 30, 32
All-American Canal	25, 32
Coachella Canal	19, 21
New River Siphon	10
Calexico, city of	2, 3, 9, 11, 22
California	
Gulf of	3, 4
Legislature	3
state of	2, 6, 25
California Development Co.	4
California Electric Power Co.	32
Callahan, W. E., Construction Company	17
Chaffey, George	4
Chicago Bridge & Iron Co.	18
Coachella Canal	17, 21
Coachella Valley	2, 3, 6, 8, 20, 28-33
Coachella Valley County Water District	5, 6, 16, 20, 27-29
Coachella, city of	18, 28

Colorado River	2, 3, 15, 25, 28, 32
Colorado River Irrigation Co.	3
Dennis, V. R. Construction	9
Department of Agriculture	31
Doran, Frank	10
East Highline Canal	11
El Centro, city of	8, 22
Emergency Relief Appropriation Act of 1935	8
Fadel, Norman I.	9
All-American Canal	23
Fall-Davis Report	5
Farm Laborers	29
African-Americans	29
Asians	29
Hispanics	29
whites	29
Fidelity and Deposit Company of Maryland	9
Fort Yuma Indian Reservation	9, 12
Gault, Homer J.	6
Gila Project	2
Gila Gravity Main Canal	2, 12, 13, 16
Great Depression	8
Griffith Co.	7
Grunsky, C. E.	5
Hasler, M. H.	17-19, 26
Holtville, city of	22
Hoover, President Herbert	28
Ickes, Harold L.	16, 24
Imperial Canal	4, 22, 24, 28
Imperial County	2
Imperial Dam	11
Imperial Irrigation District	5, 6, 8, 10, 11, 23, 24, 28, 30, 32
Ash Canal	23
Central Main Canal	11, 23
East Highline Canal	11
Imperial Valley	2, 3, 5, 8, 10, 22, 28-30, 32, 33
Imperial, city of	22
Indio, city of	28
International Boundary and Water Commission	24
J. F. Shea, Inc.	18, 19
J. P. Shirley	17
J. W. and E. M. Breedlove Excavating Company	22
John Bohannen	18
Laguna Dam	6
Lake Cahuilla	28
Lane, Franklin K.	5
Lewis-Chambers Construction Co.	10
M. H. Hasler	17, 18
Macco Corp.	21
MacDonald & Kahn, Inc.	9
Mead, Elwood	5
Mecca, town of	28
Mexicali Valley	24
Mexico	2, 3, 5, 22, 24, 30
Mexicali, city of	22

Morrison-Knudsen Co., Inc.	17-19
Morrison/Utah/Winston	12-15
Morrison-Knudsen Co., Inc.	12
Utah Construction Co.	12
Winston Bros., Inc.	12
Native Americans	12
New River	9, 10, 23
Otto B. Ashbach & Sons	20, 21
Page, John C.	11
Palm Springs, city of	3
Persian Gulf	32
Peterson Construction Co.	9
Picacho Wash	24
Pilot Knob	2, 3, 9, 22, 25
Pilot Knob Wasteway	24
Priest, Raymond M.	7
Reclamation Act of 1902	5, 28
Rehabilitation & Betterment Act of 1949	27
Riverside County	2
Rockwood, Charles	4
Salton Sea	4
Salton Sink	3, 32, 33
Schlecht, W. W.	5
Seaboard Surety Co.	9
Sharp & Fellows Contracting Co.	10
Shea, J. F., Inc.	18, 19
Shirley, J. P.	17
Southern Pacific Railroad Co.	4, 8
Southern Pacific Land Co.	5, 29
Southern Sierras Power Co.	8
Thermal, city of	28, 29
U.S. Attorney General	5
United States	
Congress	3, 5
Department of Agriculture	31
Department of the Interior	24
State Department	24
Unnamed Wash	24
V. R. Dennis Construction Company	9
W. E. Callahan Construction Company	17
War Production Board	18
Westmorland, city of	30
Wilbur, Ray Lyman	28
Williams, Roy B.	7
Wood, Clyde W.	27
World War I	32
World War II	26
Wozencraft, Oliver	3
Young, Walker R.	19
Yuma Main Canal	6
Yuma Project	2, 5, 6, 22, 24
Laguna Dam	2, 5, 6, 8, 24, 25
Reservation Division	24
Siphon Drop Powerplant	6, 9, 22
Yuma Main Canal	2, 9, 22, 24

Yuma, city of 2, 3, 7

The All-American Canal, the largest irrigation canal in the world and a key landmark along the U.S.-Mexico border, shows up in this astronaut photograph. This image captures about 15 kilometers (9.3 miles) of the important infrastructure corridor just west of Yuma, Arizona. The prominent dark line crossing All-American Canal. Download or read this story's pdf file (1.4 MB). It's Not Your Ordinary Canal Paver. The All-American Canal in southern California delivers approximately 3.1 million acre-feet (382,379 ha m) of the Colorado River to nine cities and 500,000 acres (202,343 ha) of agricultural land. The 82 mile (132 km) long canal was originally constructed in the 1930s and 1940s. All-American Canal, 80 mi (129 km) long, SE Calif.; part of the federal irrigation system of the Hoover Dam . Built between 1934 and 1940 across the Colorado Desert, the canal is entirely within the United States and replaces the Inter-California Canal, which passes through Mexico. The Imperial Dam, NE of Yuma, Ariz., diverts water from the Colorado River into the All-American Canal, which runs W to Calexico, Calif. Smaller canals move water into the Imperial Valley; the Coachella Canal branches NW to the Coachella Valley. The All-American Canal is an 80-mile (130 km) long aqueduct, located in southeastern California. It conveys water from the Colorado River into the Imperial Valley and to nine cities. It is the Imperial Valley's only water source, and replaced the Alamo Canal, which was located mostly in Mexico. The Imperial Dam, about 30 miles (48 km) northeast of Yuma, Arizona on the Colorado River, diverts water into the All-American Canal, which runs to just west of Calexico, California before its last branch heads The All-American Canal is an 80-mile long aqueduct, located in southeastern California. It conveys water from the Colorado River into the Imperial Valley and to nine cities. It is the Imperial Valley's only water source, and replaced the Alamo Canal, which was located mostly in Mexico. The Imperial Dam, about 30 miles northeast of Yuma, Arizona on the Colorado River, diverts water into the All-American Canal, which runs to just west of Calexico, California before its last branch heads mostly north into the Imperial Valley.