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CENTRAL ARIZONA PROJECT

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Central Arizona Project (Under Construction)

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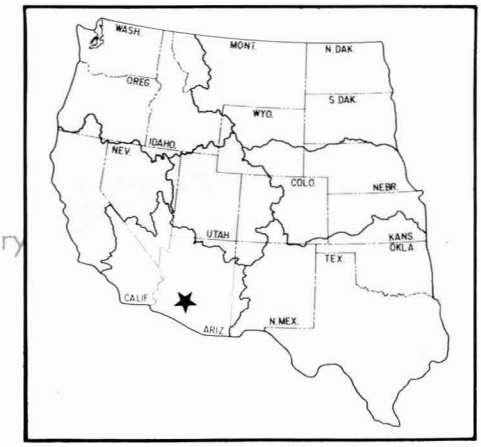
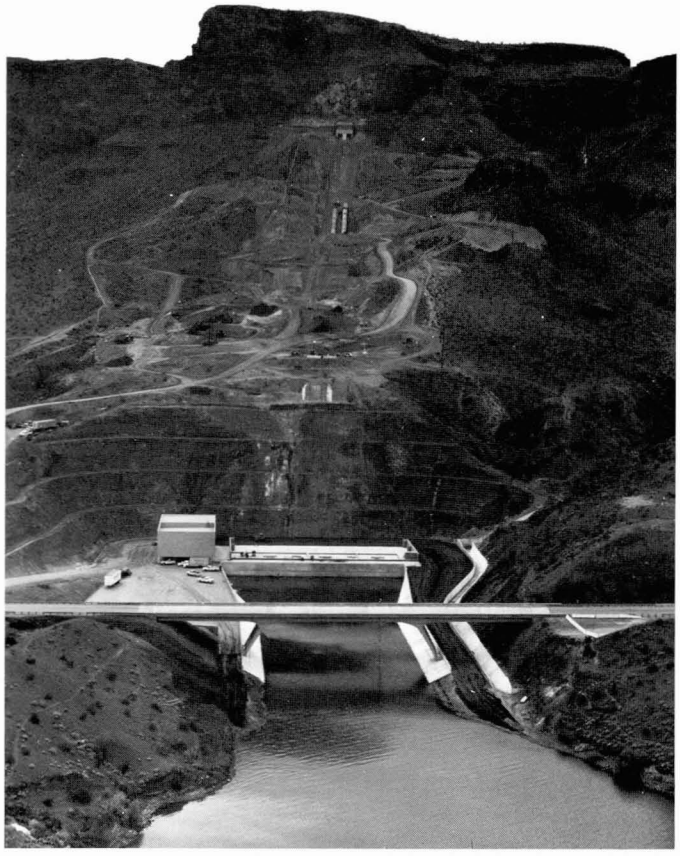


The Central Arizona Project is a multipurpose water resource development and management project which will provide supplemental Colorado River water, either directly or by exchange, to nearly 1 million acres of Indian and non-Indian irrigated agricultural land areas in Maricopa, Pinal, and Pima Counties, Arizona. The project will ultimately provide more than 650,000 acre-feet of municipal and industrial water for the Phoenix and Tucson metropolitan areas, and western New Mexico. The project will also provide substantial benefits from power generation, flood control, outdoor recreation, fish and wildlife conservation, and sediment control. The project is divided, for administration and construction purposes, into the following seven divisions: (1) Granite Reef, (2) Regulatory Storage (formerly Orme Division), (3) Salt-Gila, (4) Gila River, (5) Tucson, (6) Indian Distribution, and (7) Colorado River. Also associated with the project are drainage systems, non-Indian distribution systems, Federal participation in the Navajo Generating Station, and dam safety considerations.



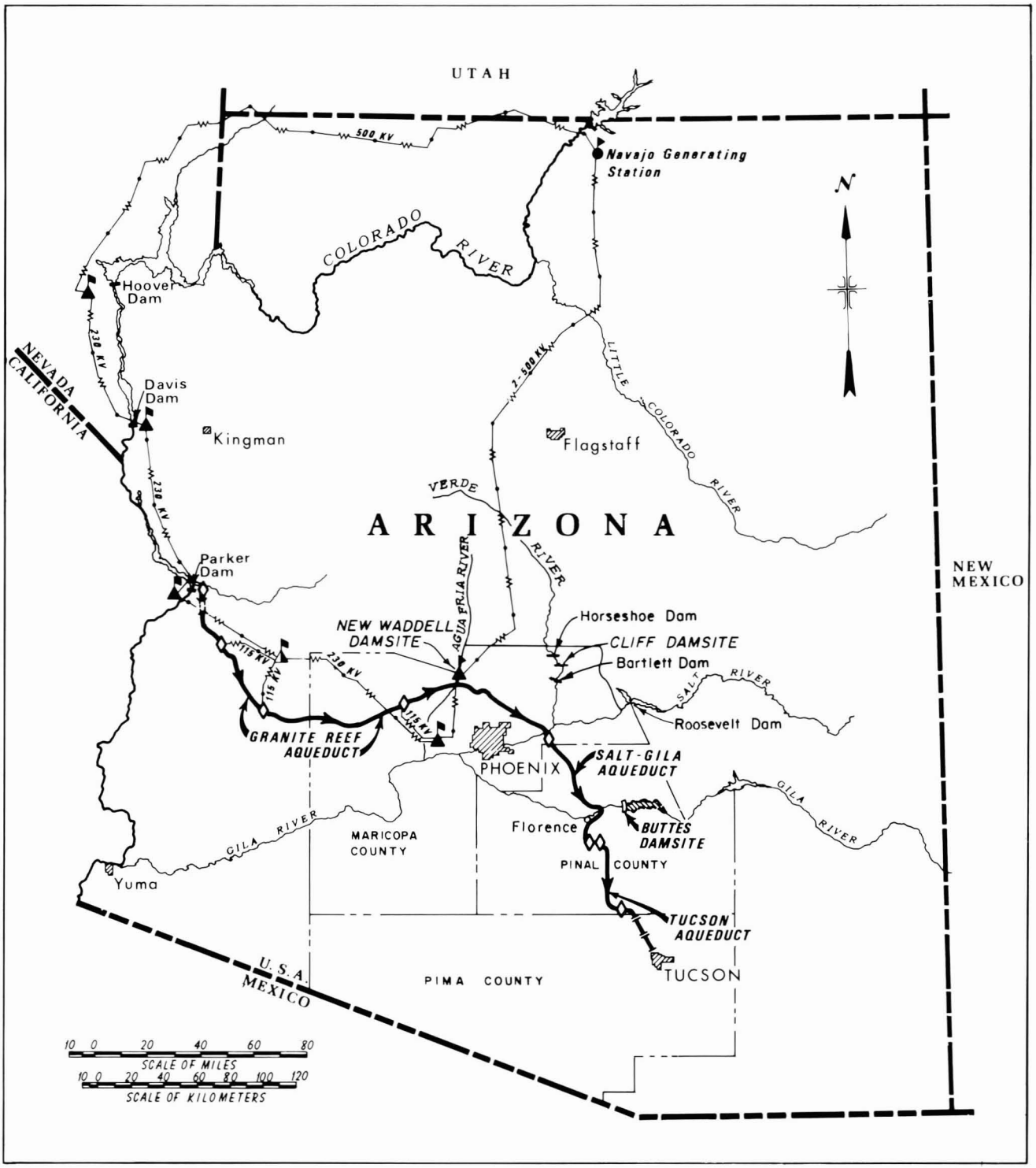
Havasu Pumping Plant nearing completion, March 1982.

The Colorado River Basin Project Act, under which the Central Arizona Project was authorized, provided for the Secretary of the Interior to enter into an agreement with non-Federal interests, whereby the Federal Government acquired the right to 24.3 percent of the power produced at the non-Federal Navajo Generating Station, Navajo Project, near Page, Ariz. The agreement also includes the delivery of power and energy over the transmission facilities to delivery points within the Central Arizona Project area.

Construction was started on the project in 1973 with the award of a contract for the construction of the Havasu Intake Channel Dike and excavation for the Havasu Pumping Plant, features of the Granite Reef Division. Construction of the Salt-Gila Division began in 1980. Construction of the other divisions will follow in an orderly fashion. Initial water deliveries are expected in 1985.

PLAN

The plan calls for construction of a system of pumping plants and aqueducts which will convey Colorado River water from the Bill Williams River arm of Lake Havasu to the project service area. As authorized, the plan also called for the construction of four dams and reservoirs: Orme Dam on the Salt River, Buttes Dam on the Gila River, Charleston Dam on the San Pedro River, and Hooker Dam on the upper Gila River in New Mexico. Since authorization of the project in 1968, the problems and opportunities for water development in central Arizona have changed considerably. Several of the authorized features included in the Regulatory Storage, Gila River, Tucson, and Indian Distribution Divisions



Colorado River Basin Project, Central Arizona Project

are currently undergoing reformulation and environmental evaluation. No further activities are envisioned for the Colorado River Division or Charleston Dam and Reservoir.

In addition to the aqueduct and pumping plant system, the plan presently includes the enlargement of Roosevelt Dam on the Salt River and construction of four other dams and reservoirs on the Agua Fria, Verde, and Gila Rivers in Arizona, and on the upper Gila River in western New Mexico. These features are to provide conservation storage, power generation, flood and sediment control, dam safety, and recreation opportunities. Federal participation in the Navajo Generating Station

will provide pumping power for the project. Distribution facilities for Indian and non-Indian agricultural water will also be provided.

Havasu Diversion and Granite Reef Aqueduct—Granite Reef Division

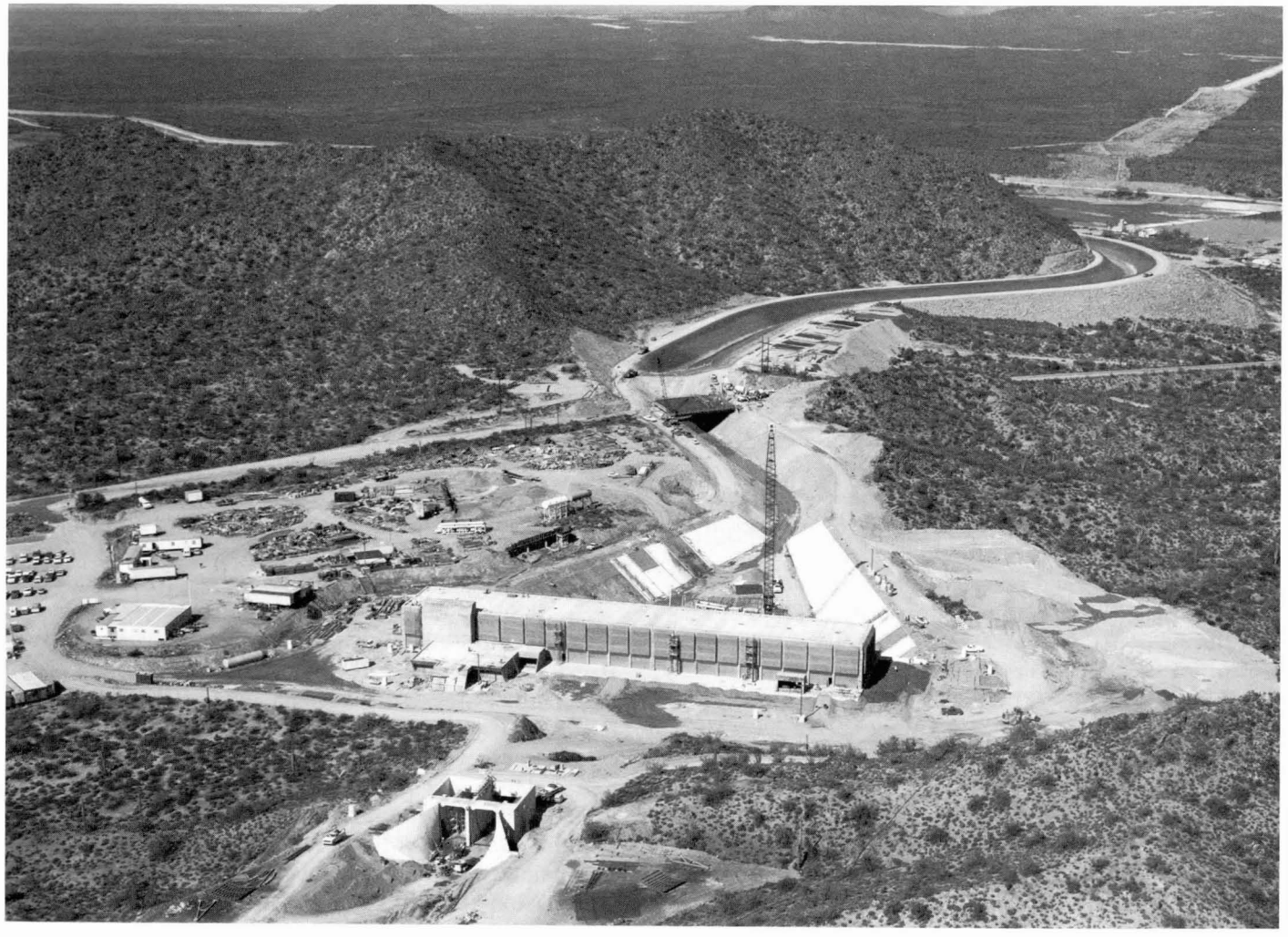
An intake channel and high-lift pumping plant, located on the south side of the Bill Williams River arm of Lake Havasu, will be used to divert and lift Colorado River water over 800 feet from the lake to the inlet portal of the 6.8-mile-long Buckskin Mountains Tunnel. The water will be discharged at the outlet portal of the tunnel into the open channel of the Granite Reef Aqueduct. It will then be conveyed through 173.9 miles of concrete-lined open channel, 7.4 miles through six siphons, 1.3 miles through two tunnels, and 0.6 mile through three pumping plants for a total distance of about 190 miles to the Phoenix metropolitan area. The aqueduct has a maximum capacity of 3,000 cubic feet per second. Relift pumping stations are located at Bouse Hills, Little Harquahala Mountains, and near the Hassayampa River. To deliver water from the Colorado River to the Phoenix service area will require a total pump lift of about 1,200 feet.

Salt-Gila Aqueduct—Salt-Gila Division

The Salt-Gila Aqueduct begins at the terminus of the Granite Reef Aqueduct just south of the Salt River Siphon, and will consist of 58 miles of open, concrete-lined canal and a siphon. The Salt-Gila Pumping Plant will lift project water about 84 feet from Granite Reef Aqueduct to Salt-Gila Aqueduct, which has an initial capacity of 2,750 cubic feet per second.

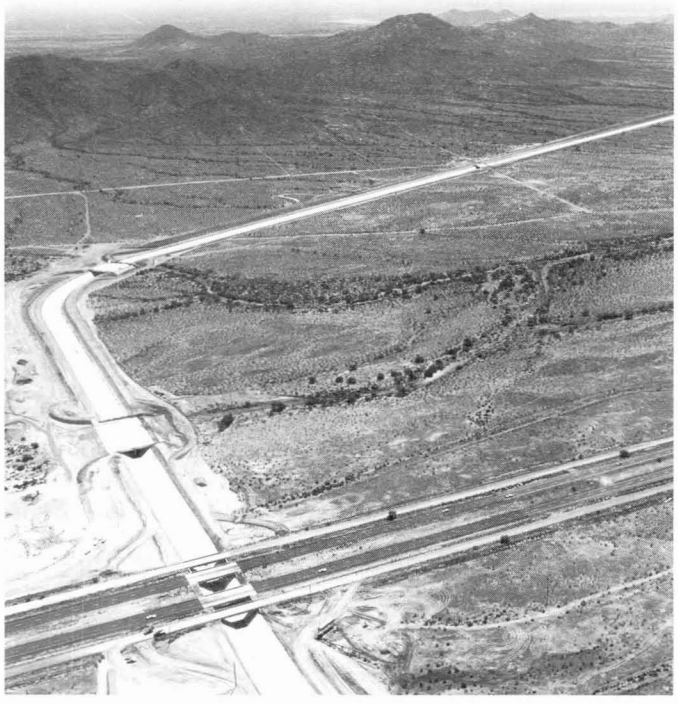
Tucson Aqueduct—Tucson Division

The Tucson Aqueduct will begin at the terminus of the Salt-Gila Aqueduct and will convey water about 80 miles to the Tucson, Ariz. area. A series of pumping plants will be required to relift the water to Tucson for municipal



Salt-Gila Pumping Plant, nearing completion, February 1983.

and industrial use. Deliveries of project water from the Tucson Aqueduct for irrigation use in Pima and Pinal Counties are planned.



Granite Reef Aqueduct - Reach 10.

Indian Distribution Division

The Indian distribution systems will deliver project water to central Arizona Indian communities which have been allocated project water by the Secretary of the Interior. Planning is underway for these systems which will be constructed by the Bureau of Reclamation under project authorization.

Allocations were made in 1981 to 12 reservation areas for irrigation purposes, and for development and maintenance of tribal homelands. Contracts have been signed to deliver water to 11 of these areas. Under these allocations, Indian users and non-Indian municipal and industrial users will share an equal priority to project water during periods of water supply shortages over lesser priorities given to non-Indian agricultural and miscellaneous water users.

Non-Indian Distribution Systems—Regulatory Storage Division

Non-Indian distribution and drainage systems will be constructed or financed by the Federal Government to obtain optimum water development and use by improved efficiencies. Costs of these facilities will be repaid through separate contracts on a fully reimbursable basis. Fourteen potential water service subcontractors have indicated an interest in participating in the Federal program, and other potential subcontractors anticipate using private or municipal funding sources to finance distribution system construction.

Regulatory Storage Division

As authorized, the Regulatory Storage Division consisted of Orme Dam and Reservoir, a multipurpose facility located at the confluence of the Salt and Verde Rivers upstream of Phoenix, Arizona. The primary project functions of this facility were to regulate project deliveries and provide flood control for the Phoenix area. In 1977, during a presidential review of water projects, Orme Dam was recommended to be deleted from the project. In 1978, the Central Arizona Water Control Study was initiated to study alternatives to provide regulatory storage and flood control on the Salt and Verde Rivers. At the same time, the Bureau began evaluating existing dams on the Salt and Verde Rivers under the Safety of Dams Act (Public Law 95-578).

Since both studies involved modifying existing dams, the studies were combined for plan formulation purposes. In November 1981, the Secretary of the Interior identified a proposed action that included New Waddell Dam on the Agua Fria River for regulatory storage purposes, and Cliff Dam on the Verde River, a new or enlarged Roosevelt Dam, and reconstructed Stewart Mountain Dam on the Salt River for water conservation, flood control, and dam safety purposes.

Buttes Dam and Reservoir—Gila River Division

Buttes Dam and Reservoir was authorized as a multipurpose facility for conservation, flood control, and sediment reduction; and is to be located on the Gila River in Pinal County, about 4 miles upstream from the existing Ashurst-Hayden Diversion Dam. A study of alternatives is presently underway addressing these project functions.

Hooker Dam and Reservoir—Gila River Division

In the 1977 presidential review of water projects, Hooker Dam and Reservoir, to be located on the Gila River in western New Mexico, was recommended to be deleted from the project. In 1981, a study was initiated to evaluate alternatives that would provide the authorized function of developing an 18,000 acre-foot annual water supply for southwestern New Mexico. This water supply would be provided through exchange. Diversion of Gila River water would be made in New Mexico and project water would be provided to downstream water-right holders to replace the diminished Gila River flows.

The Corps of Engineers is now conducting flood control studies on the Gila River. A Memorandum of Understanding between the Corps and the Bureau was signed in 1982 to facilitate the formulation of a comprehensive solution to the water supply and flood control problems in the upper Gila River basin.

Power Sources

Provisions of the Colorado River Basin Project Act allowed the Federal Government to participate in the non-Federal Navajo Project. The Navajo Generating Station, near Page, Ariz., will provide pumping power for the Central Arizona Project. The Southern and Western Transmission Systems, feaures of the Navajo Project, will transmit this power to Westwing Substation near Phoenix and McCullough Substation near Boulder City, Nev.

The Navajo Generating Station was constructed by the Salt River Project Agricultural Improvement and Power District of Arizona. The Southern Transmission System, completed in 1974 by the Arizona Public Service Co., consists of two 500-kV transmission lines to the Phoenix area. The Western Transmission System consists of one 500-kV transmission line to the McCullough Switchyard near Boulder City, Nev. This line was constructed by the Department of Water and Power of the City of Los Angeles, Calif., and was completed and placed in service on October 27, 1974. Other participants in the Navajo Project are the Nevada Power Co., the Tucson Gas and Electric Co., and the Bureau of Reclamation. The Bureau's share is 24.3 percent, or 546,750 kilowatts.

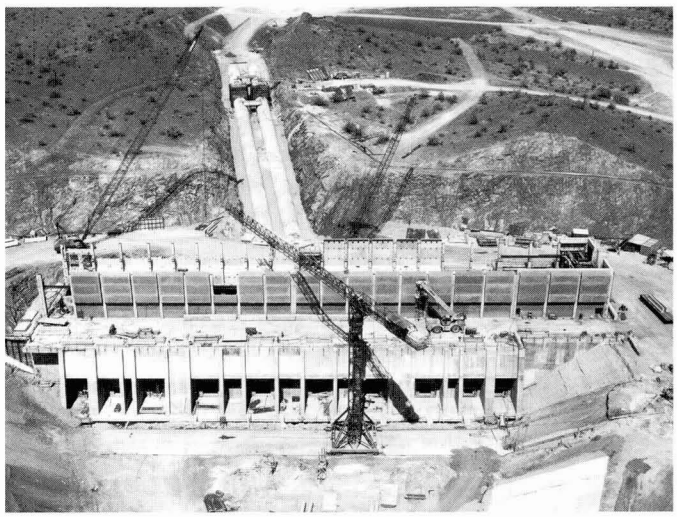
Construction of the Navajo Generating Station began in April 1970. The third, and last, generating unit was completed and placed in operation on April 30, 1976. Until energy is required for the Central Arizona Project or other purposes authorized by Public Law 90-537, Reclamation's share of the interim energy produced is being sold to other participants in the station and to the Southern California Edison Co.

Transmission System

The transmission system to supply power to the pumping plants and check structures along the Granite Reef Aqueduct is under construction. It will have a total length of about 309 miles, of which 250 miles comprise the 230-kV line interconnecting the delivery portion of the transmission system. The radial transmission lines to the pumping plants consist of about 51 miles of 115-kV lines and 8 miles of 230-kV lines.

The route of the 230-kV transmission line begins at the McCullough Switching Station in Clark County, Nevada, and interconnects Davis Switchyard, Parker Switchyard, and Liberty Substation in Arizona. A new substation, called Harcuvar, was constructed in Yuma County, Arizona, and a new tap station, Hassayampa Tap, was constructed in Maricopa County, Arizona. About 59 circuit miles of radial transmission lines will be constructed to supply power to Havasu, Bouse Hills, Little Harquahala, and Hassayampa Pumping Plants.

Bouse Hills Pumping Plant nearing completion, June 1982.



Little Harquahala Pumping Plant under construction, June 1982.

Delivery of power to Salt-Gila Aqueduct will utilize both existing transmission lines and the new transmission lines constructed for the Granite Reef Aqueduct. A new tap station, Spook Hill Substation, will be constructed in Maricopa County on the existing Mesa-Coolidge 230-kV line, and about 6 miles of 69-kV line will be constructed to feed the Salt-Gila Pumping Plant. Delivery of power to the proposed Tucson Aqueduct also will require the existing and constructed transmission lines for the Granite Reef Aqueduct. About 36 miles of new 115-kV transmission lines will be constructed to supply power to pumping plants near Picacho Mountain. Additions to

existing substations, the new tap substations, and new transmission lines will be required to supply power to pumping plants which are now in the advance planning stage.

Hassayampa Pumping Plant nearing completion, August 1982.

DEVELOPMENT

Early History

Since prehistoric times, communities have irrigated the lands along the Gila and Salt Rivers by diversion of streamflow into systems of ditches, with temporary brush and rock dams. In the late 1800's, the Pima Indians farmed possibly as much as 35,000 acres along the Gila River within the present Gila River Indian Reservation. In the 1860's, settlers began to redevelop and extend abandoned farmland along the Salt River in the vicinity of Phoenix. These early enterprises were severely handicapped by raging spring floods and low water lows during the later stages of the growing season.

The Salt River was almost totally controlled by a series of dams constructed between 1911 and 1946 on the Salt and Verde Rivers. The Bureau of Indian Affairs completed Coolidge Dam on the Gila River in 1928. Due to the increased control and regulated supply of available water, agriculture expanded and prospered along the desert plains adjoining the streams.

In the Salt River Valley, application of irrigation water led to a rise in the water table and eventually to drainage problems. By 1918, waterlogging threatened the productivity of the irrigated area. A system of shallow wells was established to draw down the water level, and the pumpage was used for new agricultural expansion. Conditions were ideal for ground-water development because of the highly permeable alluvial aquifers, a shallow water table, and good quality water. Pumping soon exceeded recharge and eventually led to a decline in water levels below the original levels.

The 1930's through 1950's brought low cost hydropower, improved well drilling equipment, and high capacity pumps. As a consequence, the pumping rate was further increased, and ground-water irrigation spread from the vicinity of the rivers throughout the central Arizona desert basins. The rate of pumping eventually far exceeded the rate of recharge, water levels dropped rapidly, and in some areas, increased pump lifts, poor water quality, and farm crop controls forced farmland out of production.

The mild winters of central and southern Arizona, the development of efficient air-conditioning, and the growth of air transportation have been factors in a tremendous expansion of urban population, particularly in the Phoenix and Tucson metropolitan areas.

As agricultural lands have been taken over by urban growth, the surface and ground-water supplies have shifted to municipal and industrial users at approximately the same delivery requirement per acre. In areas where urban projects have expanded onto raw desert areas, municipal and industrial uses have contributed to the increasing overdraft of ground-water supplies.

Investigations

Formal investigations for the Central Arizona Project were started in 1944 by the Phoenix Development Office. The Central Arizona Project report was published as House Document No. 136, 81st Congress, 1st session, and was recommended for authorization in 1949.

During the 1950's, the Central Arizona Project was tabled while the Supreme Court heard the issue of Lower Colorado River water rights in the case of Arizona v. California. In 1961, when it appeared that a Supreme Court decision favorable to Arizona might be imminent, the Phoenix Development Office reopened investigations, using funds provided by the States of Arizona and New Mexico.

The resulting report, dated January 1962, documented the major changes that had taken place since the initial report. Continuous investigations through authorization provided data for reports on this project in 1964, 1967, and 1968.

Authorization

The Central Arizona Project was authorized for construction under the Colorado River Basin Project Act, Public Law 90-537 (82 Stat. 885), approved September 30, 1968. In March 1977, a Presidential Review of water projects was initiated. A statement on the water projects was released April 18, 1977, recommending modification of

the Central Arizona Project by the elimination of Orme, Hooker, and Charleston Dams and making Federal funding contingent upon further study of ground-water supplies and institution of ground-water regulation and management by the State of Arizona. Since Public Law 90-537 qualified the authorizing language for Orme and Hooker Dams with the phrase "or suitable alternatives," other plans were formulated in an effort to determine suitable alternatives for those features.

Construction

Initial construction of the Central Arizona Project began in 1973, and completion of the Granite Reef Aqueduct is scheduled for the mid-1980's; other project features are scheduled for completion by the early 1990's.

Water Supply and Allocations

The Central Arizona Project will derive its primary water supply from diversions of the Colorado River. Under current plans, this supply will be supplemented from time to time through conservation of local floodflows at the proposed project dams. Colorado River diversions are expected to vary from a maximum of 2.2 million acre-feet during years of supply surpluses to a minimum of 0.4 million acre-feet during years of supply shortages. Under normally expected water supply conditions, project diversions from the Colorado River would be about 1.5 million acre-feet. The project's Colorado River supply is estimated to average 1.2 million acre-feet per year during the project's 50-year repayment period.

The authorizing act allocated 18,000 acre-feet per year of project supplies for use in western New Mexico. In addition, in 1981, the Secretary of the Interior allocated 309,828 acre-feet annually for use on 12 Indian reservation areas and established priorities of use during shortages among the various categories of project water uses; i.e., Indian tribal homeland, Indian and non-Indian municipal and industrial, Indian and non-Indian irrigation, and miscellaneous uses. Also, the Secretary requested recommendations from the State of Arizona on how to allocate project water among non-Indian irrigation and municipal and industrial uses. In 1982, the Arizona Department of Water Resources recommended that up to 640,000 acre-feet per year be allocated to over 70 cities, towns, and water service companies; 8 mining companies; and 2 power utilities. Project water deliveries to these municipal and industrial uses are expected to build over the years to the allocated amounts in response to future population and economic growth in central Arizona. To facilitate the increasing use of project supplies for municipal and industrial uses with time, the Arizona Department of Water Resources also recommended in 1982 that the remaining project supplies, over and above municipal and industrial and Indian needs, be allocated on a shared percentage basis to 23 non-Indian agricultural entities. These State recommendations provide for the orderly transfer of water uses from non-Indian agriculture in the earlier years of the project to non-Indian municipal and industrial in later years.

BENEFITS

Irrigation

Project water will provide irrigation benefits to non-Indian farmers with a past history of irrigation, and to Indian farmers to irrigate all of their presently developed acreage and new acreage where economically efficient.

Municipal and Industrial Water

Project works will provide water for municipal and industrial use in both Indian and non-Indian communities in Arizona, including the Phoenix and Tucson metropolitan areas, and in western New Mexico.

Flood Control

Although central Arizona usually suffers from water shortages, periodical and destructive floods do occur. Extensive flood control benefits are included in the project.

Recreation

The Central Arizona Project will create recreation potential with the development of water-oriented activities, equestrian paths, and other activities.

Fish and Wildlife

Considerable fish and wildlife benefits will be realized with completion of the project.

Reduction of Ground-Water Overdraft

Substituting most of Arizona's remaining entitlement in the Colorado River for a portion of the current ground-water overdraft would reduce the overdraft and land subsidence, which has become a major problem.

Power Generation

Project power from the Navajo Generating Station is being sold commercially until project operations begin. Once the project is operational, these sales will continue at a reduced level in the amount of project power available in excess of the amount of energy required for project pumping. Each of the proposed project dams is

also being evaluated for hydroelectric generation potential.

PROJECT DATA

Facilities in Operation

Generating plant	1	
Transmission lines[1]	239	mi
Substations	2	

[1]Transmission lines are operated and maintained by the Western Area Power Administration of the Department of Energy.

Climatic Conditions

Annual precipitation	7.7	in
Temperature:		
Maximum	116	°F
Minimum	27	°F
Mean	71	°F
Growing season	304	days

ENGINEERING DATA

Water Supply

COLORADO RIVER
(See Boulder Canyon Project.)

Granite Reef Division

Diversion Facilities

LAKE HAVASU
(See Parker-Davis Project for details.)

HAVASU INTAKE CHANNEL DIKE

Type: Earthfill land form embankment
Location: In Yuma County, about 20 mi north of Parker, Ariz.
Construction period: 1973-74

Dimensions:		
Structural height	36	ft
Top width	30	ft
Crest length	2,481	ft
Crest elevation	456.0	ft
Slope: Natural angle of repose		
Volume	739,491	yd^3

Carriage Facilities

BUCKSKIN MOUNTAINS TUNNEL

Location: From Lake Havasu 6.8 mi through the Buckskin Mountains, discharging into open section of Granite Reef Aqueduct.
Construction period: 1975-80

Length	6.8	mi
Capacity	3,000	ft^3/s
Cross section: Circular		
Diameter	22	ft
Depth of water	15.6	ft
Lining: Concrete	20	in

GRANITE REEF AQUEDUCT

Location: From the Havasu diversion facilities at Lake Havasu on the Colorado River to the Phoenix metropolitan area.
Construction period: 1973-(Under construction)

Length: 173.9 mi open channel and 16.1 mi closed	190	mi
Capacity	3,000	ft^3/s
Typical maximum section:		
Bottom width	24	ft
Side slope	1.5:1	
Water depth	16.4	ft
Lining: Concrete	3.5	in

BURNT MOUNTAIN TUNNEL

Location: In Maricopa County, about 30 mi southeast of Salome and about 60 mi west of Phoenix, Ariz.
Construction period: 1978-80

Length	0.6	mi
Capacity	3,000	ft^3/s
Cross section: Horseshoe		
Diameter	19.5	ft
Depth of water	15.17	ft
Lining: Concrete	20	in

AGUA FRIA TUNNEL

Location: In Maricopa County, about 27 mi northwest of Phoenix, Ariz.
Construction period: 1978-80

Length	0.7	mi
Capacity	3,000	ft^3/s
Cross section: Horseshoe		
Diameter	19.5	ft
Depth of water	15.17	ft
Lining: Concrete	20	in

CUNNINGHAM WASH SIPHON

Location: In Reach 2 of the Granite Reef Aqueduct, about 6 mi north of Bouze, Ariz.
Construction period: 1978-80
Description: Monolithic concrete pipe

Length	0.7	mi
Diameter	21	ft
Capacity	3,000	ft^3/s

CENTENNIAL WASH SIPHON

Location: In Reach 4 of the Granite Reef Aqueduct, about 19 mi southeast of Salome, Ariz.
Construction period: 1978-80
Description: Prestressed concrete pipe

Length	1.1	mi
Diameter	21	ft
Capacity	3,000	ft^3/s

JACKRABBIT WASH SIPHON

Location: In Reach 7 of the Granite Reef Aqueduct, about 25 mi northwest of Buckeye, Ariz.
Construction period: 1978-80
Description: Prestressed concrete pipe

Length	0.3	mi
Diameter	21	ft
Capacity	3,000	ft^3/s

HASSAYAMPA RIVER SIPHON

Location: In Reach 7 of the Granite Reef Aqueduct, about 22 mi north of Buckeye, Ariz.
Construction period: 1978-80
Description: Prestressed concrete pipe

Length	0.7	mi
Diameter	21	ft
Capacity	3,000	ft^3/s

AGUA FRIA RIVER SIPHON

Location: In Reach 9 of the Granite Reef Aqueduct, about 27 mi northwest of Phoenix, Ariz.
Construction period: 1975-78
Description: Prestressed concrete pipe

Length	1.9	mi
Diameter	21	ft
Capacity	3,000	ft^3/s

NEW RIVER SIPHON

Location: In Reach 9 of the Granite Reef Aqueduct, about 27 mi northwest of Phoenix, Ariz.
Construction period: 1975-78
Description: Prestressed concrete pipe

Length	1.1	mi
Diameter	21	ft
Capacity	3,000	ft^3/s

SALT RIVER SIPHON

Location: In Reach 12 of the Granite Reef Aqueduct, about 24 mi northeast of Phoenix, Ariz.
Construction period: 1975-78
Description: Prestressed concrete pipe

Length	1.6	mi
Diameter	21	ft
Capacity	3,000	ft^3/s

PARADISE VALLEY FLOOD DETENTION DIKE

Type: Earthfill
Location: In Reach 11 of the Granite Reef Aqueduct, about 14 mi north of Phoenix.
Construction period: 1974-76
Dimensions:

Maximum structural height	47	ft
Top width	14	ft
Crest length	16	mi
Crest elevation	1542, 1547, 1553.0	ft
Slope	1.5:1 to 4:1	
Volume	8,129,600	yd^3

Salt-Gila Division

SALT-GILA AQUEDUCT

Location: From terminus of Granite Reef Aqueduct (south of Salt River Siphon) to southeast of the city of Florence, Ariz.
Construction period: 1980-(Under construction)

Length	58.1	mi
Initial capacity	2,750	ft^3/s
Typical maximum section:		
Bottom width	24 to 22	ft
Side slope	1.5:1	
Water depth	15 to 14	ft
Lining: Concrete	3.5	in

GILA RIVER SIPHON

Location: In Reach 4 of Salt-Gila Aqueduct, about 4 mi northeast of Florence, Ariz.
Construction period: 1983-(Under construction)
Description: Monolithic pipe

Length	0.6	mi
Diameter	19	ft
Capacity	2,250	ft^3/s

Tucson Division

TUCSON AQUEDUCT

Location: From terminus of Salt-Gila Aqueduct to near the southern boundary of the San Xavier Indian Reservation, about 10 mi southwest of Tucson, Ariz.
Construction period: (In preconstruction and advance planning stage)

Length	±80	mi
Initial capacity	1,200	ft^3/s
Typical maximum section:		
Bottom width	12	ft
Side slope	1.5:1	
Water depth	12.4	ft
Lining: Concrete	3.5	in

Pumping Plants

Designation	Number of units	Total capacity, ft^3/s	Total dynamic head, ft	Total horsepower
Granite Reef Division:				
Havasu	6	3,000	824	360,000
Bouse Hills	10	3,080	118	54,000
Little Harquahala	10	3,080	113	54,000
Hassayampa	10	3,080	192	54,000
Salt-Gila Division:				
Salt-Gila	10	2,840	84	32,800
Tucson Division:				
Brady		Data on pumping plant requirements pending final designs		
Picacho				
Red Rock				
Others				

Power Facilities

Navajo Project Participation Agreement. Federal entitlement to 24.3 percent of the output (nameplate capacity is 2,250,000 kW) from the Navajo Generating Station located at Page, Ariz.

SUBSTATIONS AND SWITCHYARDS

Granite Reef Division	
Switchyard additions	2
Switchyards (new)	4
Substations (new)	2
Substation additions	2
Salt-Gila Division	
Switchyards (new)	1
Substations (new)	1