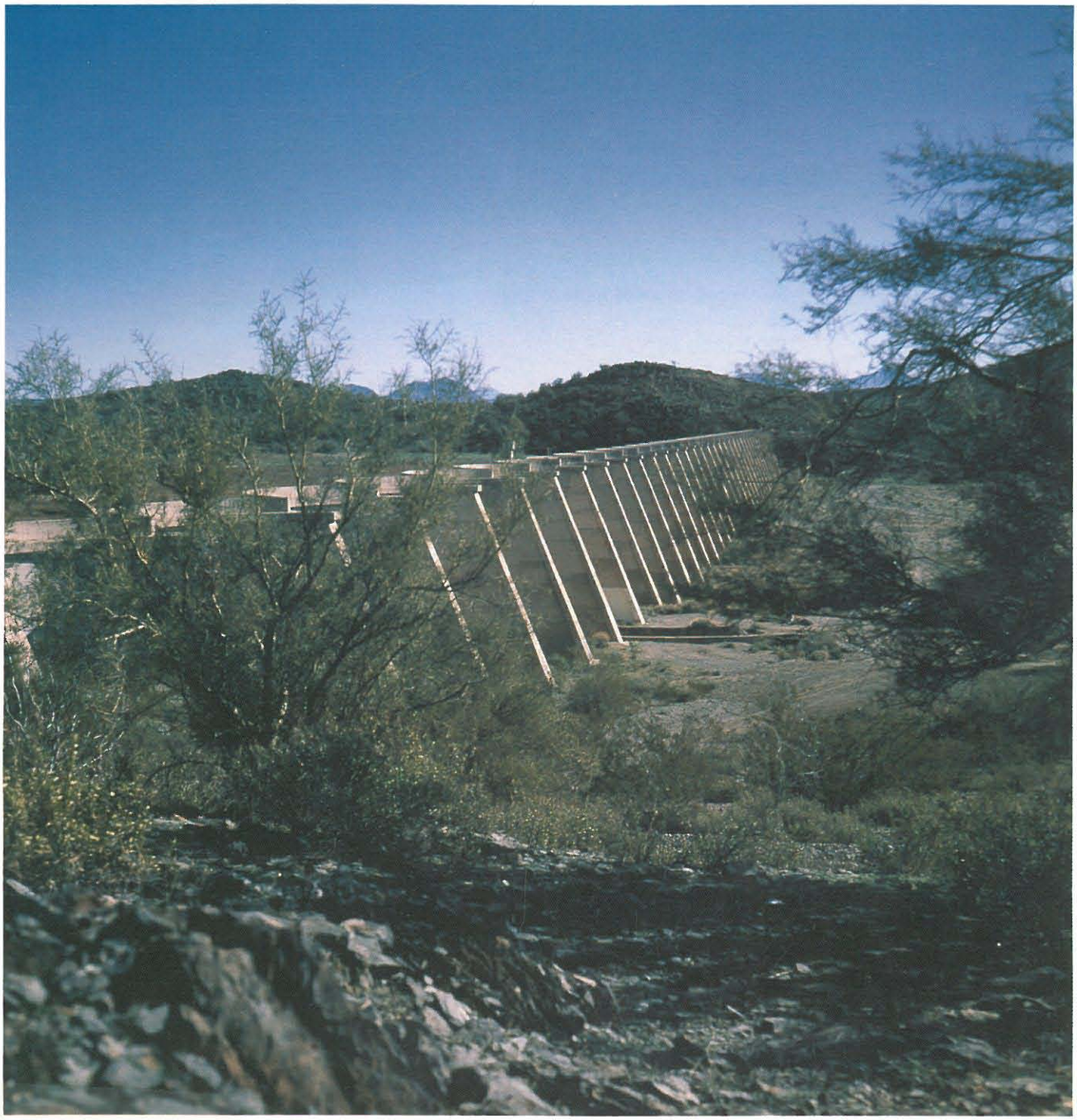
No. 4–9

CAVE CREEK DAM

OWNER: FLOOD CONTROL DISTRICT OF MARICOPA COUNTY



TECHNICAL DATA

GENERAL

Purpose	Flood control
Location—State/Nearest City	Arizona/Phoenix
River	Cave Creek
Drainage Basin Area	210 mi^2 (544 km^2)
Dates of Construction	1922–23

RESERVOIR

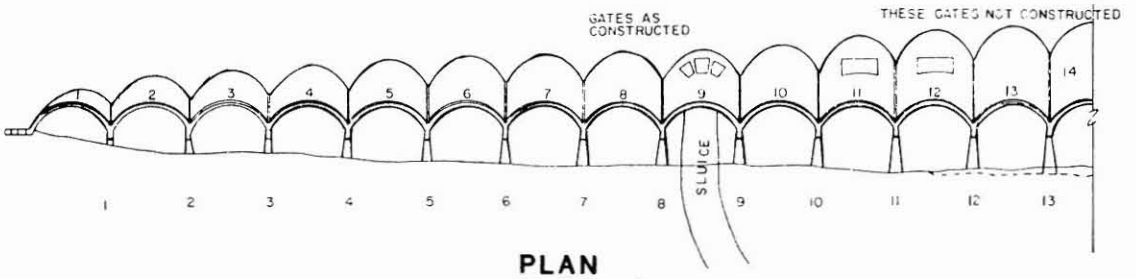
Total Storage Capacity	14,000 ac-ft (17 Hm^3)
Surface Area	600 acres (2.43 km^2)

DAM

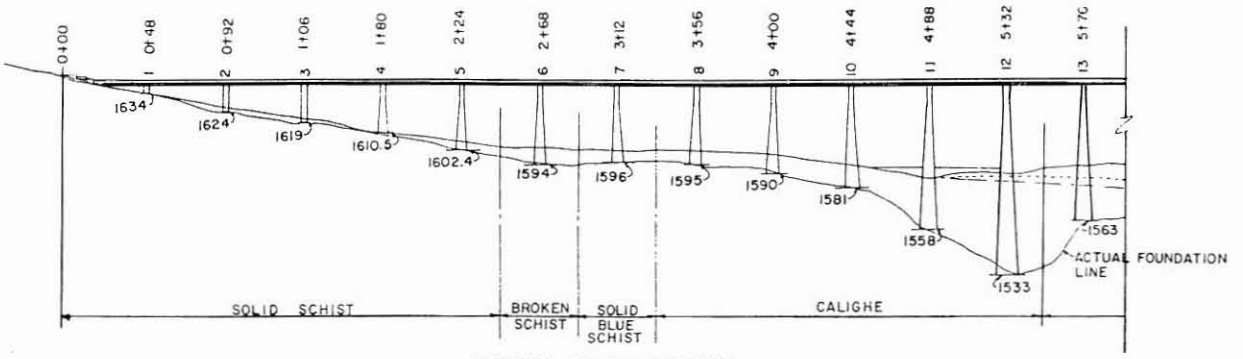
Type	Reinforced concrete multiple arch
Number of Arches	38
Height Above Foundation	120 ft (36.6 m)
Length of Dam	1,692 ft (516 m)
Arch Base Width	4 ft (1.22 m)
Arch Crest Width	12 in (0.3 m)
Buttress Base Width	8 to 10 ft (2.44 to 3.05 m)
Buttress Crest Width	12 in (0.3 m)

SPILLWAY

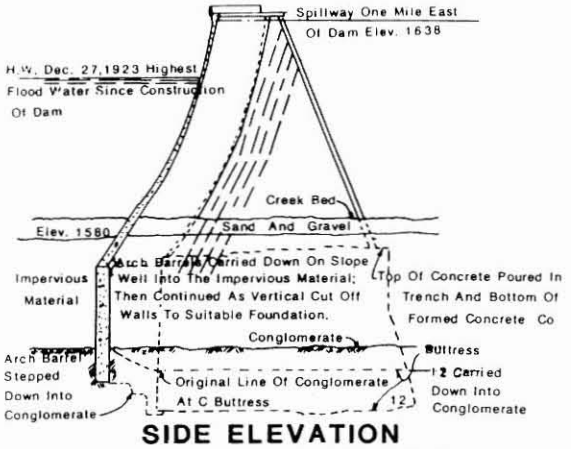
In natural saddle



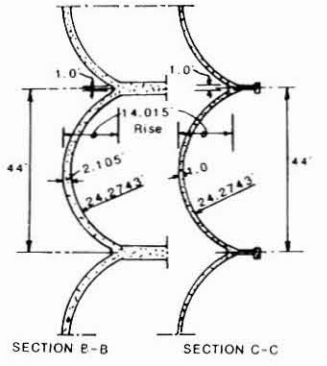
PLAN



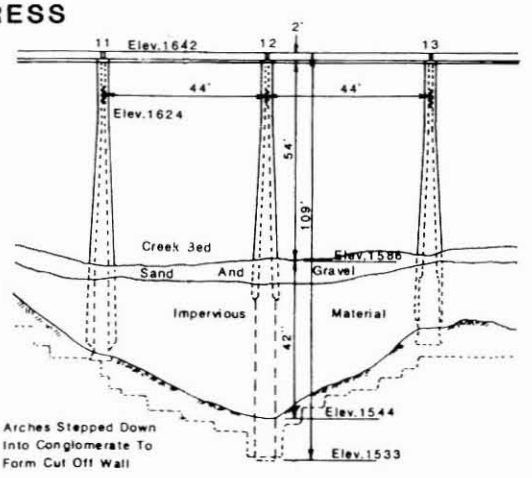
REAR ELEVATION



SIDE ELEVATION OF HIGHEST BUTTRESS



TYPICAL HORZONTAL SECTIONS



TYPICAL ELEVATION SECTION

Location—Cave Creek Dam is located on Cave Creek approximately 18 miles north of downtown Phoenix, Arizona. At the time of its construction in 1922–1923, the Phoenix city limits were many miles away, but now Phoenix is less than a mile away. Access to the dam from Phoenix is north on Cave Creek Road and then west on Jomax Road.

General Description—Cave Creek Dam was constructed between 1922 and 1923 for a total cost of $556,982. The dam was one of the first reinforced concrete, multiple-arch dams with a curved upstream face to be built in the United States.

The dam, which is 1,692 feet in length and rises 120 feet above the foundation, was constructed solely for flood control. Storage capacity is 14,000 ac-ft and surface area is 600 acres. The dam was replaced in 1980 by the Cave Buttes Dam, an embankment structure about one-half mile downstream, but is being preserved for its historical value.

Background—Following a heavy rainstorm over the Cave Creek watershed in August 1921, the resulting runoff flooded a large area in Phoenix and caused widespread damage. In addition to damage to homes and businesses, floodwaters covered the first floor of the State Capital Building. Construction of the dam began in 1922 and was completed in 1923. The State of Arizona, Maricopa County, City of Phoenix, Salt River Valley Waters Users Association (now known as Salt River Project), and the Paradise-Verde Irrigation District participated in the construction of the Dam. Contributions were received from several railroad companies and various local organizations and private individuals. The Paradise-Verde Irrigation District was to maintain the structure, but it ceased to exist and the Salt River Project operated the structure. Cave Creek, below the dam, enters the Arizona Canal, which is a major irrigation facility of the Salt River Project. The Flood Control District of Maricopa County has now assumed complete responsibility for Cave Creek Dam.

The dam served Phoenix admirably through several major floods, but it was not large enough to provide the level of protection needed. Even with the dam, there was serious flooding in 1943, 1967, 1978 and 1980. In the March 1978 storm, the Cave Creek Dam held 7,000 ac-ft of water and filled to within 6 inches of its crest. Floodwater from the dam and from the natural spillway flowed down Cave Creek into the Arizona Canal, then spilled out into the urban areas of Phoenix. The Canal also spilled over at 43rd Avenue and 59th Avenue.

In 1980, the U.S. Army Corps of Engineers constructed Cave Buttes Dam approximately half a mile downstream. Cave Creek Dam is in the reservoir area of the new dam. The Army Corps of Engineers proposed demolishing Cave Creek but it was determined that because of the historical value of the structure and possible future recreational uses, the dam should be left in place. As part of construction of Cave Buttes Dam, the Army Corps of Engineers excavated a by-pass channel to the west of the dam. In a major flood event, the old Cave Creek Dam would be completely inundated by the new Cave Buttes Dam.

SITE CONDITIONS

Hydrology—The Cave Creek drainage area above the dam consists of about 210 square miles of mountain and Sonoran Desert terrain. The dam creates a reservoir with a maximum area of 600 acres and a capacity of about 14,000 ac-ft. During the August 1921 storm, it was reported that 4 inches of rain fell on the Cave Creek watershed. The resulting runoff was estimated at 20,000 cfs to 25,000 cfs.

Geology—The dam foundation consists of Yavapai schist at the ends and calcareous conglomerate for about 1,100 feet in the center. The conglomerate was overlain by as much as 60 feet of sand, gravel, cobbles and boulders with some clayey zones.

DESCRIPTION OF MAIN FEATURES

Dam—Cave Creek Dam consists of 38 reinforced concrete arches and supporting buttresses. The buttresses are spaced at 44-ft centers. The total length of the dam, including the abutments, is 1,692 feet. At its deepest section, the crest of the dam is 60 feet above the creek bed and extends an additional 60 feet down through sand and gravel to a stratum of cemented sand and gravel (conglomerate). The arches are 12 inches thick at the crest and are approximately 4 feet thick at the arch foundation 120 feet below the crest. The top of the arches are capped with a horizontal slab that is 2.5 feet wide. A concrete wave cope, 2 feet high, extends above the cap slab. The arch barrels are nearly vertical at the crest of the dam and the slope becomes gradually flatter until the inclination of the barrels is 56 degrees with the horizontal at a depth of 80 feet below the crest. Below the 80-ft level, the arch barrels are vertical. The original designs were for a structure 80 feet high; however, when excavation was made for the arches and buttresses in the middle portion, suitable foundation was found 40 feet lower than anti-

cipated. Rather than continued with the curved arch geometry, which would have added considerably to the cost, the designer, John S. Eastwood, simply extended the arches vertically below the 80-ft level.

The buttress walls are 12 inches thick at the crest and increase to a thickness of 8 to 10 feet at the 120-ft depth. The buttresses are T-shaped with the flange on the downstream edge to provide additional stiffness to the member. The concrete for the arches consisted of a 1:2:4 (cement:sand:coarse aggregate) mix, and a 1:2.5:5 mix was used for the buttresses. Reinforcing for the arches consisted of 0.75-in square horizontal bars spaced at 2 feet on centers with 0.5-in square vertical bars on 5-ft centers.

As designed by Mr. Eastwood, the buttresses are unusually thin members and are significantly stressed in tension at their upstream ends, if the assumption is made that the buttresses and arches act as monolithic units. The buttresses are unreinforced, except at the junction of arch and buttress, where steel rods tie the unit together. Additionally, four 25-pound steel rails were placed parallel to the upstream face of the buttresses at the junction point.

Spillway—The spillway is a long natural saddle about one mile east of the dam. The elevation of the top of the dam is 1,640 feet and the saddle elevation averages about 1,637.5 feet. The spillway returned the water to Cave Creek at a point about a mile and a half downstream from the dam.

Gates—The dam was originally provided with three slide gates about 4 feet square. These gates are now in a permanently open position.

PERFORMANCE

In 1969, a consulting firm in Phoenix, Arizona provided the Flood Control District with an engineering analysis of the condition of the superstructure. As a reuslt of their investigations and in view of th fact that the dam had withstood the loads imposed upon it since 1923, it was concluded that the dam superstructure was sound provided that the loads were not increased.

Four 6-in cores were obtained and the results indicated that the concrete was of excellent quality, especially considering the concrete mixing and placing methods used in 1922. Twelve 4-in cores drilled to follow cracks indicated the concrete to be dense and of good quality. In only one 4-in core was there indication of small voids in the concrete.

The arches and buttresses were analyzed at several elevations to evaluate the structural soundness of the dam. The arches of 15, 25, 35 and 45 feet below the crest were analyzed and the maximum calculated stress was 479 psi, which did not include the effects of temperature. Thus, it appeared that the arches were structurally sound. The buttresses were analyzed for bending and shear. Tension in the upstream face of the arches exceeded the allowable stresses when considered as a monolith with the buttresses; however, when considered independently, safe bending stresses were calculated for the buttresses. It was believed that, under load, the horizontal cold joints in the arches would tend to open up and relieve the tension in the arches. The calculated resistance of the buttresses to shear and sliding was much lower than recommended for new dams at the time of the study. Safety factors as low as 1.03 were computed for a water level at El. 1,642.0.

ACKNOWLEDGEMENTS

The designer of Cave Creek Dam was John S. Eastwood, Civil Engineer.

This summary description was prepared by Sue Mutschler of the Flood Control District of Maricopa County. The information for the summary was provided by local sources and *A Report on the Condition of the Superstructure of Old Cave Creek Dam* published in April 1969 by John Carolla Engineers, Phoenix, Arizona.

George H. Beckwith of Sergent, Hauskins & Beckwith Geotechnical Engineers, Inc., Phoenix, Arizona, provided additional information and edited the summary for publication.