

The San Diego Aqueduct

by J. P. JONES, Regional Director
Region 3, Boulder City, Nevada

SPLENDIDLY DISREGARDING TOPOGRAPHY, the Aqueduct sweeps over the hills and into the valleys, through pastureland, orchards, and semi-suburban development. Photo by J. M. Welsh, Bureau of Reclamation.



Water was a problem to Junipero Serra and his followers from the time they first set foot in the San Diego area in 1769 to establish a Franciscan outpost of Christianity. In the years which have elapsed, the water problem has become no less pressing but much more complex. During these years, the agencies responsible for supplying water in the San Diego area developed local supplies, first from wells, and then from surface water sources. The area of surface water supply was limited to the western slope of close-lying coastal range of mountains. These mountains fall away on the east to what was until comparatively recent years a barren waste lying below sea level known as the Salton Sink, now become the richly productive Imperial Valley.

Beyond the coastal range and beyond the Salton Sink lay the Colorado River, long an erratic but abundant potential source of water but for many years beyond physical and economic reach of the San Diego area. With passage of the Boulder Canyon Project Act, the Colorado River water supply could be made firm by storage in Lake Mead above Hoover Dam and the physical means of carrying that water to the eastern foothills of the coastal range made available in the All-American Canal. Foreseeing full development

of the local water sources, the City of San Diego entered into contracts with the United States for storage of water in Lake Mead and for capacity in the All-American Canal. The contracts were executed in the early nineteen-thirties, at which time it was considered that the local water sources would provide full supply with safety for a considerable period. This period was shortened drastically by the expanding military and manufacturing activities in the San Diego area during the early war years.

In May of 1943, the City and County of San Diego entered into contracts with the United States which provided that the Bureau of Reclamation make investigations to determine the means and cost of bringing Colorado River water to the San Diego area. During progress of these investigations, the problem of sufficient water supply became so acute and alarming that the matter was called directly to the attention of the President in 1944. He appointed a committee to study and report on the question. The committee, on the basis of the investigations so far made by the Bureau of Reclamation, recommended immediate construction of a connection to the Metropolitan Water District's Colorado River aqueduct in preference to the alternative connection to the

All-American Canal. The President, on November 29, 1944, so directed. Construction was to be at half ultimate capacity. The Bureau of Reclamation was directed to design and the Navy Department to construct the aqueduct. The work was undertaken as directed and the first Colorado River water reached the San Diego area on the 26th of November 1947. This part of the aqueduct was known as the first barrel.

The San Diego County Water Authority, an association of cities and water districts in San Diego County, was organized on June 9, 1944. This organization contracted with the United States to repay the costs of construction and to assume operation and maintenance of the aqueduct. Subsequently, the San Diego County Water Authority joined The Metropolitan Water District of Southern California under terms which provided for joint operation by the two agencies. Beginning in December 1947, the aqueduct was operated almost continuously to full capacity. A period of deficient rainfall, which decreased the local supplies, forced greater and greater dependence upon Colorado River water for immediate use rather than as a reserve source of water. This happened at a time when increased military and manufacturing activities due to the Korean hostilities had placed additional drain on the water supplies of the San Diego area.

Acting to augment the reserve supply of water, the San Diego County Water Authority entered into a contract with the United States on April 25, 1949, under which the Bureau of Reclamation undertook investigation of the location and cost of a second barrel which would bring the aqueduct to full capacity. The Authority pressed for authorization of the construction of the second barrel through the Department of Defense and authorization for construction by Department of the Navy was made by Public Law 171 of the 82nd Congress on October 11, 1951. The Department of the Navy, at that time heavily burdened with military construction activities, asked the Bureau of Reclamation to design and construct the second barrel.

On October 21, 1951, the interested agencies, consisting of the San Diego County Water Authority, The Metropolitan Water District of Southern California, the Department of the Navy represented by the District Public Works Office, Eleventh Naval District, and the Department of the Interior represented by the Regional Di-

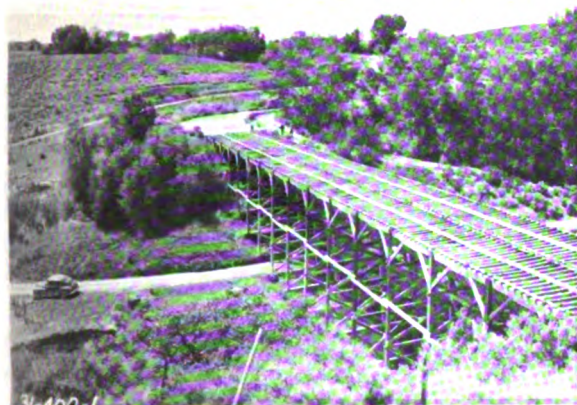
rector's Office, Region 3, met in San Diego to discuss means of getting construction of the second barrel under way as soon as possible. The conferees had early success in agreeing upon major questions which would permit the work to go forward. Public Law 171 prohibited expenditure of funds appropriated to the Department of the Navy for this work until a repayment contract had been entered into with the San Diego County Water Authority and its constituent members. To prevent delay in surveys and designs, the County Water Authority advanced under formal agreement enough money to permit the Bureau of Reclamation to start at once on this work. The first construction contracts were awarded on September 8, 1952, slightly short of eleven months after authorization. The entire aqueduct was under contract award by December 15, 1952. The second barrel was placed in full service on October 2, 1954, and all construction was declared completed and the works turned over to the Navy on January 10, 1955.

The San Jacinto-San Vicente aqueduct, to use its official name, originates by connection to the Colorado River aqueduct of The Metropolitan Water District of Southern California, near the town of San Jacinto in Riverside County, California. From point of connection, the aqueduct extends southward through Riverside County into

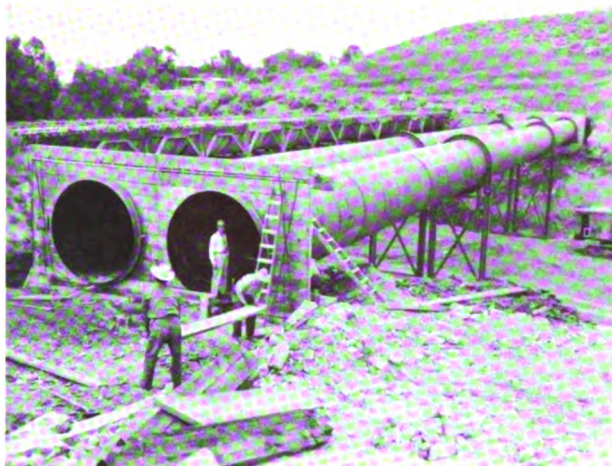
Continued on page 49

SECOND BARREL of the San Jacinto-San Vicente Aqueduct completed so as to be usable for its full length on October 2, 1954. Commemorating the occasion (l. to r.), Richard S. Holmgren, General Manager and Chief Engineer, San Diego County Water Authority; Fred A. Holbron, Chairman of the Board Authority; Dean Howell, San Diego County Supervisor; Regional Director E. G. Nielsen, Region 3 (now Assistant Commissioner), Bureau of Reclamation; and Captain C. W. Porter, U. S. Navy. Photo courtesy San Diego Union.





TWIN METAL FLUMES over Happy Canyon on the Montrose and Delta Canal.



AUTHOR can be seen in right tube. These replaced Happy Canyon flumes.

Facelifting at Uncompahgre

by JESSE R. THOMPSON, Manager-Treasurer, Uncompahgre Valley Water Users' Association

ABOUT THE AUTHOR

There is probably no one better acquainted with the Uncompahgre River Valley in Colorado and with the Uncompahgre Reclamation Project than Jesse R. Thompson, now in his eighteenth year as Project Manager.

He began his long association with the Uncompahgre Project in 1909. In 1910, while working as a ditchrider, he regulated the first water turned through the 6-mile Gunnison Tunnel, then the longest tunnel for the diversion of irrigation water.

From 1910 to 1932 he advanced steadily, holding positions as Hydrographer, Watermaster, and General Foreman, gaining experience that would be invaluable to him in the future. He studied at night and obtained the degree in engineering that qualified him for the position of Project Manager.

The Uncompahgre Valley Water Users' Association has launched a program of rehabilitation on a number of major and important structures on the Uncompahgre Project in western Colorado. Funds for the work are being raised currently by nominal additional assessments and construction is being accomplished by project maintenance forces.

The Uncompahgre Project, originally called the Gunnison Project, was one of the first five rec-

lamation projects recommended for construction to the Secretary of the Interior on March 7, 1903, and approved by him on March 14, 1903. Construction was started in July 1904 and the first water was delivered through project works in 1908. The project was substantially complete in 1922 except for drainage construction and building of Taylor Park Dam which was completed in 1937. Care of the project, operation, and maintenance were assumed by the Uncompahgre Valley Water Users' Association in 1932. The irrigable area of about 72,000 acres is served irrigation water from natural flow of the Gunnison River and the Uncompahgre River, and by stored water from the 106,230 acre-foot Taylor Park Reservoir. The 5.8-mile long Gunnison Tunnel carries water from the Gunnison River to the Uncompahgre Valley where a system of canals and laterals totaling 568 miles in length serves the farm lands. An unusual number of structures are necessary for water conveyance and control because of the steep valley slopes, mesa formations, and highly erosive soils on the project area. Deterioration of structures is increased by alkali conditions in sections of the project area and the requirement for some operation during winter periods for watering livestock. Practically all the original structures on the canal system were timber.

On December 7, 1933, the Federal Emergency



HEADWORKS of GH AND GK laterals with wasteway structure in foreground, due for replacement under rehabilitation program.



METAL FLUME over Cedar Creek on the East Canal also scheduled for replacement under water users' facelifting program.

Administrator of Public Works approved allotments for rehabilitation of the South Canal and making of general repairs and replacements to other portions of the irrigation system, and construction of Taylor Park Reservoir. On August 6, 1935, an allotment was made for construction of drainage works.

In September 1950 the Board of Directors of the Association, the Project Manager, and Bureau personnel made an inspection of major structures to obtain first-hand knowledge of the need for a rehabilitation program and nine structures were considered to be in a condition that would necessitate replacement in the near future. Another inspection was made in 1951 and the Association decided to proceed with a rehabilitation program using its own funds and utilizing project forces for construction. It was decided to spend a minimum of \$20,000 a year and assessments were levied accordingly.

The need for replacement of any structure on the project is governed by operating efficiency, annual maintenance costs, and consideration of the risk involved in case of failure. In some cases structure failure could mean a total loss of all crops on lands supplied with water through the structure.

In entering upon a program of rehabilitation, the first consideration should be the type of structure. The futility of trying to operate a project by replacement of existing facilities with short-lived structures has become forcibly apparent during the 46 years of project operation. Where formerly structures were built with a life expectancy

of from 20 to 30 years, structures can now be built economically to last for a period of from 75 to possibly 100 years.

In choosing the type of structure, time available for replacement is to be considered. Where a new structure can be placed near the old structure during the irrigation season without interference with water delivery, the need for hurried construction during the winter months is eliminated.

Another factor to consider is whether the job can be handled with local project crews and equipment. If it can, a considerable saving can be realized.

The next consideration is how long will a structure last without excessive maintenance. Reinforced concrete structures properly placed and using the proper mixture of concrete aggregates will fill the requirements as to life expectancy provided that alkali action is not a hazard.

The main types of structure to choose from are: reinforced concrete, pipe or long span tubes with concrete inlet and outlet, sheet metal with wood or metal substructure, and wood.

Using these criteria we have made satisfactory progress on replacement and improvement. The first structure was replaced during the winter of 1951-1952. The new reinforced concrete flume at mile post 6.35 on the Ironstone Canal replaced the original wood flume over Dry Creek.

A concrete structure was chosen for this point because of its durability. The old substructure was used for supporting forms (by lowering floor of old structure); water could be fed from Dry

Creek into the Ironstone Canal downstream from the old flume for winter stock. It could be built by project crews between season's run of water; soil was such that alkali action would not be a problem; and such a flume would not be subject to leakage. The new flume has a span of 70 feet across the creek with outlet section 49 feet long and inlet section 35 feet long. It rests on two piers excavated to hard shale. The structure is 8 feet wide, 5 feet 6 inches deep, and has a capacity of 300 second feet.

The next major structure to come under our program was the metal twin flume over Happy Canyon Creek on the Montrose and Delta Canal at mile post 5.43. This large structure had a capacity of 400 second-feet and was 252 feet long with concrete inlet and outlet sections. The height from ground surface to top of the old flume was about 35 feet. The old flume was size 204 sheet metal with timber substructure. Built in 1913 it has given 41 years of service, but maintenance has been excessive for many years and natural deterioration of the substructure has reached such a state that the risk of losing crops on the 22,000 acres served by the canal if the structure failed has made it mandatory to replace it.

Consideration was given to a concrete flume or siphon for this structure but was abandoned. This decision was due principally to the fact that the cost would be excessive and work would have to be contracted rather than handled by project crews with project equipment.

The final choice was twin long-span metal tubes 8 feet in diameter. It is set low enough to run full when carrying a small head for winter stock water to prevent freezing solid in winter and running water over the canal bank above the structure.

The new structure has a center span of 90 feet with end spans of 77 feet, a 7-foot section at each end for expansion joints, plus a concrete inlet and outlet.

A major problem was sinking four 6-foot diameter tubes to support the foundation under each of the two center support piers. Large sandstone, mud, and quicksand were encountered. Water was a problem, pumps had to be used for the last 12 feet of excavation at each pier. A good foundation was reached at the same elevation on both piers and consisted of good solid gravel about 30 inches above solid sandstone. End foundations and inlet and outlet concrete structures were set on solid sandstone.

Some of the rehabilitation work being performed is coordinated with a soil and moisture conservation program in which we and the Bureau of Reclamation are cooperating. During the past year the cooperative program included the replacement of an old wooden culvert on the Loutzenhizer Canal at mile post D2.28 where it crosses Montrose City Arroyo, and the control of channel erosion at that point. Although the Association was primarily responsible for replacing the culvert and the Bureau responsible for controlling erosion in the channel, personnel, equipment and other facilities were pooled to perform the overall job more efficiently and effectively at a minimum cost. The new culvert is 107 feet long and with a 7-foot diameter of heavy corrugated pipe. In addition to carrying normal and flash flood flows of City Creek Arroyo under the canal, the culvert also functions as a drop structure in which the arroyo channel is lowered 9 feet. This adds considerable stability to the arroyo channel. To further prevent erosion the arroyo channel was straightened for a distance of about 300 feet both above and below the culvert. In addition, for about 40 feet below the culvert, heavy sandstone riprap has been placed on the bottom and sides of the channel.

Rehabilitation of major structures and participation in a conservation program to protect these and other structures on the project increases the workload and expenses considerably above those encountered in the normal operation and maintenance of the project, but it will be satisfying to project farmers and us to have accomplished our goal with a minimum of cost and outside assistance.

###

NEW FLUME across Dry Creek on Ironstone Canal.

