The Navajo Unit

Colorado River Storage Project

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PREFATORY NOTE

Established in 1902, the Bureau of Reclamation is one of the major Federal water development agencies. Historically Reclamation developed water projects to "reclaim" arid Western lands for irrigated farming. The concept of "homemaking" was integral to Reclamation's early projects, i.e., homes would be made for settlers on new, irrigated farms. Over the years Reclamation's responsibilities expanded to multiple uses including water development for municipal and industrial uses, generation of hydroelectric power, flood control, and recreation.

Reclamation built about 180 projects and is currently completing the last authorized major construction on those projects. The bureau is now concentrating on management of its existing water development projects.

In the summer of 1993 Reclamation's history program began a multi-year research project. The intention is to develop a basic narrative history of each Reclamation project. Each narrative will outline the historic/prehistoric setting, the reasons for authorization, basic construction history, the aftermath of project development, and a rudimentary bibliography. These brief narrative overviews are not intended to be definitive or deeply interpretive. Each narrative is expected to be further edited for inclusion in a publication, about 2002, on the history of Reclamation projects.

In the meantime, we plan to distribute these narrative essays both to make the basic information available, and to encourage independent research in Reclamation's history.

This essay is in second draft. It is not Reclamation's final product. It is distributed in the hope it will make basic information available and stimulate further interest in Reclamation's history. We encourage the reader to do supplemental research and arrive at their own interpretive conclusions. The final edited version of this narrative likely will vary widely from this draft.

If you would like additional information about Reclamation's history program or about other narratives available, please contact:

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The Navajo Unit

The Navajo Unit, a unit of the Colorado River Storage Project (CRSP), is in northwestern New Mexico and southwestern Colorado. Together with the other three units of CRSP—Flaming Gorge, Glen Canyon, and Wayne Aspinall[1]—Navajo helps manage the resources of the Upper Colorado River Basin. Navajo serves a variety of purposes, furnishing municipal and industrial water to the surrounding area, providing irrigation water to the Navajo Indian Irrigation Project (NIIP), and regulating water for power generation at Glen Canyon Dam.

Project Location

The Navajo Unit of the Colorado River Storage Project, situated in northwestern New Mexico, consists of Navajo Dam and Reservoir. Located about thirty-four miles east of Farmington, New Mexico, the dam captures the San Juan River. The reservoir extends into southwestern Colorado.[2]

A hot, dry, and windy plateau, the San Juan River Basin receives less than ten inches of rainfall yearly. Land elevations in the area range from 5,000 feet to more than 6,000 feet above sea level. The elevation and southern location provides the area with an average growing season of around 160 days, ensuring growth of a wide array of crops when irrigation water is available.[3]

Historic Setting

Prehistoric Setting

Scholars generally agree that men of an unknown physical type first inhabited the New Mexico region. The first remnants of these early inhabitants in northwestern New Mexico take

1. Reclamation renamed the Curecanti Unit the Wayne Aspinall Unit October 3, 1980.
2. United States Department of Interior, Water and Power Resources Service, *Project Data*, (Denver: U.S. Government Printing Office, 1981), 358.
3. Herbert E. Simison, "Action on the San Juan River," *The Reclamation Era* 46, No. 1 (February 1960): 9-10.

the form of Folsom points, curious flint points of superb workmanship, dating approximately 10,700 to 10,200 years ago. The Folsom hunters died out around seven-thousand years ago, apparently when a severe drought struck the continent, resulting in the disappearance of big game animals effectively ensuring the demise of the cultures which hunted them.

West of the Continental Divide another indigenous culture, the Cochise, fared much better than the Folsom hunters when drought struck. With an economy based upon collection of wild foods and hunting of small game, the Cochise adapted to the change in climatic conditions and thus formed the basis from which the later Pueblo farming cultures developed. Cochise artifacts and small primitive ears of corn discovered in 1949 gave scholars the first real evidence of an agricultural society dating back four or five thousand years. These early agricultural endeavors likely represented only a small portion of food procurement activities. Evidence indicates that inhabitants of the southwest did not move from their dominantly hunting and gathering pattern into a largely agricultural society until around twenty-five hundred years ago; these first permanent settlements likely occurred in the vicinity of the Gila and Salt Rivers which provided the necessary water for irrigation. The development of full-blown agriculture heralded a transformation of the simple Cochise way of life into a more sophisticated southwestern tradition.

The first of the more sophisticated cultures emerged around 2,100 years ago. The Mogollon, as archaeologists categorize them, were the first representatives of the new traditions. They lived along the present day New Mexico-Arizona border. Characterized by their pit-house villages, ceremonial lodges, production of artistic ceramics, and farming on mesa tops and in stream valleys, the Mogollon soon became the cultural leaders of the southwest.

In a process similar to that of the Mogollon tribe, residents of the current Four Corners area began to adopt new traditions. Beginning about fifteen hundred years ago the Basketmakers, a desert, gathering people were named after their superbly woven baskets left behind in dry caves, evolved into the Anasazi, the direct ancestors of the historic Pueblo cultures. Anasazi, a word used by the Navajo and later archaeologists to designate the prehistoric inhabitants of the Four Corners region and generally considered to mean "the Ancient Ones," actually means "enemy ancestors." Much to the chagrin of current Pueblo peoples, the English usage of the word has become widespread and few recognize or acknowledge the historic meaning of the word.

The Anasazi built large urban centers with towering buildings; these apartment complexes gave the Pueblos their name when visited by the Spanish explorers of the area. The Pueblos created elaborate irrigation works and complex systems of communication and trade while continuing to hunt and produce elaborate ceramic pottery. The Anasazi are perhaps best known for their elaborate cliff dwellings at Mesa Verde, Colorado, though other notable ruins exist within Chaco Canyon, Aztec, Bandelier, and Pecos National Monuments in New Mexico. Eventually the Anasazi abandoned several of their settlements, including Mesa Verde around 1200; smaller tribes moved together creating large communities. Archaeologists have yet to determine if the arrival of the Navajo tribe in the region contributed to the sudden departure of the Anasazi. It was in the larger Anasazi communities, located largely in the valleys of the Rio Grande and its tributaries and on the Pajarito Plateau, that the Spanish found the Pueblo Indians in the sixteenth century.[4]

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4. Marc Simmons, *New Mexico: A Bicentennial History*, (New York: W. W. Norton and Company, Inc., 1977), 45-54; William C. Sturtevant, ed., *Handbook of North American Indians*, Vol. 9, *Southwest*, Alfonso Ortiz, (continued...)

Historic Setting

Pueblo culture developed in the Four Corners area where the Navajo Project is located. By the Spanish period Pueblo cultures had migrated south and east to Hopi, Zuni, Acoma, Laguna, and the Rio Grande Valley. Spanish occupation of the Rio Grande Valley little affected Northwest New Mexico which was seldom visited by the Spanish. There was, however, continued tension and friction among the Spanish, Pueblos, and Navajo/ Apache.[5]

William and Simeon Hendrickson, two gold seekers from Animas City, Colorado, founded the town of Farmington, New Mexico in 1876. Soon becoming an agricultural supply center for the Rocky Mountain mining camps of the San Juan Basin, Farmington boasted a small but steadily growing population that thrived on fruit and cereal production. The founding in 1881, of the nearby city of Durango, Colorado, located fifty miles northwest, coupled with the 1880s arrival of William Jackson Palmer's Denver and Rio Grande Railroad (D&RG) in Durango, set-off a burgeoning race between the two cities for control of the limited natural resources in the area. General Palmer and Edward Henry Harriman, president of the Southern Pacific Railroad, fostered the rivalry between the two towns; both sought to establish a link between Farmington and the transcontinental lines which intersected at Gallup, New Mexico. After considerable negotiation, Harriman eventually secured the contract, he envisioned transporting coal to the port city of Guaymas, Mexico for shipment and sale oversees, however his untimely death in 1909 and the outbreak of the Mexican Revolution one year later halted the project. In the meantime, the D&RG built a short-line narrow-gauge connection between Farmington and Durango. Harriman's death left the short D&RG line as the only rail

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4. (...continued)
ed. (Washington, D.C.: Smithsonian Institution, 1979), 43-4, 47, 108, 126, 131.
5. Sturtevant, Vol. 9, 206-22; Sturtevant, Vol. 10, 506-23.

transportation in Farmington.

In the next few decades Farmington became one of many small towns across America struggling to capitalize on its nearby natural resources by producing alternative sources of energy for the growing populace. In 1926, miners made a major petroleum strike just southwest of Shiprock on the Navajo Reservation; with the advent of motor travel in the 1920s, oil replaced coal as the nation's leading fuel. The petroleum strike stimulated Farmington's first true population boom with geologists and roughnecks converging on the previously tranquil agricultural community. For the most part, newcomers found work in the oil fields or at the newly built Continental Oil gasoline factory.

Further population growth and natural resources booms followed. In 1932, the Southern Union Gas Company of Dallas, Texas, discovered natural gas in the San Juan Basin. Southern Union Gas made a second significant find in the Barker Dome area, fifteen miles northwest of Farmington, in October of 1946. Three years later, in 1949, El Paso Natural Gas announced plans for a multimillion-dollar pipeline from San Juan Basin gas fields to Toprock, Arizona. From Toprock the pipeline would join the Pacific Gas and Electric pipeline to supply San Francisco with gas for heating.

At the same time that petroleum based resources were being developed in the Farmington area, an energy boom of another kind occurred near Durango. After World War II, fueled by the developing Cold War between the United States and the Soviet Union and a priority shift towards national security, the U.S. began stockpiling atomic-weapons. The shift in focus to atomic energy brought yet another energy boom to the area when the Atomic Energy Commission (AEC) released a report in January of 1948, estimating that the majority of the

world's uranium reserves were located in southeast Utah and southwest Colorado.

The news of the abundance of uranium coupled with governmental plans to reactivate Durango's smelter, closed since the end of the silver mining days in the 1880s, caused local residents to envision Durango as the nation's leading producer of uranium concentrate.

Local predictions seemed destined to become a reality after President Harry Truman's State of the Union address in 1952. Truman proposed a record-breaking defense budget, stressing production of small atomic weapons and nuclear submarines for national security reasons and underscoring the need for increased uranium production in the Mountain West.

The booming energy development lead to a population boom in both Durango and Farmington. By 1952, Farmington had become the fastest growing city (in terms of percentage) in New Mexico. Not to be outdone, Durango continued to proclaim itself the "region of wealth." in 1956, Farmington boasted a population of more than 15,000 residents, four times that of the 1950 census. Observers attributed Farmington's meteoric growth to a multifaceted economy that combined energy resource development, irrigated agriculture, and manufacturing. Plans for construction of nearby Navajo Dam fit nicely into the diverse mixture.[6]

Project Authorization

A scarcely tapped potential of agricultural, industrial, and recreational assets exists in the Upper Colorado River Basin. It contains tremendous quantities of uranium, coal, and other minerals. Realization of the potential in economic growth and contribution to the national welfare depends upon the maximum use of limited water supplies. Reclamation designed the Colorado River Storage Project to conserve the very limited precipitation, which falls primarily

6. Arthur R. Goméz, "Urban Imperialism in the Modern West: Farmington, New Mexico, vs. Durango, Colorado, 1945-65," in *Essays in Twentieth-Century New Mexico History*, ed. Judith Boyce DeMark (Albuquerque: University of New Mexico Press, 1994), 135-41.

in the form of snow in the high mountains, and use it for municipal, industrial, and agricultural growth in the Upper Colorado River Basin. In addition the project provides municipal and industrial water supplies, flood control, extensive recreation, and fish and wildlife preservation.[7]

Reclamation began investigations, with an eye for development, of the Upper Colorado River system in 1902. By 1922, and negotiation of the Colorado River Compact,[8] Reclamation began envisioning a need for the Colorado River Storage Project. The allocation of 7.5-million acre-feet of water per year to both the upper and lower basins, as specified in the Compact, hinged on the upper basin's delivery of not less than 7.5 million acre-feet of water in any period of ten consecutive years, with additional water for use in Mexico. In 1949, Congress approved the Upper Colorado River Basin Compact, which allocated the 7.5 acre-feet of water allowed between the four upper basin states (Colorado, New Mexico, Utah, and Wyoming).

The flow of the Colorado varies erratically from year to year, ranging from four to twenty-two million acre-feet per year at Lees Ferry. Dry years meant that the Upper Basin had trouble providing water committed to in the Colorado River Compact. Additionally, there was not enough water in the river system to permit full use of the Upper Basin allocations under the

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7. *Project Data*, 361.

8. The Colorado River Compact divides the waters of the Colorado River and its tributaries between seven states, Arizona, California, Colorado, New Mexico, Nevada, Utah, and Wyoming. The Compact divided the Colorado River Basin into two smaller entities, the upper (Colorado, New Mexico, Utah, and Wyoming) and lower basins (Arizona, California, and Nevada) with the dividing point located at Lee Ferry, Arizona. According to the Compact, each basin would receive 7.5 million acre-feet yearly, with an additional one million acre-feet allotted the lower basin from its tributaries. Negotiated in 1922, representatives from the seven states signed the Compact in Santa Fe, New Mexico, on November 24, 1922. The Compact then went to the State Legislatures and the Congress of the United States for approval; before becoming binding and obligatory all seven states and the Congress had to approve the Compact. Arizona refused to approve the Compact without a further division of the waters of the lower basin to keep California from taking the lion's share of the allocation. The stalemate between Arizona and California continued for six more years, when at the urging of the upper basin states Congress ratified the Compact. The revised Compact limited California's allocation of the lower basin's share of the water to 4.4 million acre-feet per year and allowed the Compact to become binding after passage by Congress and only six of the seven State Legislatures. Six of the seven Legislatures had already passed the Compact and on December 21, 1928, Congress passed the Boulder Canyon Project Act, which included the modified Colorado River Compact. Arizona did not ratify the Compact for another thirty-five years.

Compact. In order to fully use the upper basin's allocation during dry years large storage reservoirs needed to be built; filling the reservoirs would allow the upper basin to meet their flow requirements in dry years while still providing water to the Lower Colorado River Basin under the Colorado River Compact.

Reclamation, in conjunction with the Upper Colorado River Commission and other Federal agencies, prepared a formal report in 1950 describing plans for a series of dams and reservoirs, including power development and other services, to augment development in the upper basin. The report outlined plans for an initial group of participating projects, developing water for irrigation and other purposes, financially linked with the developing Colorado River Storage Project. Revenues from hydropower developed at the CRSP units (Glen Canyon, Flaming Gorge, and Wayne Aspinall) would be used to fund smaller irrigation projects known as participating projects.

After modifying Reclamation's original plan, Congress authorized construction of four storage units and eleven participating projects of the Colorado River Storage Project by the act of April 11, 1956. The original authorization included the four CRSP storage units, Glen Canyon, Flaming Gorge, Wayne Aspinall, and Navajo; the initial phase of the Central Utah Project (CUP), Emery County, Florida, Hammond, La Barge, Lyman; and additional work at Paonia, Pine River Extension, Seedskadee, Silt, and Smith Fork. Reclamation later found the La Barge Project in Wyoming infeasible and deleted it from the project. Other participating projects and their date of authorization: Animas-La Plata (1968); Bostwick Park (1964); Dallas Creek (1968); Dolores (1968); Eden (1949); Fruitland Mesa (1964); Navajo Indian Irrigation Project (1962), a Bureau of Indian Affairs project constructed by Reclamation; San Juan-Chama

(1962); San Miguel (1968); Savery-Pot Hook (1964); and West Divide (1968).[9]

Construction History

Work on the Navajo Dam and Reservoir began October 8, 1956, with establishment of the Navajo Dam Unit Field Office at Farmington, New Mexico.[10] Prior to start of construction on the project, the National Park Service (NPS), the New Mexico State Museum of Natural History, and Reclamation conducted an archaeological program examining, recording details, and preserving the artifacts, of a small portion of the archaeological sites within the project area. For the most part, these investigations concentrated on the lower canyons and river bottoms; researchers paid little attention to the mesa tops.[11]

On June 19, 1958, after completion of the archaeological investigations, Reclamation opened bids for construction of Navajo Dam and Reservoir. Six days later, June 25, Reclamation awarded the contract to Morrison-Knudsen Co., Inc., Henry J. Kaiser Co., and F & S Contracting Company, joint bidders for the contract. The contractors began work on the dam July 30, 1958.[12]

Work on the project proceeded steadily. The contractor "holed through" the main outlet-works diversion tunnel on January 27, 1959 and the auxiliary outlet-works tunnel on April 27. Work then began on the concrete lining of the outlet-works tunnel which the contractor

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9. *Project Data*, 360-1, 682; Congress authorized the Navajo Indian Irrigation Project and the San Juan-Chama Project under provisions of Public Law 87-483, June 13, 1962. Bostwick Park, Fruitland Mesa, and Savery-Pot Hook were authorized September 2, 1964. The Colorado River Basin Projects Act of September 30, 1968, authorized the remaining five participating projects, Animas-La Plata, Dallas Creek, Dolores, San Miguel and West Divide, as well as the Central Arizona Project.

10. Denver Colorado, National Archives and Records Administration: Rocky Mountain Region, Records of the Bureau of Reclamation, Record Group 115, "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume I, 1956, 2.

11. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume II, 1957, 2.

12. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume III, 1958, 1-2.

completed on October 30, 1959. By the end of the year, December 30, the contractor completed first-stage concrete and protective work in the outlet-works tunnel and portal structures as required for diversion of the river through the tunnel.[13]

Diversion of the river through the main outlet-works tunnel occurred on January 4, 1960. In March, the contractor completed the concrete lining for the auxiliary outlet-works tunnel. Grouting of the outlet-works and access tunnel and shaft was completed on April 30. The contractor reached a milestone in construction on the project August 31, 1960, the first month they reached the one-million cubic yard mark; they placed 1,019,000 cubic yards of dam embankment during the month of August. On December 19, the contractor completed first-stage concrete for the main outlet-works intake structure, finishing out construction for the year.[14]

The contractor completed installing the trashracks and the elliptical bulkhead gate on the outlet-works intake structure on January 20, 1961. By July 21, 1961, the spillway structure, with the exception of one wall section and footing, had been completed. On August 1, Miles-Sierra General Contractors, the Morrison-Kaiser-F & S subcontractor for furnishing and placing riprap for Navajo Dam, began placing riprap in the spillway stilling basin. The subcontractor completed the project September 15, 1961.

As construction of Navajo Dam steadily progressed, on June 30, 1961, Reclamation awarded the contract for clearing the Reservoir area to Universal Grading Company, of Albuquerque, New Mexico. The contractor began clearing operations on July 18. Nearly a year

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13. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume IV, 1959, 1, 3.
14. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume V, 1960, 1-2.

later, on June 12, 1962, Reclamation accepted as complete all work on the contract.[15]

On May 22, 1962, the contractor held a brief ceremony recognizing the 25,000,000th cubic yard of material in the Navajo Dam embankment, an earthfill structure, another construction milestone. Just over a month later, on June 27, the contractor placed stop logs at the diversion inlet of the outlet-works intake structure, beginning storage in the Navajo Reservoir. The thirty-six-inch bypass at the Dam was closed July 1 and the contractor began placing second-stage concrete in the outlet-works intake structure. On August 22, the contractor topped out the Navajo Dam embankment.

Prior to actual completion of the dam, Reclamation held dedication ceremonies for Navajo Dam. With numerous Federal, state, and local officials in attendance, Secretary of the Interior Stewart Udall gave the principal address.

Another year passed before Reclamation transferred the dam to Operation and Maintenance (O&M) status, during which time the contractor completed work on the structure. The contractor completed the placing of riprap on the upstream face in October of 1962 and concrete work on January 20, 1963. Reclamation accepted all work as complete on the structure April 20, 1963. On July 1, 1963, after a pre-transfer inspection in April, Reclamation transferred the Navajo Dam and Reservoir to O&M status. At the same time the administrative duties for the project moved to the Durango, Colorado, office from Farmington, New Mexico.[16]

During the construction phase of the project, Reclamation relocated two major construction obstacles, the Pine River Cemeteries and portions of the Denver and Rio Grande

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15. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume VI, 1961, 1-2.
16. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume VII, 1962, 1-3; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume VIII, 1963, 5-6.

Western Railroad (D & RGW) line, both of which would be inundated by filling of the reservoir.

Reclamation awarded the contract for relocation of the Pine River Cemeteries to Milton L. Wiley on February 16, 1959. The contractor began work on the disinterment and reinterment of thirty-four burials on March 10. All work on the project was completed on May 10, 1959, with all known burials in the Pine River arm of the Navajo Reservoir reinterred in the Los Martinez Church Cemetery, New Mexico, and the La Boca Cemetery, Colorado.

A second cemetery relocation, the Rosa and Family Cemeteries, Navajo Reservation, began August 2, 1961, when Reclamation awarded a contract to Western Vault Company, of Holyoke, Colorado. The contractor began work on August 18, in the New Rosa Cemetery area. On September 29, 1961, Reclamation accepted all work on the contract as complete. The contractor preformed a total of 254 disinterments and reinterments. Work on the contract included moving twenty grave markers from the original grave sites and furnishing and placing 234 new permanent markers. On November 27, 1962, Reclamation awarded a contract to H. C. Flaugh Construction Company of Cortez, Colorado, for construction of a Pioneer Memorial in the new Santa Rosa Cemetery. The contractor did not begin work until March of 1963. The memorial was completed April 29, 1963.[17]

On July 7, 1959, Bureau and D & RGW Railroad officials inspected the proposed alignment for relocation of the railroad around the upper end of the Navajo Reservoir.[18] Reclamation awarded a contract for initial stages of the relocation of the line the following year

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17. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume VI, 1961, 2; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume VII, 1962, 2; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume VIII, 1963, 6, 9.
18. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume IV, 1959, 1-2, 4.

on October 24, 1960, to Colorado Constructors, Inc. The contractor, responsible for earthwork and structures relocation, began work the same day. Reclamation accepted all work on the contract as completed on July 20, 1961. Reclamation awarded the contract for ballasting and track laying on March 7, 1962, to Wm. A. Smith Contracting Co., Inc., of Kansas City, Kansas. Reclamation accepted the contract as complete on September 7, 1962.[19]

Navajo Dam, a rolled earthfill structure, spans the San Juan River. Containing 26,840,863 cubic yards of materials, the dam extends 3,648 feet with a structural height of 402 feet. With a maximum base width of 2,566 feet, the structure narrows to a top width of thirty feet.[20] During construction, the dam held the distinction of being the second largest earth dam ever built by Reclamation; at the time only Trinity Dam under construction in California surpassed it in size.[21]

The spillway sits on the right abutment, comprised of an approach channel, concrete crest structure without gates, spillway bridge, concrete chute and stilling basin, and outlet channel. In the chute section the width of the spillway measures 138 feet, expanding to 195 feet in the stilling basin. The spillway was designed for a maximum capacity of 34,000 cfs.

The outlet works, located on the right abutment, allows water releases to meet downstream requirements. Water travels through an 18.75-foot diameter concrete-lined outlet works tunnel, controlled by one 6- by 13-foot fixed-wheel gate, two 72-inch ring-follower gates, and two 72-inch hollow-jet valves. The 1,603 foot long tunnel has a discharge capacity of 4,200

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19. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume V, 1960, 3, XX; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume VI, 1961, 1; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume VII, 1962, 1, 58.
20. *Project Data*, 358.
21. Simison, 8.

cubic feet per second (cfs) at elevation 6101.5. Also located in the right abutment, the auxiliary outlet works, comprised of a concrete intake structure and a concrete-lined tunnel with a gate chamber for two 4-foot-square gates, discharges into the spillway stilling basin.[22]

The main canal headworks, adjacent to the left abutment, incorporates the Navajo Unit with the Navajo Indian Irrigation Project (NIIP). Constructed as part of the NIIP, the headworks control water releases into the canal system of the irrigation project. Construction of the headworks began in 1966.[23]

On the New Mexico side, Navajo Reservoir extends thirty-five miles up the San Juan River and thirteen miles up the Pine River. On the Colorado side, the reservoir extends four miles up the Piedra River. With a total capacity of 1,708,600 acre-feet and an active capacity of 1,036,100 acre-feet, the reservoir occupies 15,610 acres when filled.[24]

Post-Construction History

Reclamation made the first irrigation releases from Navajo Reservoir during the 1963 irrigation season, even though the reservoir continued to fill. As the reservoir filled for the first time in 1963, a minor seepage problem on both abutments developed. The seepage problem resulted in a small slide on the left abutment of the dam during the night of August 1, 1963. After the slide, Reclamation personnel began monitoring the seepage areas to prevent further damage.

On October 9, 1963, heavy rainfall washed out the backfill behind the right and left spillway walls, depositing approximately seventy-five cubic yards of material near the thirty-

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22. *Project Data*, 358.
23. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XI, 1966, 10.
24. *Project Data*, 358.

inch hollow-jet-valve house. Nearly a year passed before the contractor, Saguaro Contracting Company began working on the necessary repairs to the spillway walls on August 29, 1964. Prior to the contractor beginning work, another heavy rainfall on July 9, 1964, washed out additional backfill behind the spillway walls, necessitating more repairs than originally anticipated. While repairs were underway, on September 21, 1964, yet another heavy rainfall caused further washing out of backfill from behind the spillway walls. The contractor completed all the necessary repairs December 21, 1964.[25]

Further problems developed on the dam early in 1964. On January 4, 1964, Reclamation officials noticed a crack in the dam embankment near the toe drain adjacent to the right abutment. The crack extended 178 feet from elevation 5,798 to elevation 5,824. Personnel from the Denver, Durango, and Farmington Offices inspected the crack January 24. On September 10, 1964, two additional embankment cracks adjacent to the right abutment between elevations 5,820 and 5,830 became evident. By the end of the year all of the cracks had filled or closed without any noticeable settlement.[26]

In August of 1964, an examination of the 72-inch hollow-jet-valve stilling basin by Reclamation officials revealed additional problems, most likely caused by heavy rainstorms in October of 1963 and July and September of 1964. Erosion of he original concrete surfaces of both the training wall and the center wall had caused considerable damage. Reclamation did not discover the full extent of the erosion until the following spring when divers inspected the stilling basin. The divers discovered severe erosion in the floor and through two layers of

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25. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume VIII, 1963, 10-11; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume IX, 1964, 7, 14.
26. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume IX, 1964, 14.

reinforcing steel in the walls. In addition, reinforcement bars were exposed, broken, and bent. Reclamation determined that erosion damage to the structure required immediate repairs before the structure could be used for further releases through the two 72-inch hollow-jet-valves. Reclamation awarded the contract for initial repairs to the stilling basin to Fenix & Scisson, Inc. who began work April 27, 1965. The contractor completed the job May 20, 1965, without any further problems. Further repairs were scheduled for 1967-1968.

Despite all of the existing problems at Navajo Dam the inspection team for the Regional Office Biennial Inspection declared: "even though this facility currently has several major problems which are known and either being corrected or observed by Reclamation, the overall operation and maintenance care is being satisfactorily performed. With exception of the recommended corrective actions listed below and those currently being acted upon, the facilities are in good operating condition."[27]

Construction of the main canal headworks, for the Navajo Indian Irrigation Project, adjacent to the left abutment of Navajo Dam, began in 1966. Construction activities necessitated that the surface of the reservoir be held lower than normal. The reduced storage meant less water in the Colorado area of the reservoir, causing a reduction in recreation opportunities for local residents. Work continued on this portion of the project for the next year. On July 3, 1967, Reclamation accepted the main canal headworks and tunnel No. 1, adjacent to the left abutment of the dam, as substantially complete. Representatives from Reclamation, BIA, and the contractor, Fenix & Scisson, Inc., inspected the facilities August 10. They found no construction deficiencies and on August 11, 1967, Reclamation transferred the facilities to the BIA.

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27. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume X, 1965, 10, 15, 29.

During August of 1966, problems developed in one of the 72-inch hollow-jet-valves. Valve No. 1 started drifting to the open position, most likely due to leakage in the packing. In an attempt to correct the problem, Reclamation personnel removed the “f” valve in the control cabinet and cleaned the valve seat and disc. However, the measures proved unsuccessful and the needle continued to drift. Reclamation personnel completely replaced the “f” valve in the control cabinet October 19, which again failed to stop the creepage. At this point, Reclamation opted to leave correction of the problem until the upcoming overhaul of the valves during spillway repairs in 1967-1968.

October 6, 1967, Industrial Builders, Inc., began removal of the valve for repair. By October 17, the valves had been removed and shipped to the General Electric shop in Salt Lake City, Utah. During repairs to the valves a 3/32-inch maximum outward offset of the downstream body with respect to the upstream body was noted in valve No. 2. Based on a discussion of the condition, laboratory studies, and observance of similar offsets in low surfaces in other installations, Reclamation opted to reduce the offset by grinding the upstream body. General Electric shop personnel completed necessary repairs to the valves in April of 1968. Industrial Builders received the repaired valves at the Navajo Dam site on April 26, 1968. The contractor installed the valves in May and filled the hydraulic system with oil. Reclamation then tested the valves by operating each valve through a complete opening and closing cycle. They also tested the valve seals for leaks by subjecting each valve to full reservoir head. Neither valve leaked.

During November of 1968, Chief Engineer Barney Bellport, recommended additional repairs. The Navajo O&M personnel sandblasted and filled cavitated areas, smoothed and shaped by grinding, and painted with six coats of vinyl paint, the recently repaired 72-inch

hollow-jet-valves. In order to expatiate the paint process the valves were removed and placed in an upright position. O&M personnel reinstalled the valves in December, and they were ready for operation by the end of 1968.[28]

In 1967, Reclamation began additional repairs to the spillway structure. To allow prospective bidders to inspect an unwatered stilling basin, prior to their bidding on the Navajo Dam outlet works and spillway modifications, Reclamation contracted with Hare Construction Company to dewater the outlet works stilling basin area. Hare Construction Company began construction of a cofferdam in the outlet works stilling basin area on June 23, 1967. After completing the coffer dam on June 28, the contractor set two six-inch gasoline pumps on a barge in the stilling basin. The pumps allowed the contractor to maintain the basin free from water, suitable for inspection, during the period July 15 through July 20. The contractor completed all work under the contract including final clean-up and removal of all equipment by July 24. At the end of the inspection period Reclamation allowed the outlet works stilling basin to again fill with water.

Reclamation awarded the contract for Navajo Dam outlet works and spillway modifications to Industrial Builders, Inc. The contractor established an office at the jobsite on September 7, 1967, prior to beginning a second dewatering of the outlet works stilling basin. The initial unwatering ended September 26, allowing the contractor to initiate excavation of the existing concrete in the stilling basin center wall on October 3. Excavation of the wall proved harder than originally anticipated, and the contractor tried three different methods of excavation

28. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XI, 1966, 11, 13; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XII, 1967, 12, 17; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XIII, 1968, 11, 12, 21.

before devising a workable method. The successful excavation method permitted the contractor to complete nearly ninety-percent of the excavation by year's end; the contractor excavated the remaining concrete in January 1968. Also prior to the end of the year, the contractor began grouting the anchor bars, constructing drains, and placing refill under the eighteen-inch slab.

In May of 1968, the contractor completed all concrete placement in the main outlet works stilling basin structure and all required grinding and finishing of the stilling basin floor, walls, and eighteen-inch apron. The contractor completed the first part of the contract May 22. They subsequently removed the cofferdam across the main outlet works channel and released approximately 500 cfs through the two 72-inch hollow jet valves. During June, the spillway stilling basin was again drawn down for removal of materials.

During the early part of July, the contractor initiated repairs to the floor slab of the spillway stilling basin. The floor slab contained two paths of erosion, one to the left of centerline about twenty-feet wide and one to the right of centerline about ten-feet wide. Both erosion paths began about eight-feet from the upstream end of the spillway stilling basin and extended to the downstream dentates (toothlike projections). The floor slab adjacent to the dentates near centerline and on the downstream slope of the four center dentates exhibited the most severe erosion; erosion had exposed the reinforcement steel in the downstream slope area. The contractor used epoxy-bonded concrete and epoxy-bonded epoxy mortar to repair these areas.

On July 19, the contractor completed all repair work on the spillway, except for general clean-up. Reclamation accepted all work under the contract as complete on August 7, 1968.

The following November, 1969, scuba divers inspected the main outlet works stilling

basin. They discovered a new cavitated area two feet long by 3/8-inch deep by ½ inch wide in the right wall immediately below the liner plate at Station 22+12. In addition, divers discovered five pieces of cobble less than three-inches in diameter in the outer basin and flaking or chipping on either side of a previously developed crack in the floor near the left wall at Station 24+06.[29]

In 1971, problems with the spillway persisted. In May, Reclamation installed a six-inch screened drain outlet in the right spillway wall to direct outside surface runoff and seepage water into the stilling basin. During July, channel erosion damage below the end of the outlet stilling basin necessitated moving cobble form the channel into the washed out area. As a part of the soil and moisture conservation program in 1971, Reclamation constructed 615 feet of collection ditch and dike to the west of the spillway stilling basin; the ditches were constructed to keep flood water from washing rock and trash into the spillway stilling basin. In addition, Reclamation redirected some of the surface flows on the lower right side of the spillway to enter the river downstream from the stilling basin. They excavated approximately 911 cubic yards of material and used it to form the ditch and dike. Though Reclamation made a good start in 1971, additional work was necessary to complete adequate control of surface flows in the area. Additionally, throughout the year Reclamation continued to monitor the seepage areas and submit weekly reports to the Regional and Chief Engineer's offices.[30]

On December 10, 1967, the Atomic Energy Commission detonated a subsurface nuclear blast, the Gasbuggy Experiment. The blast took place about twenty-four miles from Navajo Dam and fifty-five miles east of Farmington, New Mexico. Gasbuggy, a joint government-

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29. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XII, 1967, 11-12; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XIII, 1968, 11-2, 17, 21.
30. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XVI, 1971, 16-7, 20.

industry experiment—sponsored by AEC, Bureau of Mines, Lawrence Radiation Laboratory, and the El Paso Natural Gas Company—assessed whether underground nuclear explosions could economically stimulate the recovery of natural gas by determining whether the cavity and fissures formed by the blast would provide increased stabilized delivery of natural gas from the Pictured Cliffs Sandstone formation. With the help of the Lawrence Radiation Laboratory of Livermore, California and the Coast and Geodetic Survey, Reclamation personnel monitored the impacts of the twenty-six kiloton hydrogen blast on the dam; the AEC exploded the device 4,240 feet underground. Based on readings taken before and after the blast, no measurable movement of the structure occurred. In addition to determining the impact of the blast on Navajo Dam, Reclamation officials hoped to use the data gathered during the experiment for future development of earthquake design criteria for zoned rolled earth dams.[31]

In 1968, problems with leaking in the abutments of the dam persisted; Reclamation began monitoring the abutments in 1963, when problems first presented themselves. A trouble spot developed at the junction of the State Highway and Navajo Dam, at the left abutment. A slide developed at the curve, and approximately 300 feet of the shoulder moved out into the rock drain at the contact between the abutment and the dam embankment. The slide slip circle was evident, with two or three movements to date. The New Mexico State Highway Department resurfaced a portion of it, but a depression remained on the shoulder. Reclamation described the area as a live or moving embankment and a potential point of failure. Reclamation scheduled repairs to begin in fiscal year 1970 and began tri-weekly readings of the seepage conditions which were recorded and submitted weekly to the Regional and Chief Engineer's offices.

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31. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XII, 1967, 18; George C. Rouse and Louis H. Roehm, *Vibration of Navajo Dam Following a Subsurface Nuclear Blast*, (Denver: U.S. Bureau of Reclamation, July 1969), 1, 12.

In February of 1970, Reclamation placed approximately twenty cubic yards of embankment material on the lower side of the highway curve on the left abutment. In October, to further stabilize the right abutment Reclamation constructed a concrete check structure in the right abutment drain, including installation of 480 feet of coated twenty-four-inch diameter CMP pipe. The pipe conveyed seepage flows from the right abutment drain to the river channel. Reclamation also placed 110 cubic yards of aggregate on the access road from O&M headquarters to the toe of the dam. Reclamation continued to monitor the seepage on a tri-weekly basis. On December 15, 1970, the State of New Mexico dedicated State Highway 539, running across the crest of Navajo Dam, after correcting most of the problems that arose during the final stages of construction; cars began using the road October 6.[32]

In early August and again in October of 1971, the New Mexico Department of Game and Fish expressed concern to Reclamation regarding decreasing productivity in the tailwater fishery. Since 1968, Navajo Reservoir continued to gain elevation and decrease in temperature; the water release temperature decreased six-degrees between the mid-1960s and 1971. The cooler water reduced trout food and temperature unit days important to trout growth. Responding to the problem, Reclamation began working on ways to modify the outlet works to increase water temperatures. At the same time the New Mexico Department of Game and Fish made a profile study of the reservoir for biological characteristics to help determine the most practical elevation for release of water into the outlet structure for an acceptable increase in water temperature below the dam. In addition, the commissioner's office recommended inclusion of studies

32. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XIII, 1968, 24; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XIV, 1969, 21; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XV, 1970, 6, 16, 30.

regarding fish kills and nitrogen supersaturation in a study of the temperature problem; when water is under high pressure, dissolved gasses can be forced into solution at levels higher than atmospheric pressure, causing a supersaturation condition. This condition, especially with nitrogen, can cause severe physiological stress on aquatic life. Nitrogen supersaturation of 112-percent or higher than atmospheric pressure may cause gas bubble disease in fish, which can either seriously disable the fish, or under severe conditions, result in death. There were strong indications that fish kills below the dam in 1967 and 1968 occurred due to a supersaturation of nitrogen in released water.

Fish studies continued from 1973 to 1975. Researchers measured the nitrogen supersaturation in water releases and examined fish taken from the San Juan River to determine the affects of the nitrogen. Based on the researchers' findings, Reclamation decided to install a flip bucket at the auxiliary outlet to correct the problem; the flip bucket prevented the water from plunging deep into the stilling basin and thus, halted the cause of nitrogen supersaturation. Reclamation installed the bucket in the spring of 1976, successfully eliminating the problem.[33]

In the spring of 1973, the reservoir spilled for the first time, due to a high spring run-off. Also in 1973, Reclamation began plans for the addition of a twenty-three-megawatt powerplant, a feature of the Navajo Indian Irrigation Project, below Navajo Dam. Reclamation originally designed the dam with provisions for a powerplant, however a powerplant was not one of the original project features. By 1973, development on the NIIP was such that the demand for power exceeded current capacities, making construction of a powerplant at Navajo Dam feasible.

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33. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XVI, 1971, 13; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XVIII, 1973, 1974, 1975, 1, 23; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XIX, 1976, 1977, 1978, 2.

On November 29, 1976, Reclamation awarded the contract for construction of the Navajo Dam Powerplant and Switchyard to Jacobsen Construction Company, Inc. Construction of the powerplant began in 1976, with an expected construction time of two years. On June 21, 1977, Civil Action No. 76-2266, *National Wildlife Federation (NWF), et al., Versus Cecil D. Andrus, Secretary of the Interior, et al*, derailed the construction process. The civil suit challenged the legality of the proposed twenty-three-megawatt powerplant under construction at Navajo Dam on the San Juan River in New Mexico. The NWF contended that Congress never actually authorized construction of the powerplant, even though they appropriated funds for the project. The NWF conceded that the original authorization for the Navajo Unit included provisions for construction of a fifteen-megawatt plant, however construction of a twenty-three-megawatt plant impacted the existing environment significantly and new Environmental Impact Statements (EIS) needed to be conducted before construction progressed. NWF argued that construction of the powerplant violated the National Environmental Protection Act (NEPA) and the Fish and Wildlife Coordination Act (FWCA). The lawsuit's overriding issue revolved around operation of the powerplant as opposed to its construction. As a result of the lawsuit, the judge issued an order on June 21, pending Congressional authorization of the powerplant, curtailing all further construction activities on the project. Reclamation suspended the contractor's construction operations June 29.[34]

Congress never approved construction of a twenty-three-megawatt powerplant at Navajo Dam and on September 29, 1981, the Federal Energy Regulatory Commission (FERC) granted a

34. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XVIII, 1973, 1974, 1975, 236; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XIX, 1976, 1977, 1978, 3, 23, 88-109.

preliminary permit to the City of Farmington, New Mexico for construction of a powerplant at Navajo Dam. As the beneficiaries of a Reclamation powerplant at Navajo Dam, the Navajo Nation objected to Farmington's application for a license. The Navajo Nation contended that private development of the powerplant, with the subsequent loss of power needed by the NIIP, would deprive the Nation of the full benefits of the NIIP by jeopardizing their ability to fully develop their farming operations. At the time a contract with the CRSP provided the power necessary for the NIIP, however the Navajo Nation felt that as development of the NIIP continued power requirements would exceed the present allocation. In response to the Navajo Nation's protest the City of Farmington prepared an appendix to their license application. The appendix concluded that the loss of benefits claimed by the Navajo Nation represented merely a potential loss of benefits as long as construction of the powerplant remained unauthorized by Congress. The Navajo Nation filed another appeal in protest. In April of 1986, the City of Farmington and the Navajo Nation reached a landmark agreement and the Navajo Nation agreed to drop their license appeal before the FERC. On March 25, 1986, the United States issued a contract authorizing preconstruction, construction, and operation and maintenance of a hydroelectric powerplant at Navajo Dam to the City of Farmington. Reclamation sent a letter, on October 20, 1986, to FERC granting the city permission to begin construction. On October 24, 1986, FERC authorized the city to commence construction of a thirty-megawatt hydroelectric powerplant at Navajo Dam.[35]

On March 4, 1977, at approximately 8:00 p.m., a minor earthquake occurred southeast of Farmington, New Mexico; areas near Aztec, New Mexico, and Bloomfield and Durango,

35. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XXIII, 1982, 16; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XXVIII, 1987, 137-42.

Colorado, felt the quake. The quake measured 4.5 on the Richter Scale. On March 7, Reclamation officials made a complete inspection of the Navajo Dam, including the outlet works, penstock, and NIIP headworks. The quake did not cause any noticeable damage to the structures or the dam.[36]

In 1983, Reclamation conducted a Safety Evaluation of Existing Dams (SEED) inspection on Navajo Dam. The report concluded that open horizontal and vertical joints in contact with the embankment core material probably existed. The embankment contains an erodible core material. The potential exists for uncontrolled seepage along the embankment-abutment contact sufficient to produce piping of the embankment core material through open joints and cracks in the rock abutment, resulting in dam failure. The dam is in no immediate danger of failure, however current conditions, especially with regard to seepage, warrant corrective actions in the immediate future. Based on the conclusions reached in the SEED report, Reclamation proposed modifying the structure by constructing a concrete diaphragm cutoff wall in the left abutment and a tunnel drainage system in the right abutment.

On September 26, 1986, Reclamation awarded a contract to Solentanche and Radio, Inc., from Arlington, Virginia, for construction of a diaphragm wall in the left abutment. Made of concrete, the diaphragm wall was cut into the center of the left abutment. Reclamation held a preconstruction meeting October 22, at the Reclamation office in Cortez, Colorado, to finalize construction operations.

Solentanche Enterprise, in France, built the excavation machine (hydrofraise) that the contractor used to cut large rectangular holes in the left abutment which could then be filled with

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36. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XIX, 1976, 1977, 1978, 2.

concrete, creating a diaphragm wall. At the same time in New Mexico, the contractor assembled the guide walls, the bentonite slurry plant, and began construction on the work platform. Prior to transferring the hydrofraise to New Mexico, Solentanche conducted two excavation tests, between December 10 and 15, at their main yard in Montereau, France, located fifty miles south of Paris. The hydrofraise excavation machine excavated to a depth of 400 feet. Grouting operations took place several days later. Solentanche performed a second excavation test the following January of 1987.

Solentanche and Radio, Inc. began construction of the work platform on the crest of the dam in February of 1987. Initial work consisted of constructing a concrete diaphragm wall inside the left abutment of the dam. The diaphragm wall eliminated seepage that could potentially damage the core of the dam. In April, Solentanche completed assembling the Manitowac 4100W crane, the hydrofraise, the batch plant, and the de-sander. The contractor completed the diaphragm wall modification work on September 16, 1988.

The concrete diaphragm wall consists of a forty-inch wide wall extending from the left abutment wall into the dam; it varies in depth from 110-feet to 399-feet. Extending into the foundation rock below the dam, it cuts-off water seeping below the dam's contact point with the underlying foundation.

On February 20, 1987, Reclamation awarded the contract for the right abutment drainage tunnel to Frontier Kemper Construction, of Evanston, Indiana. Controlling the drainage and seepage at the right abutment required extensive work. Construction of about 1,200 feet of a modified horseshoe shaped tunnel with a drilling chamber and a portal structure. Drilling, grouting, and installing drainpipe in two drilled test holes. Work included, fabrication and

installation of forty-four abutment drains from within the tunnel, ranging in length from about 113-feet to 615-feet. Workers also replaced the right abutment groin drain with a two buried drainpipes about 1,000-feet long with filter and bedding materials and inspection wells. In addition, the contractor built a 600-foot long paved access road to the tunnel.

During drilling the drillers broke into a wet layer of permeable rock, causing sudden inflows of water. The inflows, predicted prior to the start of construction, were under substantial pressure. Reclamation's engineers and geologists determined that the drillers penetrated an ancient stream bed, layered with fine sands, within the abutment. As a result the stream bed served as an excellent drain field for the drill holes. The remaining construction activities passed without incident and the contractor finished construction of the right abutment drain tunnel in October of 1988.

The drainage holes collect water seeping through the right abutment rock. The drainage holes capture the water and discharge it a safe distance from the dam by the drain tunnel. In addition, flow from the tunnel abutment drains is collected and channeled into a collector drain and an outfall drain. Reclamation continues to monitor and record these flows.

On December 1, 1988, Reclamation transferred all of the modifications necessitated by the SEED report of 1983 from construction to operation and maintenance status. The transfer of the modified features to O&M status marked the end of construction activities on Navajo Dam.[37] In 1998, Reclamation preformed a CFR and Rick Analysis study on the structure.

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37. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XXV, 1984, 83; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XXVI, 1985, 18; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XXVII, 1986, 11; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XXVIII, 1987, 2, 12; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XXIX, 1988, 2-3, 13.

Per an agreement with Reclamation, the National Park Service took responsibility for modifications to the recreation areas at Navajo Reservoir. NPS contracted for construction of access roads, a boat launching ramp, and other facilities at the Pine River Recreation Site in 1962. NPS also oversaw construction of a Visitor's center which they subsequently turned over to the New Mexico State Park and Recreation Commission in 1966. During 1966, the NPS also started construction on the Sims Mesa Recreation Site.

In April of 1963, Reclamation and agencies of the State of New Mexico signed a memorandum of agreement turning administration of recreation and fish and wildlife aspects of Navajo Reservoir over to the State Agencies. Reclamation executed a similar agreement in July of 1964, with the State of Colorado, Department of Game Fish and Parks, for development and administration of the lands of Navajo Reservoir within Colorado. The State of New Mexico made various improvements to the recreation areas during the next few years. On January 14, 1972, the NPS transferred administration and development of recreation and fish and wildlife to the New Mexico State Park Commission.

Prior to October 1, 1976, the Durango Field Division Office, Western Colorado Projects Office, handled administration of Navajo Dam and Reservoir. In October of 1976, Reclamation transferred administration of Navajo Dam and Reservoir, including the recreation and lands, to the CRSP Power Operations Office in Montrose, Colorado. The transfer of the recreation and lands portion of the project resulted in some communication difficulties for the numerous state and private entities involved in activities around the reservoir. To solve the communication problems, Reclamation transferred the recreation and lands administration responsibilities back to the Durango Projects Office on October 1, 1978. Operation of the dam and appurtenant

structures remained the responsibility of the Montrose CRSP Power Operations Office. In March of 1985, Reclamation transferred the remaining responsibilities for Navajo Dam and Reservoir and appurtenant structures back to the Durango Projects Office. Reclamation transferred operation of the NIIP headworks to the BIA in April of 1988.[38] As of January of 1998, management of the Navajo Unit, CRSP resided with the Western Colorado Area Office in Grand Junction, Colorado, and handled through the Southern Division office in Durango, Colorado.

Settlement of the Project

Development of the Navajo Unit did not include project lands. However, the Navajo Unit serves about 137,000 acres of irrigable Indian lands of the Navajo Nation, developed by the Navajo Indian Irrigation Project.

Though project waters serve its lands, the NIIP is not responsible for repayment of construction costs incurred for the Navajo Unit. Under existing law, the Secretary of the Interior, has the authority to construct Indian irrigation projects and levy construction costs against the lands benefitted. In addition, revenues derived from the sale of power at the other three CRSP Units—Flaming Gorge, Glen Canyon, and Wayne Aspinall—are placed in the Colorado River Basin Fund; a portion of the repayment of the Navajo Unit comes from this

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38. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume VII, 1962, 2; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume VIII, 1963, 7; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume IX, 1964, 7, 23; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XIV, 1969, 6; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XV, 1970, 5; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XVII, 1972, 4; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XIX, 1976, 1977, 1978, 2; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XXVI, 1985, 11; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XXIX, 1988, 2.

fund.[39]

Uses of Project Water

Reclamation constructed the Navajo Dam primarily to regulate and store waters of the San Juan River, to provide an irrigation supply for the NIIP and to satisfy power revenue requirements at Glen Canyon Dam. Water releases from Navajo Reservoir satisfy downstream requirements and power production requirements at Glen Canyon Dam. Additional municipal and industrial (M&I) uses take about 67,550 acre-feet of water annually.

Navajo Reservoir provides recreation opportunities for local Colorado and New Mexico residents.[40] The project recorded 448,793 visitor days in 1993.

Conclusion

The Navajo Unit, a unit of the Colorado River Storage Project, helps to manage the water resources of the Upper Colorado River Basin. By providing irrigation waters for lands on the Navajo Indian Irrigation Project, the Navajo Unit helps to meet irrigation requirements for the Navajo Nation, while at the same time allowing the Secretary of the Interior to maintain trust responsibilities to that nation. In addition, water releases help to maintain a continuous flow of water for power generation at Glen Canyon Dam. Although an unusual unit of CRSP, because it does not generate hydropower revenues to assist in Upper Basin development, the Navajo Unit provides much needed resources to the region.

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39. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XII, 1967, 26; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XIV, 1969, 14.

40. "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XIV, 1969, 23; "Annual Project History, Navajo Unit, Colorado River Storage Project, Colorado-New Mexico," Volume XV, 1970, 19.

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Bibliography

Archival Collections

Denver Colorado. National Archives and Records Administration: Rocky Mountain Region. Records of the Bureau of Reclamation. Record Group 115.

_____, "Annual Project History, The Navajo Unit, Colorado River Storage Project, New Mexico-Colorado," 1956-1988.

Government Documents

United States Department of Interior, Water and Power Resources Service. *Project Data*. Denver: U.S. Government Printing Office, 1981.

United States Department of the Interior, Bureau of Reclamation. *Navajo Dam and Reservoir: Technical Record of Design and Construction*. Denver: U.S. Government Printing Office, 1966.

United States Department of the Interior, Bureau of Reclamation. *Repayment of Reclamation Projects*. Washington, D.C.: U.S. Government Printing Office, 1972.

United States Department of the Interior, Bureau of Reclamation. *Vibration of Navajo Dam Following a Subsurface Nuclear Blast*. By George C. Rouse, and Louis H. Roehm. Denver: Dams Branch, 1969.

Articles

Seery, J. D. "Navajo Dam." *The Reclamation Era* 47, No. 1 (February 1961): 13-6, 25.

Simison, Herbert E. "Action on the San Juan River." *The Reclamation Era* 46, No. 1 (February 1960): 8-12.

Books

DeMark, Judith Boyce ed. *Essays in Twentieth-Century New Mexico History*. Albuquerque: University of New Mexico Press, 1994.

Hundley, Norris, jr. *The Great Thirst: Californians and Water, 1770s-1990s*. Berkeley: University of California Press, 1992.

Reisner, Marc. *Cadillac Desert: The American West and Its Disappearing Water*. New York: Viking, 1986; reprint Viking Penguin, 1993.

Simmons, Marc. *New Mexico: A Bicentennial History*. New York: W. W. Norton and Company, Inc., 1977.

Sturtevant, William C., ed. *Handbook of North American Indians*. Vol. 9, *Southwest*, Alfonso Ortiz, ed., Washington, D.C.: Smithsonian Institution, 1979.

Sturtevant, William C., ed. *Handbook of North American Indians*. Vol. 10, *Southwest*, Alfonso Ortiz, ed., Washington, D.C.: Smithsonian Institution, 1983.

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