

The Boysen Unit
Boysen Division
Pick-Sloan Missouri Basin Program

Wm. Joe Simonds
Bureau of Reclamation History Program
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The Boysen Unit

The key to successful settlement and development in the West is a secure and reliable source of water. Nowhere is this more true than in the arid regions of central Wyoming where rivers which run full and fast with the spring run-off dwindle to a trickle in late summer and early fall. To ensure success in such a region, construction of storage reservoirs to trap spring floods for use in the dry months of late summer is paramount. One such development which provides multiple benefits to the citizens of central Wyoming is the Boysen Unit of the Pick-Sloan Missouri Basin Program.

Project Location

The Boysen Unit is located on the Big Horn River in Fremont County in central Wyoming. Boysen Dam, Powerplant and Reservoir are located on the Big Horn River about twenty miles south of Thermopolis. The unit provides power, flood control, sediment retention, and fish and wildlife enhancements. Water stored in Boysen Reservoir is released for use in the Owl Creek and Hanover-Bluff Units of the Pick-Sloan Missouri Basin Program. In addition, water stored in Boysen Reservoir is released to satisfy downstream water rights allowing upstream users water for irrigation through an exchange program.¹

Historic Setting

Wyoming as always been a region of wide open spaces and sparse populations. Evidence indicates that the first humans to inhabit the region were small bands of Paleo-Indian hunters who tracked and killed ancient mammoth and bison. In more recent times, Wyoming has been home to several different aboriginal groups, including Shoshone, Crow, Arapaho, and Cheyenne Indians, as well as some Oglala and Brulé Sioux.

1. United States Department of the Interior, Water and Power Resources Service, *Project Data*, (Denver: U.S. Government Printing Office, 1981), 809-11.

From the time the first Anglos, probably French-Canadian trappers, entered the area, the region that became Wyoming has been claimed by several nations, including France, Spain, Texas, Great Britain and Mexico. The Wyoming Territory was formed from parts of the Louisiana Purchase, Oregon and Utah Territories, and Texas. Wyoming became the 44th state in July 1890.²

Some of the first settlement in the region of the Boysen Unit took place in the early 1870s along Owl Creek, northwest of the Boysen Reservoir site. Beginning around 1880, cattle ranching became a primary economic activity in the area with some herds as large as 60,000 head. Along with the growth of the cattle industry, irrigated agriculture began to take hold. The first water rights date to the 1880s, and by the early 1900s, the area irrigated was greater than available water could cover, forcing area water users to look for alternative water supplies.³

In 1908, a Wyoming businessman named Asmus Boysen constructed a concrete slab and buttress dam on the Big Horn River to operate a small hydroelectric plant which supplied the towns in the area. After about 15 years of operation, the dam silted in and was breeched and abandoned. Several surveys were conducted in 1916 and 1917 to investigate the possibility of constructing irrigation works, but these studies concluded that the potential for irrigation was limited and no further investigations were carried out until the 1930s when the U.S. Army Corps of Engineers began conducting surveys in the Big Horn River Basin. The Corps report pointed to the benefits of constructing a dam on the Big Horn River, including flood control, silt retention, water conservation, and hydropower. In 1941, the Bureau of Reclamation studied the area as part of its investigations in the Big Horn and Wind River Basins. Reclamation's report,

2. Rand McNally & Company, *The New Rand McNally World Atlas*, (Chicago: Rand McNally & Company, 1985), 196-197; T. A. Larson, *Wyoming, A Bicentennial History*, The States and Nation Series, (New York: W. W. Norton & Company, 1977), 3-5.

3. United States Department of the Interior, Bureau of Reclamation, *Technical Record of Design and Construction, Anchor Dam*, (Denver: US Government Printing Office, 1962), 1, 6.

published in 1942, became the basis for the inclusion of the Boysen Unit in the Missouri River Basin Project.⁴

Project Authorization

The Boysen Unit was authorized as part of the Missouri River Basin Project by the Flood Control Act of 1944. The 1944 Act authorized the development of the Missouri River Basin through a joint program of the Bureau of Reclamation and the US Army Corps of Engineers. The name of the project was later changed to the Pick-Sloan Missouri Basin Program in honor of the men who designed the program: Major General Lewis A. Pick of the Corps of Engineers, and William G. Sloan of the Bureau of Reclamation.⁵

Construction History

Before construction of Boysen Dam and Powerplant could begin, there was a significant amount of preliminary construction that had to be completed. Among the items to be completed were a government camp, including houses, an office building and warehouse, water and sewage system, streets and electrical distribution system. Several contracts were let for this work. Contracts for construction of the warehouse and camp facilities were let to Charles W. Smith of Thermopolis, Wyoming, who bid \$112,382 for the camp contract and \$35,407 for the warehouse contract. Construction of the camp buildings was awarded to Dawson, Corbet and Shelf, of Rawlins, Wyoming, which bid \$203,815 for the contract. The low bid of \$29,536 for construction of the transmission and distribution system was submitted by S. H. Reither of Aitkin, Minnesota.

Construction of the transmission and distribution system began September 9, 1946, and was completed in early February 1947. Work on the warehouse began August 22, 1946. By

4. United States Department of the Interior, Bureau of Reclamation, *Technical Record of Design and Construction, Boysen Dam and Powerplant*, (Denver: US Government Printing Office, 1957), 1, 4.

5. *Project Data*, 777; William E. Warne, *The Bureau of Reclamation*, (Boulder: Praeger Publishers Inc., 1973; reprint, Boulder: Westview Press, 1985), 162.

December 31, all of the preparation and foundation work was complete, but the Government supplied steel for the building had not been delivered. The first delivery of steel arrived at the site on April 1, 1947, but the final shipment did not arrive until August 5. The building was completed August 14. Because of delays beyond the contractor's control, the contract period was extended 143 days without penalty to the contractor.⁶

Charles W. Smith began construction of the camp facilities on July 13, 1946, six weeks prior to receiving the official notice to proceed. Construction continued until mid-November when work was suspended for the winter. Work resumed on April 16, 1947, and continued until completed on October 6. Under the original terms of the contract, the contractor had 135 days to complete the work. But due to delays in deliveries of Government supplied materials and a significant change in the water treatment and supply system, the contractor was allowed an additional 104 days to complete the work without penalty.⁷

Work on the camp buildings began in March 1947. The terms of the contract called for the completion of the office building by August 8, and the remainder of the camp by December 6. But as with the other contracts, deliveries of supplies were delayed, pushing the completion dates back by several months. In addition, a carpenters strike contributed to the delays. The office building was completed June 11, 1948, and the rest of the camp was completed by early August. Because of delays beyond the contractor's control, 192 days were added to the contract. But it was determined that some of the delay was the fault of the contractor, and \$870.00 was withheld from the final payment as liquidated damages. The total

6. *Technical Record of Design and Construction, Boysen Dam and Powerplant*, 148-151; Denver, National Archives and Records Administration, Rocky Mountain Region, Record Group 115, Entry 10, Records of the Bureau of Reclamation, "Annual Project Histories: Boysen Unit, Missouri River Basin Project," Vol I, 1946, 6-7 (hereafter cited as "Project History, with volume number, year and page).

7. *Technical Record of Design and Construction*, 149.

contract cost was \$221,773, almost ten percent higher than the contractor's bid of \$203,815.⁸

Because Boysen Reservoir would inundate sections of U.S. Highway 20 and the Chicago and North Western Railroad, it was necessary to relocate those sections out of the reservoir area. The contract for the relocation of Highway 20 was awarded to the Gibbons and Reed Company of Salt Lake City. The contractor received notice to proceed on September 16, 1946, and was given 360 days to complete the work. Work began in late September and was halted due to severe weather on December 17. Work resumed on April 16, 1947, and by September 3, the work was sufficiently complete to allow traffic over the relocated section. Delays in deliveries of Government supplied materials and a major land slide in one section delayed final completion of the work. The contractor was awarded an addition 90 days for completion of the contract without penalty. The final contract price was \$1,006,103, more than \$250,000 over the contractor's winning bid.

The contract for the relocation of tracks of the Chicago and North Western Railroad was awarded to Peter Kiewit Sons' Company of Sheridan, Wyoming, on July 23, 1951, almost four years after construction of the dam and powerplant began. Kiewit received notice to proceed on August 13, and all work was completed in mid-July 1952. In addition to relocation of the Chicago and North Western tracks, a section of the Chicago, Burlington and Quincy Railroad had to be relocated, but this was covered under the contract for construction of the dam and powerplant.⁹

Bids for the construction of Boysen Dam and Powerplant and the relocation of the Chicago, Burlington and Quincy Railroad were opened on August 20, 1947. The contract was awarded to Morrison-Knudsen Company, Inc., of Boise, Idaho, the principal contractor in a joint

8. *Ibid.*, 150-1.

9. *Ibid.*, 143, 149-50, 153-4.

venture which included the Raymond Concrete Pile Company of New York, Peter Kiewit Sons' Company, Finlen and Sheridan Contracting Company of Butte, Montana, General Construction Company of Seattle, S. Birch & Sons Construction Company of Great Falls, Montana, and the Shea Company of Los Angeles. The winning bid was \$13,899,999. The contract called for construction of the dam and powerplant, relocation of nearly 14 miles of railroad, and construction of a 7,131-foot long tunnel. The existing railroad ran through much of the reservoir area and through the damsite. A short tunnel through the right abutment at the damsite was abandoned following completion of the relocation. Reclamation designers were able to incorporate the abandoned tunnel into the outlet works system to house the power penstock and outlet pipe.¹⁰

Because much of the work on the dam and powerplant could not be carried out until the railroad was relocated around the damsite, the contractor began work on the relocation immediately, starting work even before receiving the official notice to proceed. Work began on the cut-and-cover section of the railroad tunnel on September 16, 1947. Notice to proceed was issued on September 29. Excavations for the tunnel portals began on October 1. Work also began on the contractors camp adjacent to the government camp which was being constructed by Government forces. When completed, the camps included houses, offices, warehouses, shops, and a school for children of both the contractor's and Reclamation's employees. By the end of 1947, the camps were complete, and stripping for the spillway, outlet works, and diversion channel, and excavation of the railroad tunnel were well advanced.¹¹

Excavation for the spillway and cut-off trench began in February 1948. The cut-off trench was excavated as much as 70 feet to bedrock and was 50 to 80 feet wide. A concrete cut-

10. *Ibid.*, 48-50, 143; "Project History," Vol II, 1946, 25.

11. "Project History," Vol. II, 1947, 25-8.

off wall between 5 and 10 feet high, was constructed at the bottom of the trench. Excavation of the diversion tunnel began in February 1948, and continued throughout the year. Track laying on the railroad relocation began in May, and concrete lining of the railroad tunnel began in June. By the end of 1948, most of the excavation work had been completed except in the outlet works and powerhouse areas. Work there was on hold until completion of the railroad relocation. A small amount of concrete had been placed in the footings for the spillway before the cold weather set in, forcing a halt to concrete operations.¹²

Concrete placements in the spillway resumed in March of 1949. On March 2, a rock slide destroyed portions of one of the railroad tunnel portals, forcing Reclamation to redesign the portal to prevent further earth movement. On April 1, the contractors concrete batch plant was destroyed by fire, and concrete operations were delayed until a new plant was constructed. Concrete operations resumed in early May. The diversion tunnel was holed through on May 24, and concrete lining began in August. Placement of embankment materials began in November with placements in the upstream cofferdam which would later be incorporated into the main dam. November also saw the completion of the diversion tunnel and spillway stilling basin. The river was diverted through the diversion tunnel on December 23.¹³

With the river successfully diverted, final excavation of the cut-off trench and completion of the cut-off wall through the old river channel could begin. Placement of embankment materials in the main portion of the dam began in March. The cut-off trench and cut-off wall were completed in late May of 1950, and backfilling of the trench began in June. The trench was backfilled with impervious materials which were spread by bulldozers and scrapers and compacted into 6-inch layers by a several passes of a sheepsfoot roller. Lining of the railroad

12. *Ibid.*, Vol. III, 1948, 18-19: *Technical Record of Design and Construction*, 6 (drawing), 178-9, 190.

13. *Technical Record of Design and Construction*, 179, 190, 216.

tunnel was completed in May, and the relocation was completed sufficiently to allow rail traffic over the new section in late August. Trains began regular travel over the newly completed section on September 5, 1950.¹⁴

With the completion of the railroad relocation, it was possible to continue work on the outlet works and powerhouse. Clean up and removal of the old track began immediately and construction of the outlet works/penstock trashrack began. The first sections of the penstock were placed in the old railroad tunnel in November of 1950, and excavations for the powerhouse moved forward at a rapid pace.¹⁵

The first bids for clearing the reservoir area were opened in early September of 1950. The work was advertised under three separate specifications with a total of eight companies receiving contracts: Asbell Brothers Construction, Lichty Construction Company, and Brasel and Whitehead, all from Riverton, Wyoming; Albert M. Conrad of Big Piney, Wyoming; Watkins and Pennington of Fort Collins, Colorado; C. L. Hubner Company of Denver; Mid-States Construction Company of Chisholm, Minnesota; and Lindquist, Olson and Company of Cambridge, Minnesota. Work under the first contract began in October of 1950, and the final contract was completed in October of 1951. The total contract cost for clearing the reservoir site was just over \$637,000.¹⁶

Concrete placement in the powerhouse foundation and substructure began on February 16, 1951. At the same time, the penstock and outlet pipe sections which had been installed in the abandoned railroad tunnel, were encased in concrete. In March, installation of the spillway gates, ring-seal gates in the powerhouse, and the outlet pipes was completed.

14. B. B. Kepford, "The Boysen Dam Project in Wyoming," *Western Construction*, July 1951, 78; United States Department of the Interior, Bureau of Reclamation, *Dams and Control Works*, 3rd ed., (Washington: United States Government Printing Office, 1954), 128-130; "Project History" Vol V, 1950 vi, 26, 29, 32, 35.

15. *Technical Record of Design and Construction*, 179-81; "The Boysen Dam Project."

16. *Technical Record of Design and Construction*. 151-3.

During April and May, concrete placement in the powerhouse structure was accelerated to bring the structure up to a level above the level of the spring floods. In May, most of the embedded portions of the turbines, including the spiral cases and draft tube lines were set in place. In June, the ring-seal gates were encased in concrete, and the trashrack structure was completed. In July and August, concrete placement around the spiral cases was complete, as was most of the concrete placement in the powerhouse walls, and the 60-ton crane was installed in the power house.¹⁷

On July 23, 1951, Reclamation awarded the contract to complete Boysen Dam, Powerplant, and Switchyard, to Flora Construction Company and Flora Engineering Company of Denver. The contract covered installation of the non-embedded portions of the turbines, the generators, governors, and completion of the powerhouse and switchyard. The winning bid was \$413,377. The turbines were supplied by the Newport News Shipbuilding and Dry Dock Company of Newport News, Virginia; the governors by the Woodward Governor Company of Rockford, Illinois; and the generators by the Westinghouse Electric Corporation of Denver. The cost for the units was \$258,000 for the turbines, \$41,396 for the governors, and \$305,105 for the generators.¹⁸

The embankment was topped out in July, and the last of the embankment material was placed in August. On October 11, the diversion tunnel was plugged, and storage of water in Boysen Reservoir began. The primary contractor completed work on the powerhouse in early December, and all work under the Morrison-Knudsen contract was accepted as complete on February 16, 1952. The final contract cost was \$18,476,405, almost \$4,500,000 more than the original contract bid.¹⁹

17. *Ibid.*, 190, "Project History," Vol. VI, 1951, xii-viii.

18. *Technical Record of Design and Construction*, 155, 204.

19. *Ibid.*, 143, 225.

The contractor for the completion contract began moving equipment and material into the area in late August of 1951, and began work in the switchyard area in September. Work was concentrated on the switchyard area through the end of 1951 and into 1952 while Morrison-Knudsen completed work under the primary construction contract. Installation of the non-embedded portions of the turbines began in mid-January, and the rotors were set into place in March. By mid-July, the units were ready for testing.

Testing of the generating units began in July of 1952. During the bearing-run test for unit No. 2, difficulty was encountered trying to keep the unit at the proper speed. In addition, a slight noise was heard coming from the turbine pit. The unit was shut down and inspected. It was discovered that the turbine runner had shifted slightly and was contacting other parts of the unit. The problem required that the unit be disassembled and repaired. The turbine runner was sent to the General Iron Works in Denver for repairs and the unit was modified to prevent a repeat of the problem. In addition, Unit No. 1 was modified to avoid the same problem.

The bearing run test on Unit No. 1 began on July 26, and was completed the following day. After additional testing, the unit was placed into service on August 11, 1952. The overhaul of Unit No. 2 was completed in late August, and testing began on August 29. Testing of the unit was completed on September 8, at which time the unit was placed in service. Unit No. 1 was removed from service on September 24, 1952, so that efficiency testing could be conducted by Westinghouse testing engineers. During testing on September 26, smoke was detected coming from the unit, and inspection showed that a section of one of the stator coils had burned. It was believed that a discarded screw had become lodged in the unit during assembly and had come loose during the test and caused the fire. The unit was repaired by Westinghouse and returned to service. All work under the completion contract was accepted as complete on November 5, and

the project was transferred to operation and maintenance status on January 1, 1953.²⁰

Boysen Dam is a rock and earthfill structure 220 feet high, 1,143 feet long, and containing 1,527,000 cubic yards (cy) of material. The outlet works consist of a 66-inch diameter outlet pipe and a 57-inch diameter penstock bypass pipe. Each are controlled by a 48-inch hollow-jet valve. The capacity of the outlet works is 1,300 cubic feet per second (cfs). The spillway is concrete lined chute on the right abutment controlled by two 30-by 25 foot radial gates. The maximum capacity of the spillway is 25,000 cfs. Boysen Reservoir has a maximum capacity of 1,493,000 acre-feet (af) with a normal operating capacity of almost 820,000 af. The reservoir covers more than 30,750 acres at maximum capacity.

Boysen Powerplant houses two 7,500 kW generating units. Each generator is driven by a 10,500 horsepower (hp) Francis-type turbine. The total rated capacity of the facility is 15,000 kW. Water is supplied to the turbines by a 15-foot diameter steel penstock which splits in to two 10 ½-foot penstocks immediately upstream from the turbines.²¹

Post Construction History

Since its completion in the early 1950s, the Boysen Unit has operated without significant problems or modifications. A thorough maintenance program ensures that both the dam and powerplant will continue to operate without problems well into the next century.

Settlement of Project Lands

The Boysen Unit provides no direct irrigation benefits and no lands were withdrawn for future settlement. Water stored in Boysen Reservoir helps stabilize existing settlement and sufficient surplus is available to help with future settlement in the region.

Project Benefits and Uses of Project Water

20. *Ibid.*, 147, 210-1; "Project History," Vol. VII, 1952, vii, 29.

21. *Technical Record of Design and Construction*, frontispiece; *Project Data*, 812-3.

The primary benefits of the Boysen Unit are power generation, flood control, recreation, and fish and wildlife enhancements. There are also irrigation benefits realized from the operation of the unit, but not directly. Power generated by Boysen's two, 7,500 kW generators is fed into the transmission system of the Pick-Sloan Missouri Basin Program for distribution to the Program's Western Division. The Boysen Unit also plays an important role in flood control along the Big Horn River. Over 670,000 af of Boysen Reservoir's total capacity is available to help control and reduce floods, with an additional 150,000 af of storage available in emergency situations. In 1997, the most recent reporting year, flood control operations at Boysen Reservoir prevented an estimated \$19,478,000 in damage along the Big Horn and Missouri Rivers. Since its completion, Boysen Reservoir has prevented almost \$70,000,000 in damage from flooding.²²

Boysen Reservoir is a popular recreation area, annually hosting thousands of visitors who enjoy camping, fishing, swimming, and boating at the site. Recreational activities at Boysen Reservoir are administered by Wyoming Division of State Parks and Historic Sites and the Wyoming Game and Fish Department.²³

The irrigation benefits provided by the Boysen Unit are indirect. Water stored in Boysen Reservoir is released into the Big Horn River for use on lands in the Owl Creek and Hanover-Bluff Units. Just over 7,400 acres in the Hanover-Bluff Unit and 2,300 acres in the Owl Creek Unit receive water from Boysen Reservoir. In addition, water users upstream from Boysen Reservoir are now able to divert water for irrigation purposes without interfering with rights of down stream users. Water stored in Boysen Reservoir can be released to fulfil the rights of

22. *Technical Record of Design and Construction, Boysen Dam and Powerplant*, 29; United States Department of the Interior, Bureau of Reclamation, *Future Generations: A New Era of Power, Performance, and Progress*, (Denver: US Government Printing Office, 1998), GP-C1; Memorandum, Dan Jewell, Group Leader, Water Resources Services Group, to Assistant Commissioner - Resources Management, "1997 Flood Control Operations and Benefits - Great Plains Region: 1997 Flood Prevention Benefits Report, Wyoming Area Office," 20 February 1998.

23. United States Department of the Interior, Bureau of Reclamation, *1992 Summary Statistics, Water, Land, and Related Data*, (Denver: US Government Printing Office, [1995]), 111, 116; "Boysen," <<http://commerce.state.wy.us/sphs/boysen.htm>>, June 1, 1999.

downstream users. In 1992, more than 49,000 acres of land benefitted from the operation of Boysen Reservoir.²⁴

Conclusion

When Boysen Dam and Reservoir were completed in 1952, they ranked among the ten largest earthfill dams, and the ten largest reservoirs constructed by Reclamation. In subsequent years, newer and larger dams and reservoirs have pushed Boysen into relative obscurity. But the multiple benefits which the dam, reservoir, and powerplant provide combine to place the Boysen Unit among the most successful Reclamation projects. And those benefits; flood control, long-term water storage, and recreation, will ensure the continued success of the project.

About the Author

William Joe Simonds was born and raised in Colorado and has a clear understanding of the importance of water in the American West and its influence on the development of that region. He attended Colorado State University where he received a BA in History in 1992 and a Masters in Public History in 1995. He lives with his wife and two children in Fort Collins, Colorado.

24. 1992 Summary Statistics, 284; Project Data, 809, 812.

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