Palisade Project

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The Palisades Project

The first use of irrigation in the upper Snake River region of eastern Idaho began in the early 1870s when the first settlers, immigrants from Utah, began farming the area near Rexburg and Blackfoot. By the turn of the century, over 500,000 acres of land were under irrigation, with the amount of irrigated acreage growing steadily. Following the passage of the Reclamation Act of 1902, the United States Reclamation Service[1] constructed four projects to help meet the needs of water users in eastern Idaho. These projects, Lake Walcott, constructed in 1909, Jackson Lake, constructed in 1916, American Falls, constructed in 1927, and Island Park, constructed in 1938, failed to quench the growing thirst for water along the upper Snake River. A period of drought in the early 1930s combined with growth in population and industry increased the need for additional water storage on the river. It was this need that led to creation of the Palisades Project.[2]

Project Location

Palisades Dam, Reservoir, and Powerplant is located on the south fork of the Snake River about 55 miles southeast of Idaho Falls, Idaho. The dam is located at Calamity Point, about 11 miles west of the Idaho\Wyoming border, and the reservoir extends up the Snake River into Wyoming. The area above Palisades Dam drained by the Snake River is approximately 5,200 square miles with an average annual runoff of over 4,800,000 acre/feet (af). Water from the project is used for supplemental irrigation of 670,000 acres of land located in the Minidoka and Michaud Flats Projects, located west and northwest of the Palisades Project.[3]

The waters of the Snake River begin their journey to the Pacific Ocean in the southwestern part of Yellowstone National Park at an elevation of nearly 10,000 feet. The river flows through Wyoming for about 130 miles before turning west into Idaho. Palisades Dam is located at Calamity Point, a large mass of rock that creates a narrow constriction where the

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1. The United States Reclamation Service was renamed the Bureau of Reclamation in 1923.
2. Denver, Colorado. National Archives and Records Administration: Rocky Mountain Region. Records of the Bureau of Reclamation. Record Group 115. "Project Histories: Palisades Project," 1951, Vol. I, pg. 14-8(hereafter referred to as "Project History: Palisades Project" with volume number, year, and page number).
3. United States Department of Interior, Water and Power Resources Service, *Project Data*, (Denver: US Government Printing Office. 1981), 745,748.

valley walls rise over 1,000 feet above the valley floor.[4]

Historic Setting

Pre-History

Idaho is a land of striking contrasts: high mountain ranges tower over broad plains, deep river canyons cut through massive plateaus and dense evergreen forests border great sagebrush deserts. Gradual geologic and climactic change, sometimes punctuated by massive flooding or catastrophic volcanic eruptions, shaped the face of the landscape. Continental ice sheets advanced into the northern regions before retreating back into Canada leaving numerous glacial lakes and cutting deep canyons through the mountains. Cutting through the southern portion of the state, a wide flat plain separates the mountains of the southeast from those in the north. Winding through this plain is the powerful Snake River.

More than 14,000 years ago, Idaho was inhabited by a race of people who hunted big game and gathered fruits and vegetables. The land received a great deal more rain and snow than it does now and game, mostly pre-historic elephants and bison, was abundant on the grass-covered plains. About 10,000 years ago, the climate began to change. Temperatures rose and the grass-covered plains gradually turned into sagebrush deserts. The game moved on to less arid regions, and many of the inhabitants of the region moved with them. Those who stayed became more dependant on small game, roots, and berries for their survival.

About 4,500 years ago, the climate began to change again, becoming cooler. The inhabitants of the mountains and valleys began to build pit houses for protection and developed a pattern of movement from the plains to the mountains in the summers and back to the plains when winter arrived. They continued to survive on fruits and berries and small game and fish, especially salmon, which were abundant in the rivers and streams. About 1,200 years ago, pottery became common, and the southern desert peoples made baskets that could be used for cooking as well as gathering seeds and berries.

The prehistoric inhabitants of Idaho survived for hundreds of generations by adapting and

4. United States Department of Interior, Bureau of Reclamation, *Technical Record of Design and Construction: Palisades Dam and Powerplant*, (Denver, Colorado: Bureau of Reclamation, 1960), 3.

developing new ways of living in their ever changing environment. By the dawn of the eighteenth-century, on the eve of European contact, there were six major aboriginal groups in Idaho. The Nez Perce, Coeur d'Alene, Pend d'Oreille, and Kutenai lived in the forests and along the rivers of the northern mountains, while the Northern Shoshoni and Northern Paiute lived and hunted on the plains of the northern Great Basin which extend into southern Idaho.[5]

History

The native peoples of Idaho would feel the impact of European invasion long before making actual contact with white explorers. Through their trading contacts with the Comanche, who traded with the Spanish in New Mexico, the Shoshoni and Paiute acquired horses and tools. In turn, they introduced horses to the Nez Perce and the other northern groups. While introduction of the horse helped increase the mobility of Idaho's native groups, it brought with it seeds of death. Smallpox and other European diseases for which the native people had no natural immunity, devastated many native groups, killing thousands before they had ever seen a white man.[6]

An event that would lead to even greater disruption was the arrival of Meriwether Lewis and William Clark, who, in 1805, were the first white explorers in the Idaho region. Others soon followed, and the native culture that had taken hundreds of years to develop was again be forced to adapt. A few years after Lewis and Clark ventured into the Idaho region, Canadian fur trappers penetrated the area from the north. In 1809, Canadian trapper David Thompson established a post on the shore of Lake Pend d'Oreille and began trapping operations throughout the region. Others followed, and Idaho soon became center of the beaver trapping industry in the western United States. Numerous companies, including the Hudson's Bay and Pacific Fur Companies, sent parties into the region in search of beaver. Among those who led or participated in the exploration of Idaho were Captain B. L. E. Bonneville, Kit Carson, and Jim Bridger. In the late 1830s, a decline in the world market for beaver pelts and a shift to silk hats

5. Merle Wells and Arthur A. Hart, *Idaho, Gem of the Mountains*, (Northridge: Windsor Publications Inc., 1985), 13-8.
6. *Ibid*., 18-20.

in the fashion world brought the fur trade in Idaho to an end.[7]

Missionaries followed the fur trappers into Idaho. As early as 1836, Catholic and Protestant missionaries began to venture into the Indian lands in northern Idaho, introducing farming and acculturating elements of the Nez Perce and Coeur d'Alene Indians to white ways of living. Among the missionaries who served in the wilderness lands of Idaho was Eliza Hart Spaulding, who operated a successful Indian school at Lapwai, in northern Idaho. Among her students was the Nez Perce leader, Chief Joseph. Also prominent among missionaries in Idaho was Father Antonio Ravalli. Ravalli, an Italian Jesuit, took over a mission near Coeur d'Alene in 1844. There he designed and supervised construction of a large church. Completed in 1850, it stands today as the oldest building in Idaho.[8]

Along with the missionaries, other elements of white culture began to filter into Idaho. Stock raising had been introduced in the late 1830s by the Hudson's Bay Company at Fort Boise and Fort Hall to serve early emigrant traffic on the Oregon Trail, and many emigrants brought substantial herds with them. As a result, over-grazing along the Oregon and California trail routes became a major problem, creating hostilities that forced abandonment of both Fort Boise and Fort Hall by 1856. By that time, a new force had begun to influence the native peoples of Idaho. In 1855, the Mormons established a settlement at Fort Lemhi in north central Idaho to minister to the Shoshoni Indians. This settlement flourished until 1858 when an anti-Mormon military campaign forced their temporary withdrawal from Idaho. By 1860, Anglo activity in Idaho was limited to a few missionaries near Coeur d'Alene and the occasional traveler along the Oregon Trail in southern Idaho.[9]

In the early 1860s, two events forever altered the environmental and cultural face of Idaho. In the late 1850s. Army Captain John Mullen was attempting to build a road from Fort Walla Walla in eastern Washington to Fort Benton in central Montana. During construction, one of Mullen's crew discovered gold. Mullen, afraid that he would lose his construction crew to a

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7. *Ibid*., 20-7.
8. *Ibid*., 27.
9. *Ibid*., 27-30.

gold rush, attempted to down play the incident. But word soon got out and thousands of gold hungry miners descended upon eastern Washington and northern Idaho. Every rumor of a new strike caused a new surge of activity as prospectors from one valley overflowed into the next and then into the next leaving a devastated landscape in their wake. Small camps grew into large towns. By 1861, Lewiston, on the Washington/Idaho border, had grown into a major outfitting and supply center for the gold fields of northern Idaho.[10]

In 1862, Moses Splawn, a veteran of the diggings near Florence and Elk City, led a group of prospectors into the Boise Basin. Turned back by hostile Indians, Splawn and his party, backed by hundreds of gold-seeking adventurers, returned in the fall, drove the Indians from the basin, and struck it rich at Idaho City. The Boise Basin gold fields turned out to be the most productive in Idaho, producing over 24 million dollars worth of gold by 1866. For those who did not prosper in the diggings, the basin offered good agrarian opportunities and many settled there permanently. The city of Boise was founded on the banks of the Boise River downstream from Idaho City. A military detachment was assigned to the area to help protect the miners, and many emigrants decided to stay in Boise rather than push on to Oregon. Many of Idaho's boom towns faded, but Boise grew because it could be easily supplied overland from California or Salt Lake City. Boise became the primary supply center for Idaho's mining industry. As the placers and mines played out, the population of Idaho dwindled. At the peak of the gold rush in 1864, as many as 24,000 people lived in Idaho, but by 1870, that number had fallen to around 15,000.[11]

The second event of the 1860s that dramatically altered the course of Idaho's history was the return of the Mormons to southeastern Idaho. A few years after the Fort Lemhi missionaries had been forced to return to Utah, Thomas Smart led a small band of Mormons into the Cache Valley. There they founded Franklin, the first permanent white settlement in Idaho although the settlers did not realize for several years that they had crossed border into what was then known as the Washington Territory. As more families arrived, a fort was constructed and a communal

10. F. Ross Peterson, *Idaho, A Bicentennial History*, The States and the Nation Series, (New York: W. W. Norton & Co., Inc., 1976), 55-6.
11. *Ibid*., 58.

irrigation ditch was built and placed into service. Soon a sawmill, gristmill, and creamery were providing for many of the needs of the settlers. The Franklin pattern was repeated throughout the border region and by the time the Civil War ended and the Idaho Territory was organized, southeastern Idaho was dotted with numerous Mormon settlements. Mormon influence would continue to grow, stretching far beyond the southeastern corner of the state. By the 1880s, Mormon influence had spread into the central regions of the state and throughout the upper Snake River valley.[12]

Two factors combined to cause a significant anti-Mormon sentiment among the other citizens of the territory. The first was the Mormon practice of plural marriage, a practice seen as particularly sinful among non-Mormons. The second was the Mormon practice of voting as a block. This disturbed many as it was believed that church leaders in Salt Lake City did more to influence Mormon voting in Idaho than did events in Idaho itself. Due to these concerns, many non-Mormons, most notably U.S. Marshall Fred T. Dubois, sought to remove the Mormon influence from Idaho politics, and through a series of political moves denied Mormons the vote. When Idaho was admitted to the United States in 1890, the state constitution prohibited Mormons from voting or holding office. In 1896, the Idaho legislature restored the vote to the Mormons, who had by then abandoned their practice of plural marriage.[13]

By the end of the Civil War, most of the naturally well-watered lands in southeastern Idaho had been claimed. If further settlement was to occur, a reliable source of water would need to be found. The earliest form of irrigation in Idaho was the use of ditches to supply water to gardens in the Mormon settlement at Fort Lemhi, a practice they continued at their Cache Valley settlements. Numerous projects, both Federal and private, were constructed to supply water to thirsty settlers. Many projects failed, leaving farmers with no water and speculators with full pockets. Other projects, such as the Twin Falls Project, succeeded and the arid lands along the Snake River began to bloom. In 1902, the National Reclamation Act was approved and the U. S. Reclamation Service was formed. One of the first projects undertaken by the new

12. *Ibid.*, 53-4.
13. *Ibid.*, 93-7.

service was the Minidoka Dam and Lake Walcott. Constructed on the Snake River between 1904 and 1907, it was followed closely by construction of the Jackson Lake Dam near the headwaters of the Snake in Wyoming. Even with the addition of water stored at Lake Walcott and Jackson Lake, farmers along the Snake often found themselves without enough water to irrigated their lands. Construction of the American Falls Dam in the 1920's provided reliable service to the farmers of the lower valley, but left those in the upper reaches wanting, especially during dry years. Following several dry years in the early 1930's and the loss of over $7,000,000 in crops in 1935, investigations into construction of a large storage unit in the upper valley were begun.[14]

Project Authorization

A detailed investigation of the project site was made by Reclamation and a report issued in 1940. This report, summarized in House Document No. 457, 77th Congress, 1st Session, became the basis for authorization of the project on December 9, 1941. Pre-construction activities began immediately, but were suspended in 1942 due to America's entry into World War II. In 1949, Reclamation issued a supplemental report that proposed changes in the operating plan for the project, increasing the allotment for flood control and the size of the power installation. The project was re-authorized by Congress on September 30, 1950 (Public Law 864, 81st Congress) based upon the supplemental report of 1949.[15]

Construction History

Investigations

Investigations of reservoir sites on the upper Snake River began in 1932 when Reclamation surveyed 27 possible sites. The requirements for a suitable site included a storage capacity of 1,400,000 af with the lowest dam and suitable geology for the foundation, spillway, and outlet works. Of the 27 sites investigated, 13 were found to be unsuitable geologically. Others were eliminated because the height of the dam that would be required to meet project storage needs was too high. Extensive investigations at the Palisades site were conducted in

14. *Ibid*., 128-37.
15. *Technical Record of Design and Construction*, 1-2; *Project Data*, 747.

1934 and 1935. In 1939, a site known as the "Grand Valley" site was selected as being most suitable for development. In 1941, to avoid confusion with the Grand Valley Project in Colorado, the project name was changed to Palisades.[16] Investigations resumed in 1941, following the initial authorization, and continued through 1942 when they were interrupted by World War II. Field work at the site resumed in March 1945.[17]

Preliminary design studies for the dam began in 1935. The first design called for a reservoir capacity of 1,400,000 af and a side channel, open chute spillway with a 70,000 cubic-foot-per-second (s/ft) capacity controlled by five drum gates. The outlet works and power penstock were combined in a single 32-foot diameter tunnel through the left abutment. In 1939, the design was revised to correct deficiencies in the 1935 design. The 1939 design called for two 27-foot diameter tunnels: one each for the outlet works and power penstocks. The increased capacity afforded by two tunnels allowed the designers to reduce the capacity of the spillway to 50,000 s/ft. The spillway was further changed from a side channel to an open channel controlled by three fixed wheel gates.

In 1947, the design was once again revised due to changes in reservoir storage and flood control requirements. The 1947 design adopted the configuration of the 1939 design, but changed the spillway from an open channel to a tunnel through the left embankment. Two designs, one with an outlet capacity of 20,000 s/ft and one with a capacity of 30,000 s/ft were studied, and in 1951, the design with the 30,000 s/ft outlet works was adopted.[18]

Construction

The first contract awarded in association with construction of the dam and powerplant was the contract to supply and erect forty pre-fabricated houses for the government construction camp. This contract was awarded to the Green Lumber Company of Laurel, Mississippi, on June 28, 1946. Several additional contracts were awarded for completion of the houses.[19]

The first contract for work on the dam and powerplant was awarded to J. A. Terteling and

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16. *Technical Record of Design and Construction*, 1-2.
17. *Ibid*., 3.
18. *Ibid*., 84-7.
19. "Project History" Vol. I, 1952, 8.

Sons, Inc. The contract was for open-cut and tunnel excavations, and the erection of a temporary electrical sub-station. The winning bid was $1,242,700, and the company was given 230 days to complete work under the contract. Notice to proceed was given on December 17, 1951, with work on the sub-station beginning February 20, 1952, and excavations of the tunnels beginning on April 10, 1952.[20]

The primary contract, which included construction of the dam, powerplant, and the relocation of several roads in the reservoir area, was awarded to Palisades Contractors, a joint venture of J. A. Jones Construction Company and Charles H. Tompkins Company. The contract was awarded on April 18, 1952, at a cost of $29,180,346. Notice to proceed was given on May 8, 1952, with work under the contract beginning on May 17, 1952.[21]

The contract to provide and install the four, 30,000 kilo-volt (kv) generators was awarded to the Pacific Oerlikon Company of Tacoma, Washington, on May 25, 1953. The company's name was later changed to United Power Control Corporation. The generators were manufactured in Switzerland by the Oerlikon Engineering Company of Zurich.[22]

Two other major contracts were awarded. The contract to supply and install four, 39,500 horse-power turbines was awarded to the S. Morgan Smith Company of York, Pennsylvania, and the contract for fabrication of the steel penstock manifolds was awarded to the American Pipe and Construction Company of Portland, Oregon.[23]

The first construction work on the dam itself began with open cut excavations for the power and outlet tunnels. The open cut was necessary to provide a suitable face in which to begin tunneling operations. Open cut excavations began on April 10, 1952, with tunnel excavations beginning on June 16. Prior to commencement of tunneling operations, the contractor constructed a drilling jumbo for use in drilling and loading holes for blasting. The jumbo had three work decks that carried a total of fifteen drills. Air to power the drill units was supplied by three compressor units mounted on the jumbo. Each shot consisted of 96 to 110

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20. *Technical Record of Design and Construction*, 249-50.
21. *Ibid.*, 250-2.
22. *Ibid.*, 252-3.
23. *Ibid.*, 254.

holes loaded with up to 750 pounds of explosives. A single jumbo was used for both tunnels. While one tunnel was being cleared of debris, the jumbo was drilling and loading the face of the other tunnel. During the early stages of tunnel excavations, the drill jumbo was also used to place support steel. As this proved to be slow and time consuming, the contractor constructed a smaller jumbo for setting steel.[24]

Clearing the dam site began on June 2, 1952, when J. A. Terteling and Sons, Inc., under sub-contract with Palisades Contractors, began work clearing the stilling basin and spillway outlet channel areas. Palisades Contractors began work under the primary contract on June 12, 1952, with clearing operations in the area of the powerplant switch yard. Both companies continued clearing operations throughout 1952 and into 1953 with all clearing within the dam site completed on February 16, 1953.[25]

Diversion of the Snake River involved two stages. The first stage confined the river to a channel along the right side of the construction area. The second stage involved diversion of the river through the completed outlet and power tunnels. Work on the first-stage diversion began on June 26, 1952, and involved excavation of 1,450 feet of channels and construction of 4,400 feet of dikes. Work on the first-stage was completed in late August 1952, and the river confined to a channel along the right abutment. Work on the dikes that would be needed for the second-stage diversion also began in 1952, but it would be several years before the tunnels would be completed and the river diverted through them.[26]

Stripping operations began in late June 1953, and followed closely behind clearing operations. Stripping is necessary to remove all lose materials from the dam site and to provide a solid foundation for the dam. Suitable materials stripped from the dam site were stockpiled for later use in the dam embankment and unsuitable materials were wasted. Stripping operation continued intermittently through 1957, staying just ahead of embankment placement operations. Early stripping operations were hampered by excessively wet materials. In all, over 250,000

24. *Ibid*., 302-4.
25. *Ibid*., 262.
26. *Ibid*., 259.

cubic yards (cu/yd) of material was removed from the dam site.[27]

Palisades Dam was constructed with two cut-off trenches; one near the upstream toe and one just upstream from the axis of the dam. A cut-off trench is a deep cut excavated down to bedrock that provides a barrier against leakage and helps to anchor the dam embankment. Excavations in the upstream trench began at the left end in late August 1952, and continued until mid-October when work was halted for winter. Work resumed the following June, and when work was halted in early August, excavations were 80% complete. Excavations resumed in early June 1954, and continued until the end of the month when all work that could be performed prior to the second-stage river diversion was complete. Work began again in early August and all excavations were completed on August 24, 1954.

Excavations for the main cut-off trench, just downstream from the axis of the dam, began in early September 1952, with work near the left abutment. This was followed a few days later by excavations in the old river channel. Cold weather halted excavations in early November. Excavations resumed in early February 1953, and continued throughout the summer. Excavations on the right abutment began in early October, but were halted later that month when cold weather forced suspension of excavations for the season. Work resumed in early May 1954, with excavations substantially complete by early September 1954. Minor trimming continued as needed until late 1957.[28]

Excavations in the power and outlet tunnels continued through 1952, with the power tunnel being holed through in December 1952, and the outlet tunnel the following January. The design of the power and outlet tunnels required inclined shafts to be driven downward to the tunnels from a point some seventy feet above the floor of the tunnels. The shafts would form the intakes for the tunnels and would be located at the upstream ends of the tunnels. When completed, that portion of the tunnels upstream from the intersections of the shafts and tunnels would be filled with concrete. Excavations for the inclined-shafts began in late March 1953, with excavations for the outlet tunnel inclined-shaft being completed in November, and the

27. *Ibid*., 262-3.
28. *Ibid*., 266-7.

power tunnel inclined-shaft in January 1954.[29]

Excavations for the spillway tunnel began from the downstream portal on June 2, 1953, with excavations for the inclined shaft beginning in October 1953. Excavations for the spillway tunnel and inclined shaft were completed in May 1954.[30]

Concrete operations in the tunnels began in May 1953, with work in the outlet tunnel. Placement in the invert, or lower section, of the outlet tunnel began July 15, was work in the unlined section being completed in early March 1954. Concrete work in the power tunnel began in January 1954 with placements in the invert section, which was completed in early March. Placement in the sides and arch sections began in mid-March 1954, and were completed in late April. Backfill operations around the steel liners of the outlet and power tunnels began in the outlet tunnel in late August 1953. Backfill operations were completed on May 1, 1954, with the final placement in the power tunnel.[31]

With the substantial completion of the power and outlet tunnels, final river diversion could be carried out. The first attempt to divert the river through the permanent outlet tunnel took place on July 22, 1954. This attempt failed when high flows prevented the contractor from damming the diversion channel, forcing the river into the channel of the permanent outlet tunnel. Following the first attempt, the contractor stock piled additional materials on either side of the channel and constructed a 15-foot diameter, 100-foot long log boom to aid in closure of the channel. The original diversion plan had called for diverting the river through just the outlet tunnel, but it was decided to use both the outlet and power tunnels. Late in the day of August 5, 1954, the outlet gates at Jackson Lake, up river in Wyoming, were closed to reduce the flow of the Snake River. By 4:00 a.m. August 6, the flow at Palisades had been reduced from 12,000 s/f to less than 7,000 s/f. The contractor began the closure attempt by floating the log boom into place across the mouth of the channel. This was followed by the placement of large boulders in the channel. Once the boulders were in place, earthmovers began pushing the stockpiled

29. *Ibid*., 311; "Project History: Palisades Project," Vol. III, 1953, p.10.
30. *Technical Record of Design and Construction*, 307.
31. *Ibid*., 328-9.

material into the channel from both sides, and by 6:30 a.m., the channel was closed and the river flowing fully through the outlet and power tunnels.[32]

Embankment placement operations began in August 1952 and continued until completion in July 1957. The embankment consists of various types of materials placed in specific zones and compacted by rollers. Zone 1 type material consists of selected clays, silts, and sands, and is roller compacted into five-inch layers. Zone 1 material makes up the central core of the dam and is impervious to water. Zone 2 material is made up of clay, silt, sand, gravel, and rock fragments up to five-inches in diameter that is rolled in to six-inch layers. Zone 2 material is placed upon zone 1 on both the upstream and downstream portions of the embankment. Zone 3 material consists of sand, gravel, and stone and is placed in 12-inch layers upon zone 2. Zone 4 material is made up of larger rocks and stone and is dumped into place. The use of zone 4 material is confined to the downstream toe of the dam. In addition to the various zoned materials, the upstream face of the embankment was covered with a three-foot layer of riprap consisting of large boulders. This layer helps to reduce erosion of the embankment from wind and wave action. The downstream face is protected by a three-and-a-half foot thick layer of rocks and stones.[33]

The behavior of embankment materials under various loads can be reasonably estimated using controlled laboratory studies. But for the information to be used with confidence, the laboratory results must be compared to actual behavior of materials in an embankment. In order to gain information on embankment behavior, Reclamation installs a series of devices designed to monitor the embankment in most dams that it constructs. Three types of test devices were installed in Palisades Dam. A piezometer system with 28 foundation and 22 embankment tips was installed in the embankment. The piezometer system measures conditions within the embankment and transmits the information to a terminal well. In addition to the piezometer system, Reclamation installed 33 surface settlement points and one embankment settlement installation. These devices are used to measure any movement, settlement or deflection of the

32. *Ibid*., 259-61.
33. *Ibid*., 17, 279.

embankment, spillway walls, tunnels, or other structures. Installation of the testing system was carried out by Government forces and was ongoing throughout the entire construction period.[34]

Concrete lining of the spillway tunnel began on August 11, 1954, with placement in the invert section. Placement in the sidewalls and arch sections began on October 16, and continued with only minor delays until completion in early July 1957. Placement of concrete in the inclined portion of the tunnel began in November 1954 and continued until May 2, 1957, when the final placement was made. Concrete work on the spillway inlet structure commenced in November 1954, and was completed in mid-April 1956.[35]

Concrete placement in the intake structure of the power tunnel was completed in September 1956, with placement in the outlet tunnel intake structure completed in October. Work to plug the upstream portion of the power tunnel was essentially completed on April 19, 1956, with the final placement of concrete in the plug. On November 3, 1956, the bulkhead gate at the mouth of the outlet tunnel was closed, and storage of water in Palisades Reservoir began. Water flowed through the completed power tunnel for the first time on November 10. Concrete placement in the outlet tunnel plug began on November 11 and was competed the following January.[36]

Concrete placement in the outlet works control house began on September 17, 1955. The control house contains control works for the six slide gates and two hollow jet valves that control flows through the outlet tunnel and power tunnel by-passes. Gates one through six are used to regulate flows through the outlet tunnel. Gates seven and eight are connected to the power tunnel by-pass manifold and are used to by-pass water when power operations are shut down. The first gates to be installed were numbers six and seven. Work on gates six and seven began on August 5, 1955, and testing of the gates took place on June 12, 1956. The last concrete was placed in the control house on August 10, 1957. Brick work on the exterior of the structure began on August 5, 1957 and was completed on October 1. Installation of the remaining slide

34. *Ibid*., 287-302.
35. *Ibid*., 331-2.
36. *Ibid*., 329; "Project History: Palisades Project", 1956, Vol. VI, 5-6; 1957, Vol. VII, 17.

gates, the two hollow jet valves, and the outlet controls would not be complete until mid-1958.[37]

Installation of the two 20- by 50-foot radial spillway gates began in April 1956, with the installation of the wall plates and sill plates. The gates consist of three primary components: the leaf, the arms which connect the leaf to the trunnion, and the trunnion assembly from which the gate rotates. Installation of the trunnion pedestals began on April 17, with installation of the gate arms beginning on April 26. Assembly of the gate leaves began on April 27 with work on the right gate. Assembly and installation of both gates leaves was completed on June 22, with installation of the side and bottom seals completed on July 24, 1956. Installation of the two, 125,000 pound (lb) capacity gate hoists began in early June and was completed by the end of the month. The gates were successfully raised for the first time on June 27.[38]

Work to install the two fixed-wheel gates that provide emergency closure for the outlet and power tunnels began in April 1956 with installation of the gate tracks and guides. Installation of the two hydraulic gates hoists began in early June. Installation of the gates began in early August when the first of five pre-fabricated gates sections was moved into place in the power tunnel erection pit. Assembly of the power tunnel gate was completed on August 29 with assembly of the outlet tunnel gate completed on September 20. All work on the gates was completed and all testing performed by the end of October 1956.[39]

Construction activities for the Palisades Powerplant began in 1952 with clearing of the foundation area. Excavations for the foundation began in September 1952. Concrete placement for the powerhouse began in July 1953, with first-stage placement completed in October 1954. Erection of structural steel framing began in early August 1954, and continued, weather permitting, until completion in late January 1956. The Palisades powerhouse was the first such structure built by Reclamation to be constructed with brick masonry walls. Brick work began on June 1, 1955, and was completed in early October.[40]

Fabrication of the penstock manifolds, outlet pipe manifolds, and associated steel piping

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37. *Technical Record of Design and Construction*, 331, 350, 426-8.
38. *Ibid*., 410-2.
39. *Ibid*., 413-9.
40. *Ibid*., 269, 317, 349-50.

was carried out by the American Pipe and Construction Company. The fabrication facilities were built at the construction site during the early summer months of 1955. Pieces having a diameter of 14-feet or less were fabricated at American's shops in Portland, Oregon, and shipped by rail to the construction site. For larger pieces, the rolling, bending, marking, and some welding were conducted at the Portland shops, and the pieces shipped to Palisades for final fabrication. Both automatic and manual welding was used in the fabrication process. Once a section had been welded, the weld was subjected to x-ray examination. If any faults were found, the bad section was chipped out and re-welded. Following x-ray examination, the completed sections were placed into a specially constructed stress-relieving furnace. Heating the sections relieved the stress caused by bending, rolling, and welding the pieces of the section together. The first penstock pieces were delivered to the site in mid-June 1954.[41]

Installation of the penstock and outlet manifolds was carried out by American Pipe and Construction under subcontract with Palisades Contractors. The pieces were installed in three stages. The first stage involved the section downstream from were the lateral for generating unit number one branches from the main penstock. Stage two involved installation of sections leading from the end of the power tunnel to stage one, and stage three involved installation of the entire outlet manifold and connections from the butterfly valves to the turbines. Work on the first stage began on October 20, 1954, when the first section was set into place. The final section was set into place on March 29, 1955, and all work performed during stage one was successfully tested on June 5, 1955.

Second stage work began on July 26, 1955. Work to install the by-pass sections from the main penstock to the outlet gates began in early February 1956, and was completed in early April. Work on stage three began on June 13, 1955, with installation of sections between the butterfly valves and the turbines. This work was completed on March 21, 1957. Work on the outlet manifold, part of stage three, began in early May 1957, with the first piece being set into place on May 27. All work was completed by September 20, with testing starting on September

41. *Ibid*., 355-63.

22. On September 23, during hydrostatic pressure testing, a crack was discovered in section W-1, where the main pipe branched into three. The crack was repaired and testing resumed. On September 26, with the test pressure at 155 lbs per square inch, section W-1 failed completely. The section was removed, repaired, and successfully retested. This was the only significant problem encountered during installation of the penstock and outlet manifolds. Following installation of the penstock and outlet manifolds, the sections were completely embedded in concrete.[42]

Installation of the turbines and generators began with work on those portions of the units that are embedded in concrete. The embedded parts consist of the draft tube lines, which form the outlets for the units, and the spiral cases, which direct water through the turbine blades that drive the generator. Assembly of the liners began on April 21, 1955, and the first liner, for unit number four, was set into place in the powerhouse on May 5. The liners were installed in reverse order beginning with unit four, then units three, two, and one. Concrete placement around the unit four liner began on June 2. Once the tube liners were in place and embedded in concrete, the spiral cases were installed. Each case is made up of six pieces which are assembled in place atop the tube liner. Once assembled, the cases are sealed and filled with water for hydrostatic testing. When testing is completed, the pressure is reduced from a high of 225 lbs per square inch to 82 lbs per square inch, and the case is then embedded in concrete. The pressure in the case is maintained throughout the embedding process to prevent the case from collapsing under the weight of the concrete. All work associated with assembling, testing and embedding the spiral cases was completed by the end of March 1956.[43]

Assembly and installation of the non-embedded turbine parts began on January 25, 1956, and was completed on June 29. As with the embedded parts, the installation began with unit number four and finished with unit number one. Work associated with the installation of the generators began in April 1956. Assembly and installation of the generators continued without significant delay until the night of August 17, 1956, when a fire seriously damaged unit number

42. *Ibid*., 364-8.
43. *Ibid*., 369-76.

4, which was almost completed. The damaged parts had to be removed and sent back to the manufacturer for repairs, delaying completion of the number four unit. Work on the other three units continued without difficulty. The first unit to go on line, unit number three, was placed into operation on February 16, 1957, with the commercial power operations beginning on February 25. Unit number two was placed on line on May 14 followed by unit number one on August 8. Unit number 4, its fire damaged parts repaired or replaced, was placed into service on May 6, 1958. With the completion of unit number four, the dam and powerplant were essentially complete, and the project was transferred from the construction phase to operation and maintenance on July 1, 1958.[44]

Palisades Dam is a zoned earthfill dam 270 feet high and 2,100 feet long. The maximum width of the base from upstream toe to down stream toe is 2,100 feet and the width of the crest is 40 feet. The dam embankment contains 13,571,000 cu/yd of material. At the time of its completion in 1957, Palisades Dam contained the greatest volume of material of any dam constructed by Reclamation, rivaling such notable dams as Hoover and Grand Coulee. Palisades Reservoir has a total capacity of 1,401,000 af with a surface area of 16,150 acres and a shoreline of over 70 miles. The spillway is a 28-foot diameter, concrete lined tunnel with a concrete crest controlled by two 20-by 50-foot radial gates, and has a capacity of 48,400 sf.[45]

The outlet works consists of two, 26-foot diameter concrete and steel lined tunnels. One tunnel is used for river and irrigation bypass while the second tunnel supplies water to the powerhouse. The river outlet is controlled by four, 7.5-by 9-foot slide gates and two 96-inch hollow-jet valves and has a capacity of 33,000 sf. When power operations are shut down, water is diverted from the power tunnel via two penstock bypass branches each controlled by one 7.5-by 9-foot slide gate. The bypass capacity of the power tunnel is 14,000 sf. Emergency shutdown of the river and power tunnels can be achieved by two 19.6-by 28-foot emergency

44. *Ibid*., 376, 389: "Project History" 1957, Vol VII, 13-4, 17; 1958, Vol. VII, 6-7.
45. *Technical record of Design and Construction*, frontispiece; *Project Data*, 747; Flynn, Robert T. "In the Shadow of Calamity Point", *The Reclamation Era*, November 1955, 81.

gates located at the intakes of the tunnels.[46]

Palisades Powerplant, located on the downstream toe of the dam, has four generating units. The original installation of two 30,875 kw and two 28,500 kw units provided a total generating capacity of 118,750 kw. Each of the units is driven by a single, 39,500 hp vertical shaft turbine. Water supply to the turbines is controlled by four, 186-inch butterfly valves, one for each turbine.[47]

In addition to the dam and powerhouse, construction activities included relocation of over 20 miles of highway, almost 30 miles of forest service roads, and construction of three bridges.[48]

Post-Construction History

The Palisades Project was officially dedicated on September 19, 1959. Among the officials in attendance were the governors of Idaho and Wyoming, several congressmen, and Secretary of Interior Fred Seaton. Entertainment at the ceremony included a fly-by of the Idaho and Wyoming Air National Guards. Although the weather was cool and rainy, about 1,000 people attended the dedication.[49]

Palisades Reservoir spilled for the first time on July 6, 1959. This is an event that occurs almost yearly. As a result of the frequent spills, the channel downstream from the spillway outlet is subject to increased erosion, requiring frequent channel repairs. To aid in de-watering the channel for inspection and repairs, a concrete weir was constructed across the downstream portion of the channel in 1970.[50]

Palisades Dam and Powerplant have operated efficiently for over forty years without major problems or modifications. Frequent inspections have revealed no major deterioration in the dam embankment or outlet works, and the four generating units have required only normal

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46. *Technical Record of Design and Construction*, frontispiece, 99.
47. *Ibid*., frontispiece, 200.
48. Denver, Colorado, National Archives and Records Administration: Rocky Mountain Region, Records of the Bureau of Reclamation, Record Group 115, "Project Histories: Minidoka Area Project," Vol. LII, 1958, 279 (hereafter referred to as "Project History: Minidoka Area Projects" followed by year, volume number and page number).
49. *Ibid*., Vol. LII, 1959, 117-9.
50. *Ibid*., Vol. LXIV, 1970, 150.

maintenance. In the late 1970s, the Department of Interior and Bureau of Reclamation began investigations into potential upgrading of Reclamation's numerous power facilities. As a result of this study, the four units at Palisades were scheduled for upgrade with work beginning in the early 1990s and scheduled for completion by mid-decade. The work consisted of rewinding the generators, replacing the transformers, and repairing or replacing most of the electrical and mechanical components within the generators and turbines. The last unit to be upgraded, unit number one, was returned to service in late June 1995, and on July 3, 1995, a new record for power output from Palisades Powerplant was established with a continuous output of 168 megawatts: more than 30% greater than the previous record of 125 megawatts.[51]

Settlement of Project Lands

Palisades Dam and Reservoir are designed and dedicated to supplying supplemental water to lands already under irrigation in the Minidoka and Michaud Flats Projects. Because of this, no lands within the project area were withdrawn for settlement or development. The Michaud Flats Project had been under investigation by Reclamation since 1926, but it was only with the addition of water made available by the Palisades Project that the Michaud Flats Project was determined to be feasible. The Michaud Flats Project, a four unit pumping plant located downstream from the American Falls Dam serving over 50 miles of canals and laterals, was begun in 1955 and completed in 1958. It serves over 11,000 acres.[52]

Uses of Project Water

The Palisades Project is a multi-purpose project providing water for irrigation, recreation, and electrical power generation. In addition, the unit provides a significant amount of flood control along the upper reaches of the Snake River. Although there are no lands directly associated with the project, Palisades Reservoir provides supplemental irrigation water to over 650,000 acres of farm lands in the Minidoka and Michaud Flats Projects.[53]

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51. United States Department of Interior, Bureau of Reclamation, *Hydropower 2002, Reclamations Energy Initiative*, November 1991, 67-71; Mike Roluti and Dennis Sloan, Power Resource Office, Bureau of Reclamation, Interview by author, 2 August 1995; John Keys, Regional Director, Pacific Northwest Region, Bureau of Reclamation, to Commissioner of Reclamation (Daniel Beard). Electronic Memorandum dated July 12, 1995.
52. *Project Data*, 615-8.
53. *Ibid*., 747.

Palisades Powerplant's four upgraded 41,140 kw generating units provide over 500,000 mega-watts of power to electrical users in southeast Idaho each year. Recreational facilities at Palisades Reservoir are administered by the Bureau of Reclamation and the United States Forest Service. Fishing, camping, and hiking are among the activities available on over 11,500 acres of land and 70 miles of shore in the project area.[54]

Flood control is one of the primary functions of Palisades Dam and Reservoir. Since its completion in the late 1950s, the project has prevented over $250,000,000 in flood damage along the upper portions of the Snake River. Only four other projects constructed by Reclamation have prevented more damage due to flooding than Palisades, and those are all multi-unit projects.[55]

Conclusion

Built to quench eastern Idaho's thirst for water, Palisades Dam, among the largest of its kind, stands as a giant among Reclamation projects. Like the benevolent giant of legend, Palisades both protects and provides for those who live in its shadow. Supplying water and power for the inhabitants of the region, Palisades also protects them from the ravages of flood and drought. Given its many benefits, the Palisades Project may be Reclamation's most successful, single unit, multi-purpose 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.

54. United States Department of Interior, Bureau of Reclamation, *Summary Statistics: Water, Land, and Related Data*, (Denver: Bureau of Reclamation, 1990), 9, 95, 102.
55. *Ibid*., 14.

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