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SHPO welcomes questions, comments, and suggestions on the document (particularly the documentation standards, resource types, and evaluation guidance sections) from cultural resource professionals, archaeologists, federal agencies, Tribal Historic Preservation Offices, and others who work with the type of resources covered by this context.

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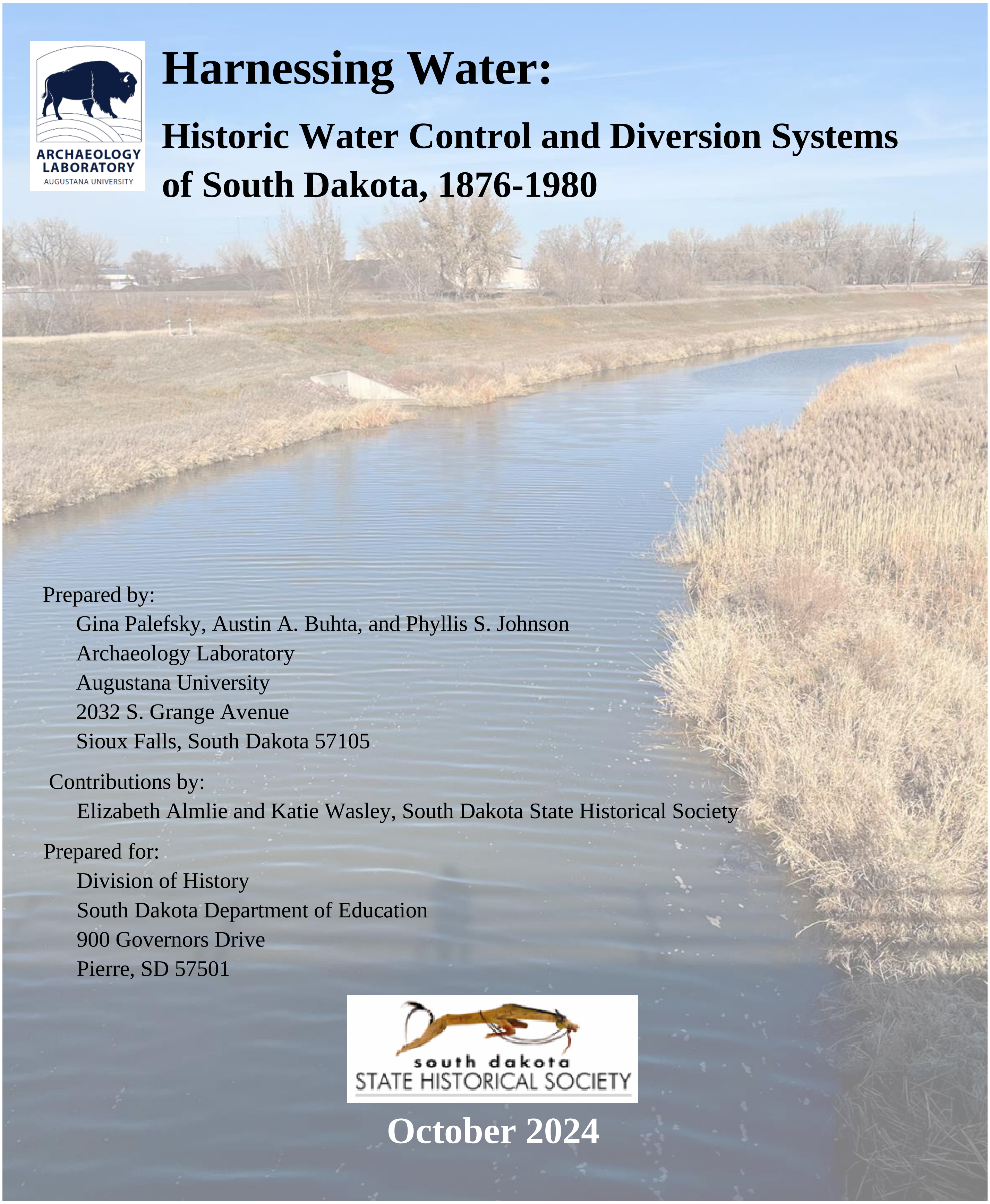

Harnessing Water:

Historic Water Control and Diversion Systems of South Dakota, 1876-1980

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National Trust *for* Historic Preservation

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Introduction: Moving Water in South Dakota

This document is a public resource that provides contexts to histories of water conveyance and management sites and structures in South Dakota dating from 1876 to 1980. Discussed are five topics, many of which are interrelated throughout South Dakota state history: agricultural irrigation and drainage, hydroelectric power, flood control, wildlife conservation and management, and recreation. Where possible, we highlight themes of archaeology, engineering, administration, labor, vernacular construction, and American Indian history in the post-reservation period. Considering the vast array of topics and themes included in this historic context, this document aims to provide an overview of historical trends and dynamics that foreground water infrastructure developments across the state with specific examples of sites and structures characteristic of these topics, themes, and eras of focus.

In addition to presenting thematic historical contexts, this document also includes survey documentation standards for practitioners who complete survey records of water conveyance and management resources in the state. These standards include guidance on specific resource types, recommendations for how specifically to record and submit them, and evaluation guidance under the National Register of Historic Places (NRHP) criteria. Other historic context documents, inventories, and NRHP multiple property nominations are available on the State Historic Preservation Office website (https://history.sd.gov/preservation/SHPOdocs).

The scope of this work considers water conveyance and management sites and structures over time and across regional boundaries. After presenting an abbreviated overview of the state's settlement history, the first chapter, "Moving Water Sites and Structures during the Territorial Period and Early Statehood, 1876-1910," presents histories of agricultural irrigation and drainage constructed at the behest of individuals and corporations, including farmer-owned irrigation ditches, corporate-investment canals, artesian wells, stock dams, dugouts, and stormwater reservoirs, along with private hydroelectric power facilities and state fish hatcheries. The second chapter, "Federal Reclamation and Relief Construction of Moving Water Sites and Structures, 1902-1941" summarizes early federal projects related to agricultural irrigation and drainage in the state built under the authorization of the Reclamation Act of 1902. This chapter also provides a synopsis of moving water sites, structures, and associated recreation developments built as part of federal work relief programs during the Great Depression and World War II. The third and final chapter, "Post-War Moving Water Site and Structure Developments, 1945-1980" synthesizes the outcomes of water infrastructure built under authorization of the 1944 Flood Control Act through the Pick-Sloan Missouri River Basin Program, focusing on developments in irrigation, hydroelectric power generation, wildlife conservation and management, and recreation. We also consider how the resulting dams and reservoirs impacted South Dakota tribes and review the archaeological legacies of their construction. This chapter also describes more recent developments, including the rise of center pivot irrigation, changes to flood control strategies in the wake of the Black Hills-Rapid City Flood of 1972, and major water-related wildlife conservation and management developments up to 1980.

This historic context document relies on a variety of primary and secondary sources accessed via the Center for Western Studies and Mikkelsen Library at Augustana University and through interlibrary loans in partnership with university libraries throughout the state and across the country. We also consulted a number of state-specific digital archives, including South Dakota State Historical Society's South Dakota Digital Archive, South Dakota State Historical Society's Archaeological Research Center, and South Dakota State University's Open PRAIRIE (Public Research Access Institutional Repository and Information Exchange). Various reports available via the United States Geological Survey's USGS Publications Warehouse were included in this research, along with reservation-era records from the University of Wisconsin's Digital Collections archive of Annual Reports of the Commissioner of Indian Affairs (1826-1932). Numerous sources were compiled from digital libraries including HathiTrust and Google Books, which have preserved, digitized, and made publicly accessible numerous texts consulted in this research. Reports published by the Spearfish Historic Preservation Commission and Historic American Engineering Record were also foundational to the content of this historic context document.

Moving Water Sites and Structures during the Territorial Period and Early Statehood, 1876-1902

Overview of South Dakota's Early History of Settlement

Throughout South Dakota's history, the availability of water has played a major role in patterns of settlement and agricultural developments throughout the state. South Dakota's contemporary political boundaries are located within the ancestor-occupied homelands of many Native tribes including the Ponca, Omaha, Cheyenne, Arapaho, Pawnee, Ioway-Otoe, Kiowa; Mandan, Hidatsa, and Arikara (Three Affiliated Tribes); and the ancestral territory of the Očeti Šakówiŋ (Seven Council Fires).[1] Among the ancestors of the Three Affiliated Tribes and Očeti Šakówiŋ, and likewise among many of their descendants and contemporary tribal communities, water is vital to everyday life and holds spiritual significance. The horticultural ancestors of the Three Affiliated Tribes and nomadic hunting ancestors of the Očeti Šakówiŋ, however, interacted predominantly with *natural* waterways like rivers, creeks, and lakes; pre-contact moving water sites and structures of the types considered in this document (i.e., agricultural irrigation and drainage, hydroelectric power, flood control, wildlife conservation and management, and recreation) were not typical during prehistoric and protohistoric periods on the Northern Great Plains. As such, this context document begins during the historic period, when Euro-American settlement expanded westward, and settlers began to modify the landscape through the construction of moving water sites and structures.

The land that became South Dakota was opened to Euro-American settlement primarily through three transactions between local tribes and the U.S. government: the Yankton Treaty of 1858, the Sioux Agreement of 1877, and the Sioux Agreement if 1889. The Yankton Treaty of 1858, ratified between the United States government and the Ihanktonwan (Yankton) Dakota tribe, ceded 11,155,890 acres east of the Missouri River to the U.S. government and restricted the Yankton Sioux to a 430,000-acre reservation on the east side of the Missouri River near the Nebraska border.[2] With millions of acres made available for Euro-American colonization, the first settlers in the region formed small communities in fertile river bottomlands where they could easily access foodstuffs, building materials, and river transportation, primarily along its eastern margins and in the southeasternmost section of the Territory. By 1860, approximately five hundred non-Native people lived in the southeastern portion of Dakota Territory, but the challenges of social and environmental strife winnowed the population each year. An estimated half of the non-Native population of southeastern Dakota Territory left amidst the violence and uncertainty of the Dakota War of 1862, and many more abandoned their homesteads after drought and grasshopper infestations wrought havoc in 1864 and 1865. The population of this

[1] The Očeti Šakówiŋ include Lakota and Dakota (including Ihanktonwan and Ihanktonwanai that are sometimes termed Nakota) people, that were termed the Sioux by Euro-Americans, a name that has continued to be associated with their people.

[2] Hoover, "The Sioux Agreement of 1889 and Its Aftermath," 56–94.

region increased dramatically in the years that followed, in large part because of the Homestead Act of 1862, expansion of railroad lines, and the return of normal rainfall. In 1868, weather conditions were ideal for farming and coincided with the completion of a Pacific Railroad station in Sioux City, Iowa, opening up the possibility for farmers to sell their wheat in more distant markets.[3]

Within a decade of the Yankton Treaty, permanent agricultural settlements were established in the southeastern portion of Dakota Territory, and the population increased rapidly. Census records from 1870 indicate that about 10,000 non-Native people had settled in what is today South Dakota, with most arriving from nearby states between 1867 and 1870. Railroad service expanded in 1873, when a completed railroad line from Sioux City to Yankton further improved farmers' access to markets for the sale of Dakota wheat and facilitated the transport of new settlers to Dakota Territory. [4] This confluence of factors set the stage for a massive influx of non-Native settlement during a time that historians have characterized as the Great Dakota Boom, from 1878 to 1887. The population of southeastern Dakota Territory reached 81,781 residents by 1880, and 248,569 by the end of 1885.

West of the Missouri River, settlers traveling on trails through designated Indian territory met with indigenous resistance by Oglala Lakota leader Red Cloud and others. The U.S. Army established itself in the area to support settlement. After years of conflict, the Treaty of Fort Laramie of 1868, among other provisions, demarcated those lands west of the Missouri River that would become the Great Sioux Reservation.

The Black Hills were designated as unceded Indian Territory, to be protected from non-Native settlement in perpetuity. In direct violation of the Treaty, settlers continued to push further west, and a deluge of prospectors flooded into the region after gold was found in 1874. The Lakota, in alliance with the Northern Cheyenne and Arapaho Tribes, resisted land seizure in a series of battles known as the Great Sioux War of 1876. Following the conflict's infamous Battle of the Little Big Horn, the U.S. government retaliated by attaching a "sell or starve" rider to the Indian Appropriations Act of 1876, which cut off rations to the Lakota until hostilities were quelled and the Black Hills were ceded. The next year, the U.S. Congress issued the Sioux Agreement of 1877, which removed the Black Hills from the Great Sioux Reservation boundary, in violation of the Treaty of Fort Laramie of 1868. The Great Sioux Reservation was thereby reduced from 60 million acres to less than 22 million acres. [5]

The seizure of the Black Hills coincided with two pieces of federal legislation that were consequential to the experiences of American Indians and settlers throughout the Dakota Territory that also framed systems of water infrastructure developed therein. The Dawes Act, or General Allotment Act of 1877, broke apart communally owned reservation lands into allotments of 160 acres that were assigned to individual tribal families. Across the country, 90 million acres

[3] Hufstetler and Bedeau, "South Dakota's Railroads: An Historic Context."
[4] Hufstetler and Bedeau, "South Dakota's Railroads: An Historic Context."
[5] Hoover, "The Sioux Agreement of 1889 and Its Aftermath," 58.

of unallotted land were removed from Native control. The Desert Lands Act of 1877, intended to encourage non-Native settlement of arid lands in the western United States, amended earlier provisions set forth by the Homestead Act of 1862, expanding claims from 160 acres to up to 640 acres, so long as the lands were irrigated. By 1880, an estimated 81,781 settlers lived in southeastern Dakota Territory, and an estimated 16,487 lived in and around the Black Hills.[6]

Thousands of immigrants settled in southeastern Dakota Territory during the Great Dakota Boom (c. 1878-1887), spurring politicians to seek out control of additional land for newcomers and open new regions to railroad access, particularly west of the Missouri River. The Sioux Agreement of 1889 further reduced tribal land holdings by 9,274,669 acres, breaking up the Great Sioux Reservation into six smaller reservations: Cheyenne River, Crow Creek, Lower Brule, Pine Ridge, Rosebud, and Standing Rock. So-called "surplus" land was made available for agrarian settlement and business development as non-Natives flocked to the region. After passage of the Sioux Agreement of 1889, tribes retained just 18.3 percent of land controlled prior to the Yankton Treaty of 1858. [7]

Reservations marked a radical rupture to lifeways among the Očeti Šakówiŋ as the U.S. government sought to "civilize" Native people.[8] By about 1883, bison—one the most culturally important food resources among the Očeti Šakówiŋ—were nearly extirpated from the region, and federal Indian policies centered agriculture as a way to assimilate Native people into Euro-American society.[9] An overseeing non-Native agent from the Office of Indian Affairs was assigned to each reservation to disburse rations, direct a paramilitary police force, and oversee practices intended to assimilate Native people. [10]

South Dakota historians have identified the transfer of land from tribal control to non-Native settlement and subsequent changes in their aftermath as among the most pivotal developments in state history. [11] Consequently, histories of water conveyance sites and structures in South Dakota are closely interwoven with related social, political, and economic developments and likewise have left enduring traces of the past on the landscape today.

Early Agricultural Irrigation: Private Ditches and Canals, 1876-1902

Farmer-Owned Irrigation Ditches in the Black Hills, beginning c.1876

During the Black Hills gold rush, mining was the primary focus among most early settlers, but irrigated agriculture developed to provision growing populations with food and forage. Soon after Euro-American settlers entered the Black Hills, they began to modify the landscape for agricultural purposes, digging earthen irrigation ditches that are among the oldest

[6] Schell, "Drought and Agriculture in Eastern South Dakota," 162–80.
[7] Hoover, "The Sioux Agreement of 1889 and Its Aftermath," 59.
[8] Biolsi, "The Birth of the Reservation: Making the Modern Individual among the Lakota."
[9] Moorehead, *The American Indians in the United States: Period 1850-1914*.
[10] Biolsi, "The Birth of the Reservation: Making the Modern Individual among the Lakota," 28.
[11] Hoover, "The Sioux Agreement of 1889 and Its Aftermath," 57.

historic sites and structures associated with water conveyance in South Dakota. As early as 1876, settlers in the Black Hills banded together to construct private irrigation works, bringing water from natural water courses to farmlands and making this a prosperous agricultural district.[12] Crops grown under irrigation included grains like wheat, oats, rye, and barley and a variety of fruits and vegetables that were sold almost exclusively within local markets.[13] Forage plants like alfalfa, timothy, clover, and native hays were also grown under irrigation and sold to ranchers as winter feed for livestock. Harvests of these plants supported the cattle range industry that emerged during the late 1870s, meeting local demands for meat and dairy, supplying beef that the federal government bought for rations on reservations, and raising cattle that could be sold on eastern markets at high prices.[14]

The era of farmer-owned irrigation in the Black Hills extended from the late 1870s through the late 1890s, during which time settlers dug hundreds of miles of ditch, predominantly in the fertile valleys of Butte, Custer, Fall River, Lawrence, and Pennington Counties.[15] Ditches designated as farmer-owned include both "ditches which were constructed and operated by farmers, but never officially organized, as well as those systems owned by corporations in which stock was held by the farmers."[16] While some groups of farmers worked together in unofficial capacities and never incorporated, most organized themselves into more formalized ditch companies to construct irrigation works, or transitioned to this form of organization after years in operation.[17] When ditch companies underwent legal incorporation, they typically took over the water rights of one or more members, and issued capital stocks that farmers purchased to secure a stake in the company and access to water.[18]

Construction and Maintenance of Earthen Gravity Irrigation Ditches

Farmer-owned irrigation ditches in the valleys of the Black Hills were simple earthen channels to transport water from creeks down an elevation gradient directly to farmlands without storage in an intermediary dam or reservoir (Figure 1).[19] Most farmer-owned ditches were dug directly into the sloping ground surface using rudimentary tools like shovels, picks, and horse- or mule-drawn scrapers known colloquially as "slip-arounds" or "fresnoes" (Figure 2). To ensure a consistent fall or slope, farmers used tapered boards and water levels (similar to carpenter levels) to measure.[20] In some cases, soil removed during the ditch digging process was redistributed to create a berm around the main conduit of the ditch.[21] Channels smaller than the main ditch known as laterals or lateral ditches were then dug to carry water from the main ditch to adjacent

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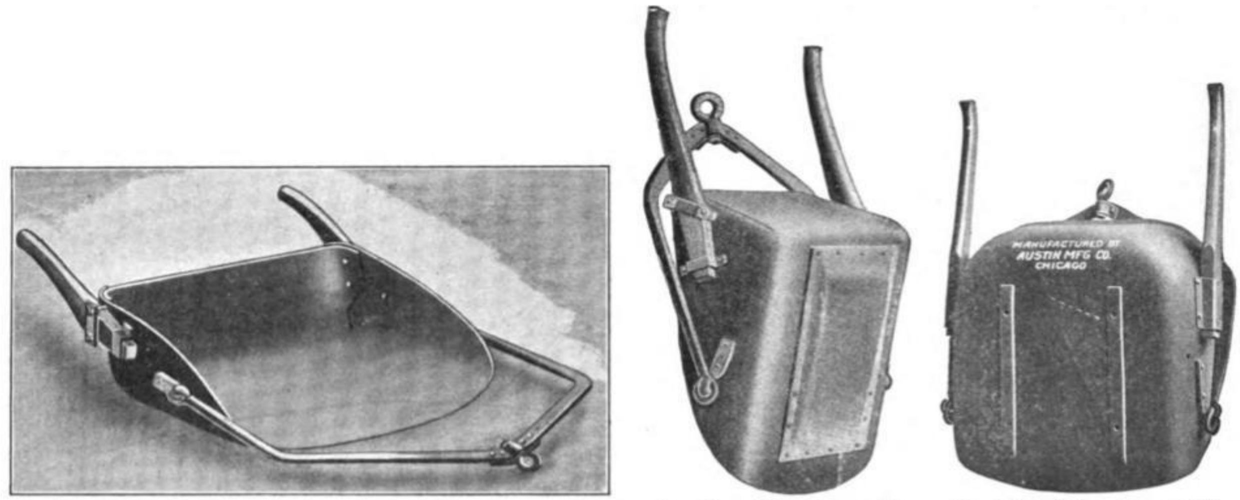
[12] Lea, *Irrigation in South Dakota*.
[13] Whiteside, "A History of Irrigation in South Dakota."
[14] Schell, *A History of South Dakota*.
[15] Whiteside, "A History of Irrigation in South Dakota".
[16] Johnson, "Lower Rapid Valley Irrigation Ditches," Irrigation Ditches, 3.
[17] Johnson, "Lone Tree Ditch."
[18] Johnson, "St. Germain Ditch."
[19] Lea, "Fourth Biennial Report of the State Engineer to the Governor of South Dakota for the Years 1911-1912."
[20] Higbee, *Lifeblood of The Valley: Watering Spearfish and Its Croplands*.
[21] Johnson, "Hawthorne Ditch."

farmlands. Headgates were installed at the point where water was divided from the main ditch into the lateral and regulated the amount of water that was distributed to farmers' fields. Some headgates were made of wood and raised or lowered the gate using a wooden gate stem held in place by a wooden peg. Other headgates were more substantial. Some farmer-owned ditches had concrete headgates that appear as a wall built across the waterways with one or more ditch gates mounted in its center. Numerous irrigation ditches in the Black Hills were outfitted with headgates with a rectangular or round gate housed within a welded angle iron frame, raised or lowered by turning a cast iron handwheel attached to a threaded stem.

Figure 1. A person and horse-drawn carriage near an irrigation ditch with snow on its embankments. The inscription reads "First Irrigation in Pennington County." Courtesy of the South Dakota State Historical Society (SDSHS), South Dakota Digital Archives (2012-10-03-311).



Front View of Drag Scraper. **Rear View of Drag Scraper with Double Bottom.** **Rear View of Drag Scraper with Runners.**

Figure 2. Drag scrapers were used to dig irrigation ditches in South Dakota during the late 1800s and early 1900s. One scraper could excavate an estimated 40 cubic yards each day.

With a few notable exceptions, irrigation ditches typical of the era were shallow, about 1-3 feet deep, and narrow, spanning from approximately 1-4 feet wide at the bottom.[22] Their modest dimensions meant that people and animals could easily wade through or jump across them. Farmer owned ditches were built and maintained by farmers themselves, sometimes individually, but most commonly in collaboration with fellow members of ditch companies. Despite the rudimentary nature of their design, irrigation ditches were labor-intensive to build, use, and maintain, and required close attention to detail during construction to ensure the longevity of their water carrying capacity. Water needed to move through the ditch quickly enough to prevent sediment from accumulating, but slowly enough to avoid eroding the ditch into a deep gully.[23] Many of the early settlers of the Black Hills had previous experience mining in other states or territories and arrived with practical knowledge of redirecting moving water through ditches, flumes, and sluices for mining purposes. Some settlers shifted their focus from mining to agriculture sometime after arriving in the Black Hills, putting their previous experiences constructing water conveyance systems to use in irrigation as the region's economy diversified.[24]

Ditch maintenance was a laborious task associated with irrigated agriculture. A main ditch was used to divert water from a moving stream, channeling it along the boundaries of irrigated farmlands. Laterals functioned as secondary channels, branching off from the main ditch to deliver water to specific fields. Farmers were responsible for looking after their own laterals throughout the year and worked together to maintain shared portions of the main ditch. These tasks followed a predictable annual cadence. Headgates that controlled the distribution of

[22] Higbee, *Lifeblood of The Valley: Watering Spearfish and Its Croplands*.
[23] Higbee, *Lifeblood of The Valley: Watering Spearfish and Its Croplands*.
[24] Schell, *A History of South Dakota*.

water from main ditches to laterals were closed in autumn before the first freeze of the season. This allowed the ditches to remain dry over winter, avoiding damage from ice.[25] Farmers then worked together to prepare ditches for the reintroduction of water in the spring. Around the beginning of April, farmer-owned ditch companies selected one of their members as superintendent to lead maintenance efforts. They were responsible for coordinating activities and ensuring that all members of the company contributed their required proportion of the work, often determined by the acreage of irrigated land or proportion of ditch company stock owned. Together, the farmers cleaned out the ditch from headgate to terminus, cutting back vegetation, repairing in-ditch fixtures used to regulate water flow like headgates and weirs, and ensuring that trash racks and fish-screens were clear of debris that would otherwise clog the system.[26] "Ditch walking" was a common practice for irrigators, and often involved not just the farmers and fellow irrigators of ditch companies, but oftentimes their whole families, who helped to ensure that ditches flowed smoothly when gates were opened.[27]

Black Hills farmers focused their efforts in irrigated agriculture on the intensive cultivation of small areas of land.[28] When it came time to irrigate, some groups allocated water from the ditch by rotation, providing water first to the field that had gone the longest without it. Farmers took a "head of water," a subjective quantity defined loosely as what was reasonably needed to irrigate a field.[29] Distribution varied, however, and some ditch companies allocated water in volumes proportional to the shares of stock a farmer owned in an incorporated ditch company.[30] In both cases, water distribution oftentimes became a flashpoint, especially during periods of drought and as the number of water users increased in the region over time. Prior to 1905, there were no state regulations on flowing streams, and "appropriation could be made by posting a notice on a post or tree at or near the point of diversion."[31] Disputes between farmers over water use practices were commonplace, and typically revolved around over-appropriation and the maintenance of laterals, as one farmer's failure to maintain a section of ditch could create issues for other water users downstream. Larger and more public legal battles were underway by the turn of the century throughout the Black Hills, and especially in Spearfish and Lower Rapid Valleys,[32] which became home to the largest and most extensive farmer-owned irrigation systems in the state.[33]

Spearfish Valley, Lawrence County

Early settlers of Spearfish Valley, the majority of whom arrived in the Black Hills from Montana, recognized Spearfish Creek and the surrounding topography of the valley as ideal for

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[25] Crane, "Irrigation in the Black Hills, South Dakota".
[26] Henris, "Spearfish: The Environmental Margins of a Northern Great Plains Apple District, 1882-1914."
[27] Higbee, *Lifeblood of The Valley: Watering Spearfish and Its Croplands*.
[28] Lea, *Irrigation in South Dakota*.
[29] Crane, "Irrigation in the Black Hills, South Dakota".
[30] Johnson, "Lower Rapid Valley Irrigation Ditches," Irrigation Ditches.
[31] Lea, *Irrigation in South Dakota*, 46.
[32] Crane, "Irrigation in the Black Hills, South Dakota", 175.
[33] Whiteside, "A History of Irrigation in South Dakota".

irrigation and, "being acquainted with the use and value of water, located with reference to a water supply, filing their water rights almost as soon as they took out their land claims, many as early as 1876 and 1877." [34] One prospector-turned-farmer, Robert Evans, was among the earliest to irrigate land in the Black Hills, and is credited with leading construction of ditch networks that transformed the Spearfish Valley into a burgeoning cropland. Though he was not formally educated in irrigation or hydrology, Evans had experience building ditches, tunnels, and flumes from his years spent gold mining in Montana. Shortly after arriving in Spearfish Valley, his focus shifted from mining to farming. In May 1876, Evans and a team of five other farmers began to dig a ditch with a consistent fall of two inches every hundred feet, working backwards from their adjacent fields toward the creek.

Between 1876 and 1897, 12 ditches were constructed along Spearfish Creek, and an additional 3 ditches were built along its tributaries, Higgins Gulch and Spring Creek. The resulting 30 miles of ditch irrigated a total of 5,335 acres in the Spearfish Valley.[35] Irrigated farms in Spearfish Valley ranged in size from 5 to 15 acres. [36] Truck gardens, also referred to as market gardens, became prevalent and profitable. Located near the center of Black Hills populations, Spearfish farmers found a ready market for local sales of perishable produce that otherwise would not have been able to survive transportation elsewhere, including fruits and vegetables like potatoes, onions, carrots, beets, turnips, and a variety of berries, which were sold to growing populations in nearby mining towns. [37]

A number of Spearfish's historic irrigation ditches are still in use, including, among others, the Ramsdell, Evans-Tonn, Walton-Schuler, Mann, and Owens-Gay Irrigation Ditches, which have been mapped and are available online via the City of Spearfish.[38] The Evans-Tonn Ditch, built in 1876, is recognized as the oldest running irrigation ditch on Spearfish Creek. It is managed by the Evans-Tonn Ditch Company and supplied 88 irrigators with water as recently as 2020.[39]

Lower Rapid Valley, Pennington County

The most extensively irrigated region of the Black Hills was the Lower Rapid Valley, where settlers dug irrigation ditches drawing water from Rapid Creek as early as 1877. Lower Rapid Valley farmers focused their efforts on fresh produce that could be sold at local markets, alongside smaller and oftentimes experimental plots of wheat and other small grains. During the late 1870s, irrigation in the Lower Rapid Valley provided a diverse array of fruits and vegetables to the local markets, and by 1885, had diversified into wheat, rye, oats, barley, corn, and buckwheat.[40] They also grew substantial quantities of alfalfa to supply the burgeoning cattle

[34] Crane, "Irrigation in the Black Hills, South Dakota", 166.
[35] Crane, "Irrigation in the Black Hills, South Dakota."
[36] Crane, "Irrigation in the Black Hills, South Dakota."
[37] Whiteside, "A History of Irrigation in South Dakota".
[38] City of Spearfish, "Irrigation Ditch Information."
[39] Evans-Tonn Ditch Company, "Spearfish Evans-Tonn Ditch Co."
[40] Johnson, "Lower Rapid Valley Irrigation Ditches."

industry, dedicating acreage nearly equivalent to that on which small grains were planted. By 1909, ditches of the Lower Rapid Valley alone irrigated over 15,000 acres, an area three times larger than any other irrigated by stream in South Dakota. [41]

In 1902, eight or more irrigation ditches were in operation, and investigations carried out by the United States Department of Agriculture that year proclaimed that practically all of the land in the Lower Rapid Valley was “under ditch.” [42] Two in particular, the Hawthorne and Iowa Ditches, were later identified by the state engineer as "typical of a large number of irrigation systems in use in Rapid Creek Valley."[43]

Figure 3. The headgate of the Hawthorne Ditch consists of a concrete wall with a low arch. The side facing downstream reads, “Hawthorne Ditch, Established July 10, 1886.” Courtesy of the Historic American Engineering Record (HAER) (SD,52-RACI.V,2-3).

The Hawthorne Ditch was a farmer-owned irrigation system built on the north side of Rapid Creek in 1886 (Figures 3 and 4). [44] It has a one-bank side-hill cross section, meaning that, during construction, soil excavated was thrown downhill to create a berm. The Hawthorne measured about 8 feet wide at the bottom and 2 feet deep, carrying water through 9.6 miles of

[41] Johnson, “Lower Rapid Valley Irrigation Ditches.”
[42] Lea, *Irrigation in South Dakota*, 46.
[43] Lea, “Fourth Biennial Report of the State Engineer to the Governor of South Dakota for the Years 1911-1912.”
[44] Johnson, “Hawthorne Ditch.”

ditch to irrigate 1,028 acres. [45] In 1890, the Hawthorne Ditch Company incorporated, issuing $5,000 in capital stocks. By 1910, it was owned by four farmers, and the ditch and associated assets were valued at $15,000. [46] More than one hundred years after its initial excavation, the Hawthorne Ditch continued to flow, providing water to 1,014 acres as recently as 1989. [47]

The Iowa Ditch was also farmer-owned, built on the northern benchlands above Rapid Creek in 1896.[48] The Iowa was about 12 feet wide at the bottom, 25-30 feet wide at the top, and 4-5 feet deep. It carried water through 6 miles of ditch and irrigated 1,023 acres of land. When incorporated in 1895, $125,000 in capital stocks were issued. By 1915, the Iowa Ditch assets were valued at $15,000. The Iowa Ditch was the last of the farmer-owned ditches constructed in Rapid Valley. [49] It was destroyed by the Black Hills-Rapid City Flood of 1972 and today is no longer in use (Figure 5). Its path has been disturbed by urban and residential development, and its diversion area is now a greenway.

Figure 4. The diversion dam and intake canal of the Hawthorne Ditch as it looked c. 1995. The diversion dam, made of boulders with concrete facing, was built across Rapid Creek and channels water to an intake canal. The diversion dam and intake canal are some of the only remaining examples of historic headworks in farmer-owned irrigation ditches in the Lower Rapid Valley. Courtesy of the HAER (SD,52-RACI.V,2).

[45] Lea, “Fourth Biennial Report of the State Engineer to the Governor of South Dakota for the Years 1911-1912.”
[46] Johnson, “Hawthorne Ditch.”
[47] Johnson, “Hawthorne Ditch.”
[48] Johnson, “Iowa Ditch."
[49] Johnson, “Iowa Ditch."

Figure 5. A portion of the Iowa Ditch on the north branch above Rapid Creek as it appeared c. 1994 after two decades of disuse. Courtesy of HAER (SD,52-RACI.V,3).

While the Hawthorne and Iowa Ditches were identified as typical irrigation systems from the time, they were among the largest and most well-documented. Some farmers who built irrigation works in the Lower Rapid Valley collaborated in loosely organized groups that did not hold annual meetings, leaving behind fewer detailed records of ditch company goings-on, if any. Administrative records from the Hawthorne Ditch, Iowa Ditches, and others in the Lower Rapid Valley have been documented and summarized in reports by the Historic American Engineering Record (Figure 6). [50] These records include the following extant farmer owned ditches, listed with the acreage of their watering capacity as reported in 1989: Cyclone Ditch (722 acres), Little Giant Ditch (1,014 acres), Lone Tree Ditch (992 acres), and the St. Germain Ditch (1,527 acres).[51] The last records regarding the Rapid Valley (Murphy) Ditch date to 1937, at which time it reportedly irrigated 840 acres.[52] The Lower Rapid (South Side) ditch is also extant, but a canal dug in 1904 now splits from the original ditch, skipping a portion of its original route on the valley floor, instead carrying water southward through foothills until it later rejoins with its original course.[53] The course of aforementioned ditches documented by the Historic American Engineering Record (excluding Little Giant) are visible to the public on Google Maps.

[50] Johnson, "Hawthorne Ditch."
[51] Johnson, "Cyclone Ditch."
[52] Johnson, "Lower Rapid Valley Irrigation Ditches."
[53] Johnson, "Lower Rapid Ditch (South Side Ditch)."

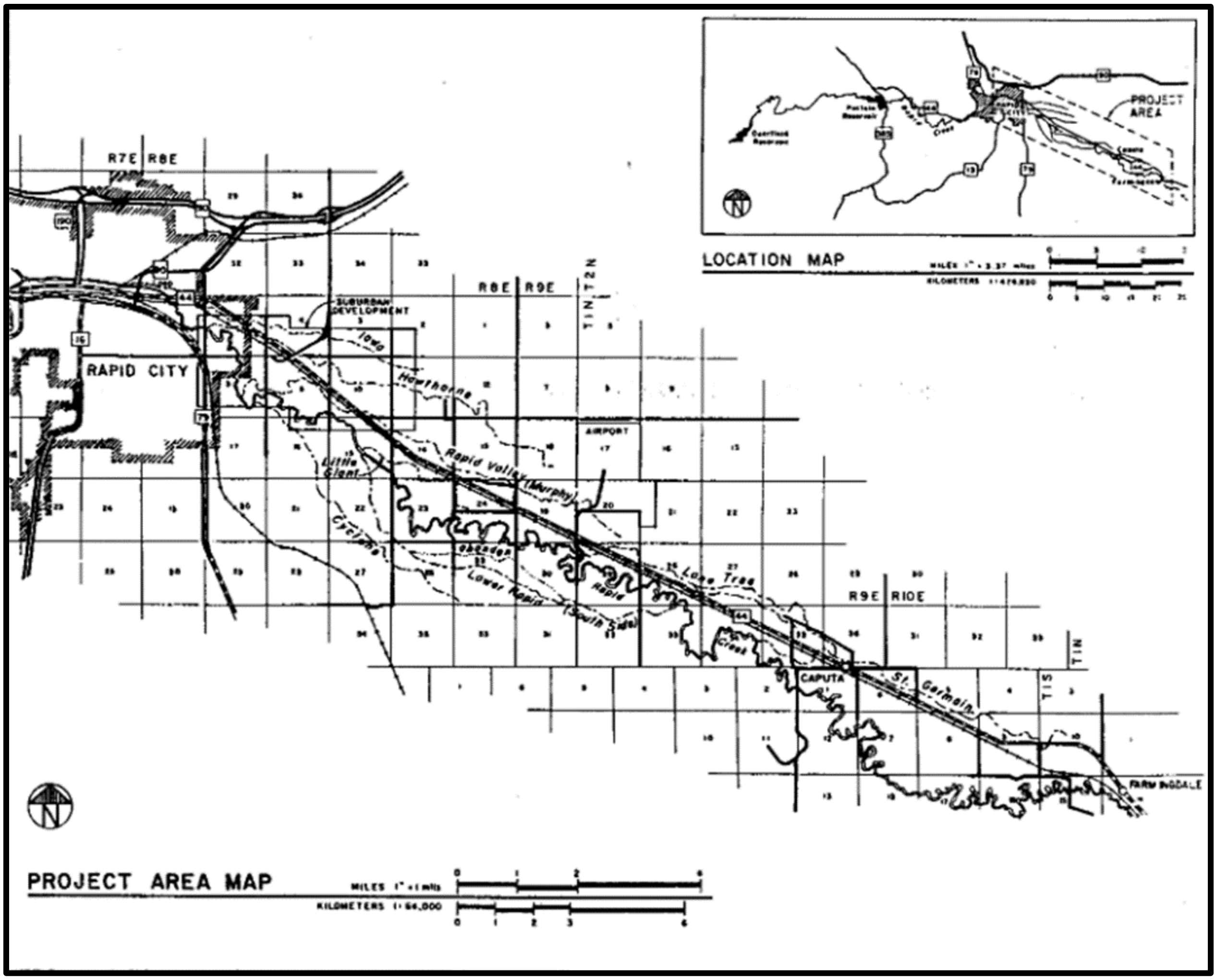

Figure 6. Irrigation ditches along Rapid Creek mapped by HAER.

Private Capital and Corporate Irrigation Projects, late 1880s-1902

The success of farmer-owned irrigation ditches in the Black Hills encouraged investment in corporate irrigation projects of a greater scale. During the late 1880s, speculators formed commercial irrigation companies to develop thousands of acres of land, installing irrigation infrastructure, and selling smaller individual tracts of land, often with the intention of attracting new settlers to recently established towns.[54] In some cases, these developments were also intended to attract new settlers to recently established towns.[55] Unlike farmer-owned system, corporate irrigation projects were built and maintained by hired workers on behalf of the commercial irrigation company, and farmers secured access to water via the purchase of a farm and payment of water rent and/or quantity-based use fees, or in some cases, through time and

[54] Taylor, *Glimpses into Edgemont's Past: A Recording of Early-Day Events about Edgemont, South Dakota*.
[55] Taylor, *Glimpses into Edgemont's Past: A Recording of Early-Day Events about Edgemont, South Dakota*, 19.

labor, by returning a portion of crops harvested to the corporation for sale.[56] Ultimately, however, many large-scale irrigation projects were not as profitable as anticipated, and as a result, corporations often failed. Despite the short-lived nature of these projects, historians have argued that the collapse of large-scale private capital irrigation projects, in part, helped to enable passage of the Reclamation Act of 1902 and subsequent federal involvement in irrigation projects.[57]

The Redwater Canal is an early example of a corporate irrigation project in South Dakota. At the time of its construction in 1888, the Redwater Canal was the largest irrigation system in South Dakota, spanning approximately 42 miles in Butte County, 30 of which were used, and 12 eventually abandoned.[58] The Redwater Canal was built and maintained by the Redwater Land and Canal Company, an English corporation that furnished irrigators with water for profit. Using weirs at headgates and laterals, the company measured and dispersed water to customers, who paid rent based on acreage, and additional fees for the quantities of water consumed.[59] The canal provided water to about 5,000 acres in the Redwater Valley, and had an estimated capacity of 10,000 acres.[60] In 1890, the Redwater Canal conveyed water to more than 60 customers, mostly on large ranches that grew hay for livestock.

Some capitalist irrigation projects expanded the size and capacity of existing farmer-owned irrigation ditches. The Cascade Ditch in Fall River County, for example, was built by Herman Mahler in 1887 to supply water to his own farm. In 1890, the ditch was expanded to provide water to neighboring farms, irrigating 877 acres. It was later purchased by the Cheyenne Valley Ranch Company, and they continued to furnish water to neighboring farms at a flat rate, until the ditch changed hands again to the Hot Springs Irrigation and Livestock Company. In 1900, the ditch was expanded by 11 miles, nearly tripling the lands irrigated to 2,600 acres. As late as 1931, Cascade Ditch irrigated about 1,000 acres in Fall River County.[61]

The Edgemont Canal in Fall River County was another corporate irrigation work of the era, noteworthy for its scale and ultimate failure. In 1893, southern Black Hills speculators formed the Edgemont Land and Improvement Company. Their primary goal was to build an irrigation canal that could draw settlers to the county.[62] In 1896, the company completed construction on a 14-mile canal that drew water from Beaver Creek, a tributary of the Cheyenne River, at a reported cost of $80,000 (Figure 7).[63] A small earthen dam was built at the confluence of Beaver Creek and the Cheyenne River, behind which log-and-stone riprap was installed along the riverbank, outfitted with a wooden floodgate to regulate intake into the canal. The teams of workmen hired by the Edgemont Land and Improvement Company excavated the

[56] Lea, *Irrigation in South Dakota*, 46.
[57] Johnson, "Lower Rapid Valley Irrigation Ditches."
[58] Crane, "Irrigation in the Black Hills, South Dakota."
[59] Crane, "Irrigation in the Black Hills, South Dakota."
[60] Lea, *Irrigation in South Dakota*, 46.
[61] Whiteside, "A History of Irrigation in South Dakota".
[62] Taylor, *Glimpses into Edgemont's Past: A Recording of Early-Day Events about Edgemont, South Dakota*.
[63] Taylor, *Glimpses into Edgemont's Past: A Recording of Early-Day Events about Edgemont, South Dakota*.

ditches using horse-drawn scrapers and shovels, removing surface vegetation and extracting stones from the canal's intended path with these tools and pickaxes. Wooden flumes were built to carry water across low-lying areas, and a reservoir was also constructed. The Edgemont Land and Improvement Company reported an estimated irrigation capacity at 10,000 acres. The company sold 4,000 acres of land divided into 40-acre parcels along the ditch to experienced irrigators from Colorado, Iowa, and Nebraska. The Edgemont Company also built a stable, shed, and home referred to as a "ditch house" for new settlers who planned to farm "under ditch," using irrigation (Figure 8). Seeds were provided by the Edgemont Company, and farmers paid back the company with their time, labor, and a share of the crops grown under irrigation.

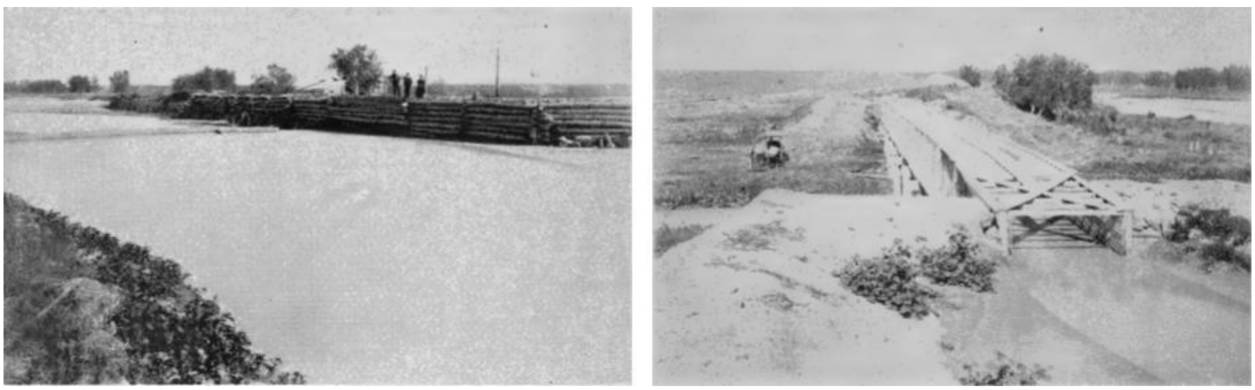

Figure 7. "Dam and headgate in Cheyenne River at head of the Edgemont Canal" (left); "Flume carrying canal water over Moss Agate Creek" (right).

Figure 8. "A home of a settler under the canal," (left) and "A salt-box type house with settlers under the canal" (right).

Initially, the Edgemont Canal irrigated about 4,000 acres of land. The first year's harvest was a success, but the following two years were adversely affected by drought, economic panic, and depression. Water shortages discouraged a number of settlers, who abandoned their farms altogether. A similar exodus of recent settlers occurred after a fire destroyed Edgemont's business district in 1898.[64] The Edgemont Land and Improvement Company, which by that time

[64] Darton and Tangier Smith, "Description of the Edgemont Quadrangle."

had also invested in local quarrying, smelting, and wool milling, could not find interested investors for new projects, let alone secure the capital necessary to sustain projects already in progress. In 1898, the Edgemont Canal was abandoned, "upon the failure of the company that promoted the enterprise."[65] Later reports of the state engineer indicate that, following litigation over possession and ownership of the ditch, it was repaired and used again, irrigating about 2,000 acres well into the early 1900s. [66]

In 1899, as the era of privately owned irrigation infrastructure drew to a close, 223 miles of ditch and canal irrigated over 38,000 acres in western South Dakota, representing over 180 private projects managed by unincorporated farmer organizations, farmer-owned ditch companies, and private investment corporations.[67] Remarkably, many of the early historic irrigation ditches remained in use well into the late twentieth or early twenty-first centuries, providing water to contemporary people living in the Black Hills and surrounding regions.

Beginnings of the State Adjudication of Water, 1905-1909

In 1905, South Dakota adopted new legislation that standardized and systematized water use and water rights. The Water Law of 1905 (amended 1907, 1909) created the Office of the State Engineer, who was responsible for issuing permits to appropriate water and inspecting the safety, capacity, and efficiency of irrigation systems. [68] Ultimately, the State Engineer would be responsible for administering the state's water code, locating artesian wells for counties and townships, and carrying out provisions of the legislation related to drainage.[69] All water except navigable streams was placed under state supervision and divided the state into three water divisions, each of which was provided with its own water commissioner.[70] It also clarified water rights as defined by state law, established standards for construction, equitable distribution, and efficiency of irrigation works, and expanded the scope of state control beyond irrigation systems to complete control of the water supply. Most substantively, ditch and canal owners were required to install and maintain headgates and measuring devices at the point of diversion, both of which were subject to supervision of the State Engineer.[71] New ditch and canal constructions required permitting from the State Engineer, obtained by submitting construction plans, specifications, maps, and other data for review and approval. Pre-existing water rights established under territorial laws or local customs remained valid, so long as they had not lapsed from two years of non-use. [72] Determining their validity of pre-existing water rights took some time, however, as doing so required the state engineer to conduct fieldwork to assess compliance. Owners of existing ditches who failed to install headgates and measuring devices, or otherwise

[65] Lea, *Second Biennial Report of the State Engineer to the Governor of South Dakota for the Years 1907-1908*, 58.
[66] Lea, "Fourth Biennial Report of the State Engineer to the Governor of South Dakota for the Years 1911-1912."
[67] Whiteside, "A History of Irrigation in South Dakota"' Robinson, *A History of South Dakota*.
[68] Whiteside, "A History of Irrigation in South Dakota".
[69] Lea, *Third Biennial Report of the State Engineer to the Governor of South Dakota for the Years 1909-1910*.
[70] Lea, *Third Biennial Report of the State Engineer to the Governor of South Dakota for the Years 1909-1910*.
[71] Lea, *Second Biennial Report of the State Engineer*, 76.
[72] Lea, *Second Biennial Report of the State Engineer*, 11-15.

failed to comply with regulations, could have their water supply turned off as a consequence, and could be cited with a misdemeanor. [73] By 1908, the State Engineer's *Second Biennial Report* indicated that 94 permits to appropriate water had been issued since the law's enactment, of which 74 (~78.7 percent) were intended for the purposes of irrigation. [74] As the first decade of the 1900s drew to a close, State Engineer Samuel Lea estimated approximately 125,000 acres were under irrigation in South Dakota, but still considered it to be in a "formative period" for irrigation in the state. [75]

The Artesian Well Movement in East-Central South Dakota, 1881-1919

In the late 1800s and early 1900s, South Dakota's irrigated acreage was concentrated primarily in the Black Hills, and commercial scale irrigation was virtually absent from eastern portions of the state.[76] Eastern South Dakota is considered a semi-arid region, located between the 97th and 100th meridians that demarcate the humid east from the arid west. Historically in eastern South Dakota, areas along the North Dakota border and the east side of the Missouri River receive around 16 to 17 inches of rainfall annually, compared to 25 to 30 inches in the southeastern counties.[77] As such, eastern South Dakota was a viable region for agriculture without irrigation and early Euro-American settlers grew small grains, mostly wheat, during years with typical precipitation.[78] Irrigation was of little concern until a series of dry years occurred between 1886 and 1897.[79]

During the drought, inconsistent precipitation, high temperatures, high winds, and low relative humidity contributed to frequent and devastating crop failures. [80] As drought conditions intensified, attention turned to a newly identified potential source of relief: artesian water. A large, confined aquifer underlaid most of the lands between the Missouri River and James River (Figure 9).[81] Thick deposits of impermeable shale-dominated strata trapped water in permeable layers of Cretaceous-aged sandstones that are part of the Dakota formation.[82] Because the water bearing sandstone formations slope upward from west to east, fairly shallow artesian wells in eastern regions could bring water to the surface under the natural pressure created by its entrapment, forcing water upward until the point at which it reached hydrostatic equilibrium, without mechanical interventions from pumps or lifts.[83] The first artesian well in Dakota Territory was sunk at Yankton in 1881, followed by installations in Aberdeen and Andover in

[73] Lea, *Second Biennial Report of the State Engineer*, 20.
[74] Lea, *Second Biennial Report of the State Engineer*, 52-54.
[75] Lea, *Third Biennial Report of the State Engineer*, 70.
[76] Dumke and Dobbs, "Historical Evolution of Crop Systems in Eastern South Dakota: Economic Influences."
[77] Visher, *The Geography of South Dakota*."
[78] Schell, "Drought and Agriculture in Eastern South Dakota during the Eighteen Nineties," 162.
[79] Whiteside, "A History of Irrigation in South Dakota," 29; Schell, "Drought and Agriculture in Eastern South Dakota during the Eighteen Nineties.
[80] Schell, "Drought and Agriculture in Eastern South Dakota during the Eighteen Nineties," 162.
[81] Darton, "Preliminary Report on Artesian Waters of a Portion of the Dakotas."
[82] Wenzel and Sand, "Water Supply of the Dakota Sandstone in the Ellendale-Jamestown Area."
[83] Crane, "Irrigation in the Black Hills, South Dakota."

1882, Ashton in 1883, and Fort Randall in 1886.[84] During the "artesian well movement" of the 1880s and 1890s, thousands of artesian wells were sunk into the Dakota sandstone. Other water-bearing formations in and around the Black Hills were also exploited, to a lesser extent, during the early 1900s.

Legislation and Research on Artesian Wells

Beginning in the late 1880s, territorial, state, and federal legislation funded geological research and agricultural experimentation that investigated the feasibility of using artesian water for irrigated agriculture and ranching purposes in South Dakota. In 1887, with a combination of Congressional appropriations and funds approved by the Legislature of Dakota, a 320-acre experiment station was established at the land-grant Dakota Agricultural College in Brookings (Figure 10).[85] In 1890, the newly established state legislature of South Dakota created the office of the State Engineer of Irrigation, tasked with collaborating with the federal government and state experiment stations to develop systems of irrigation and establish best practices for using artesian waters. At a national scale, Congress appropriated $20,000 in 1890 to investigate the feasibility of artesian well irrigation in the semi-arid region of the United States, from the 97th meridian to the eastern foothills of the Rocky Mountains. [86]

Research and experimentation in the artesian belt of South Dakota began under the auspices of the U.S. Department of Agriculture and its newly created Office of Irrigation Inquiry. Congressional funds also supported intensive research conducted by the United States Geological Survey (USGS), which set out to ascertain the depths and extent of the Dakota Formation sandstone. At a state level, qualified engineers and experienced irrigators led research at the experiment station, where much attention was paid to the safety of consuming artesian water and its impacts on soil during irrigation, as concerns mounted about the iron, saline, and alkali taste of artesian waters, which were often accompanied by an "offensive odor." [87] Early results from experiment stations determined that artesian waters were perfectly safe for human consumption, livestock watering, and agricultural irrigation, even though they were not "first-class potable water."[88] Experimental crops were irrigated with water from artesian wells conveyed through ditches, and initially proved promising, abating farmers' concerns about salinity and alkalinity. Researchers determined that mineral residues, which harmed crops and soils, only precipitated when excessive quantities of water were used.[89] If such practices could be avoided, experiment station staff reasoned, artesian wells could be used as a viable source of water for irrigation.

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84 Robinson, *Doane Robinson's Encyclopedia of South Dakota*.
85 Lalley, "First Annual Report of the U.S. Agricultural Experiment Station for Dakota.
86 Whiteside, "A History of Irrigation in South Dakota".
87 Whiteside, "A History of Irrigation in South Dakota".
88 Shepard, "The Artesian Waters of South Dakota," 47.
89 Schell, "Drought and Agriculture in Eastern South Dakota during the Eighteen Nineties," 162.

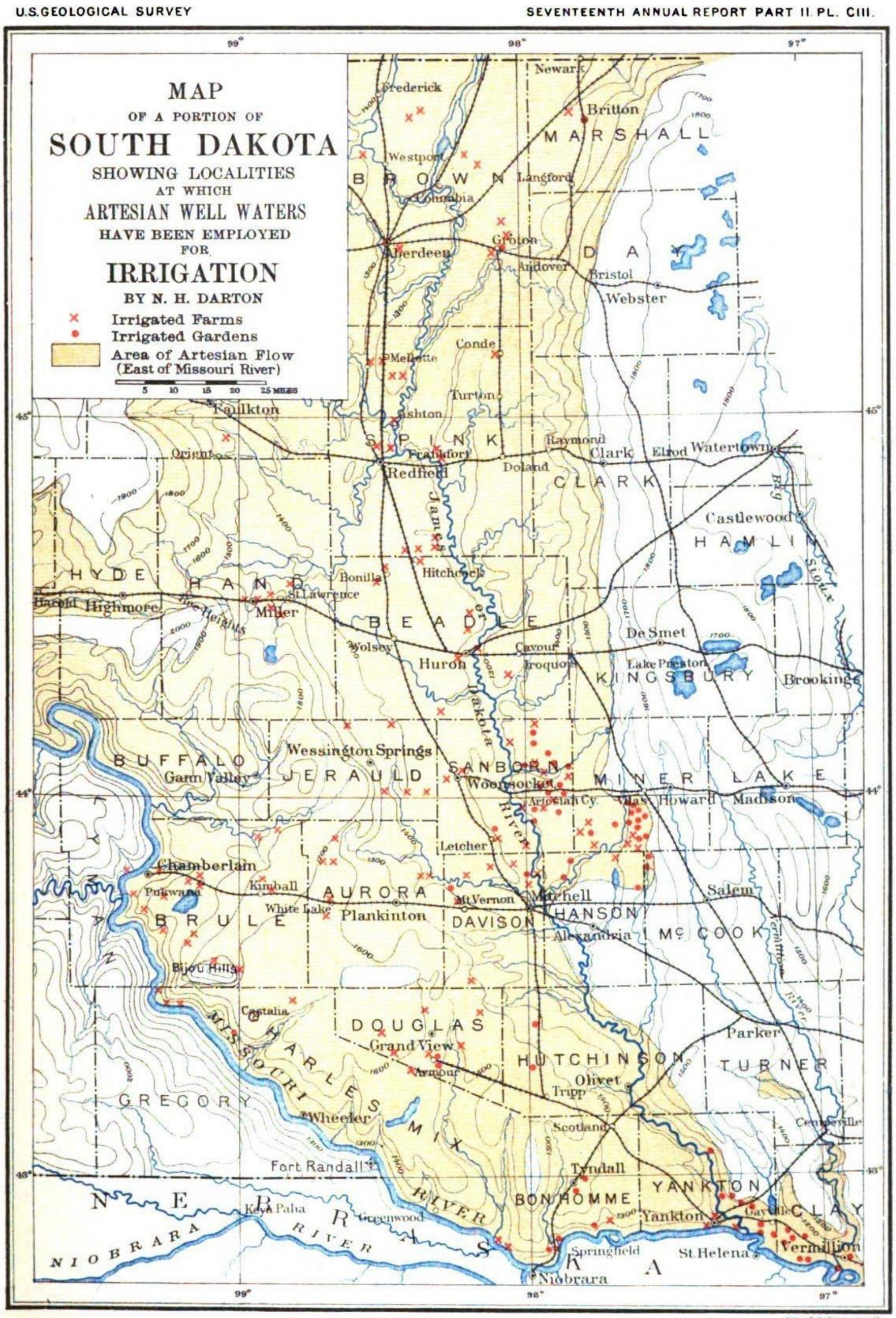

Figure 9. Map from Darton's (1896) *Preliminary Report on Artesian Waters of a Portion of the Dakotas* showing locations of artesian wells used for irrigation.

Figure 10. Experiment station plots at the South Dakota Agricultural College in Brookings, showing an irrigation ditch watering tomatoes on the left along with cabbage and other vegetables on the right.

Results from USGS were less optimistic. Many South Dakota farmers, ranchers, and legislators had become convinced that artesian wells were key to the growth and development of the state and described the water as unending. Geological evidence concurred that the water was renewable but may not be replenished fast enough to meet the demands of irrigation in the region. "Artesian reservoirs can never be an important source of water for irrigation," warned USGS Director, John Wesley Powell in 1891. He reasoned that "The supply of water thus naturally stored is small. The share of it that agriculture can economically obtain through wells is still smaller. Though irrigation has aided agriculture from the earliest times and though artesian wells have long been understood, the world has succeeded in using artesian water for agriculture in but a few exceptional spots. The Great Plains may become one of these exceptional localities, but the conditions do not warrant great expectations."[90] Powell's warnings went unheeded, or were dismissed altogether, and South Dakota legislators moved forward with water infrastructure that centered artesian well irrigation in the State's agricultural plans. The optimistic idea of an inexhaustible water supply and its infinite benefits were furthered by promotional materials and irrigation manuals directed toward farmers and ranchers in the region. Early irrigation manuals urged Dakotans to "lose no time in stopping to figure–as many are continually doing–whether

[90] Powell, "Eleventh Annual Report."

irrigation will pay or not, for it never did anything else but pay, here or elsewhere."[91] Farmers and ranchers were encouraged to dig artesian wells and secure a steady water supply this way by any means necessary.

Sinking Artesian Wells

During the 1880s and early 1890s, sinking a typical artesian well for irrigation cost between $3,000 and $5,000, and required the additionally expensive and labor-intensive construction of a system of ditches and reservoirs for water conveyance.[92] As such, artesian wells were largely inaccessible to individual farmers and ranchers. Some counties constructed artesian wells for communal use,[93] and others purchased well drilling rigs that could be loaned to farmers.[94] In 1891, the State Legislature of South Dakota passed the Melville Law, allowing townships to issue bonds to cover the cost of sinking artesian wells, pending support from a public election.[95] The Melville Law was amended in 1893 and again in 1895, extending this authority to county jurisdictions, and later, increasing the limit of public debt allowable for the purposes of sinking artesian wells for irrigation and domestic use. [96] Passage of the Melville Law in 1891 led to a marked increase in the number of artesian wells sunk across the state. That year, State Engineer of Irrigation J. H. Baldwin reported over 100 wells sunk under provisions of the Melville Law, with over 100 applications also in progress. [97]

Between 1889 and 1892, numerous well drilling corporations emerged, including 15 in-state and 2 out-of-state groups, with intentions of organizing irrigation east of the Missouri River. [98] Among these, the James River Irrigation Company and Dakota Irrigation Company were most prominent (Figure 11). [99] Unlike private individuals, these larger companies had specialized expertise and were able to secure the capital necessary for well drilling.

Artesian wells were typically sunk on or near the highest point on the land intended to be irrigated, but in some cases were placed at more convenient lower points on the landscape, especially near outbuildings. Early wells in South Dakota tend to be large bore, most commonly 4½ or 6 inches in diameter, drilled using pole or cable rigs.[100] As the well was drilled, excavated sediment was pumped out, and a snugly-fitted pipe called a casing was inserted to maintain the bore. Sinking large-bore wells was common at the time because, compared to wells of smaller diameter. Large-bore wells were less likely to clog, less costly and easier to clean, and casings could be replaced instead of abandoning the artesian well altogether. The volume of water

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[91] Butler, *Irrigation Manual,* 8.
[92] Schell, "Drought and Agriculture in Eastern South Dakota during the Eighteen Nineties."
[93] Fite, *Peter Norbeck: Prairie Statesman*, 15.
[94] Whiteside, "A History of Irrigation in South Dakota".
[95] Schell, "Drought and Agriculture in Eastern South Dakota during the Eighteen Nineties."
[96] Whiteside, "A History of Irrigation in South Dakota".
[97] Whiteside, "A History of Irrigation in South Dakota".
[98] Whiteside, "A History of Irrigation in South Dakota".
[99] Whiteside, "A History of Irrigation in South Dakota," 15.
[100] Butler, *Irrigation Manual,* 10.

brought to the surface was not dependent on the diameter of the well, however, but rather was determined by its depth, pressure, and a variety of geological variables. Innovations in well drilling technology soon reduced both the size and cost of artesian wells. Jetted wells were typically between 1⅓ and 3 inches in diameter.[101] They were more durable and more affordable and, by the mid-1890s, cost between $300 to $500, or about a quarter the price of earlier wells.[102]

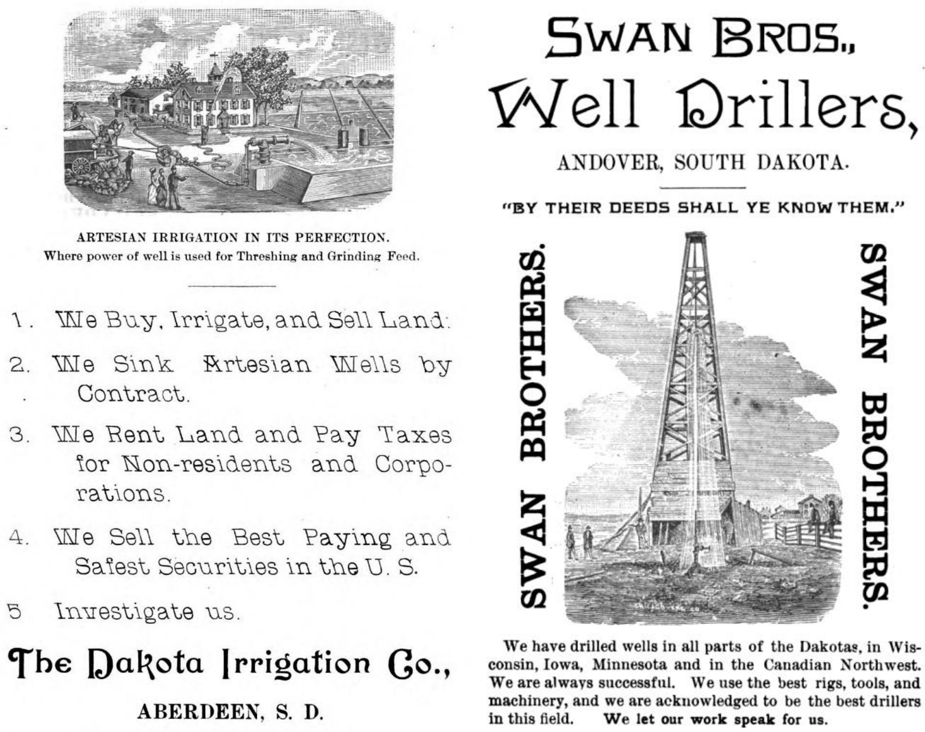

Figure 11. Advertisements for The Dakota Irrigation Company (left) and Swan Brothers Well Drillers (right) featured in Butler's (1892) *Irrigation Manual*.

Many depictions of early artesian wells show them in an uncontrolled state, blasting water high into the air or horizontally into water retaining areas (Figure 12). High pressure necessitated the use of materials that could withstand such force. Irrigation manuals encouraged the use of wrought-iron lap-welded pipes, connected with tapered or sleeve couplings to ensure the success of a well (Figure 13).[103] The high pressure also resulted in a variety of debris from within the well to be brought to the surface. Initially, perforated pipe was installed at the bottom of wells to limit the expulsion of sand, mud, rock, and other materials (Figure 14), but over time, drillers opted for aboveground solutions. Water from artesian wells was usually stored in reservoirs, ponds, or other artificial bodies of water for stilling, allowing sediment to settle before water was used for irrigation or other purposes. Storage was further emphasized as a means of letting water from the continuous flow not go to waste. The typical volume was not

[101] Wenzel and Sand, "Water Supply of the Dakota Sandstone in the Ellendale-Jamestown Area."
[102] Fite, *Peter Norbeck: Prairie Statesman*, 19.
[103] Butler, *Irrigation Manual*, 10.

usually sufficient for irrigation, unless it was compiled and stored during non-irrigating times for future use.[104]

Artesian well components visible from the ground surface typically include a vertical main pipe and gate valve operated by hand wheel. Some may be outfitted with a curved tee or reducer that channels the water horizontally (Figure 15). The flow of water could be controlled using a gate valve operated by a handwheel that was turned to increase flow of water or stop it altogether (Figure 16). Many farmers were under the impression that the artesian water supply was unending and allowed wells to flow unabatedly, and gate valves on artesian wells were not required by state law until 1939. Uncontrolled artesian wells ejected enormous volumes of water, depleting the pressure within an aquifer, and limiting the areas in which new wells could be sunk. As artesian pressure in underlying aquifers declined over time, some artesian wells stopped flowing to the ground surface and were outfitted with hand pumps or windmills to move the water the remaining distance from its apex to the ground surface.

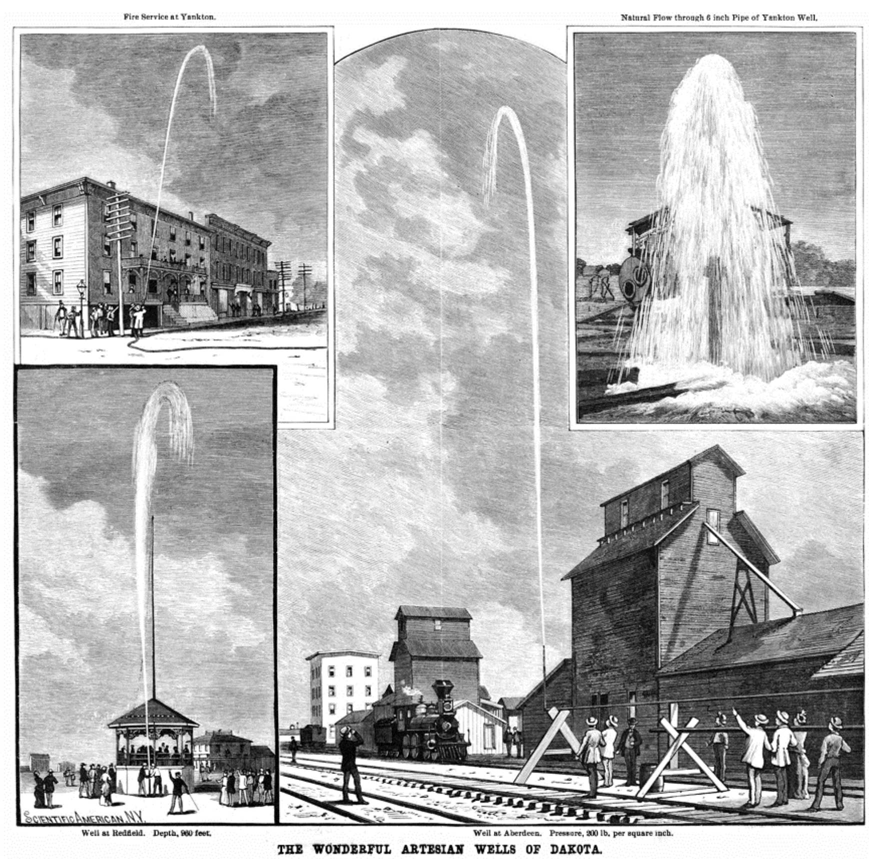

Figure 12. Depictions of “the wonderful artesian wells of Dakota” featured in Scientific American in 1889. The engravings show artesian wells at Yankton (upper left and upper right), Redfield (lower left), and Aberdeen (lower right and center).

[104] Wilson, *Manual of Irrigation Engineering*, 91.

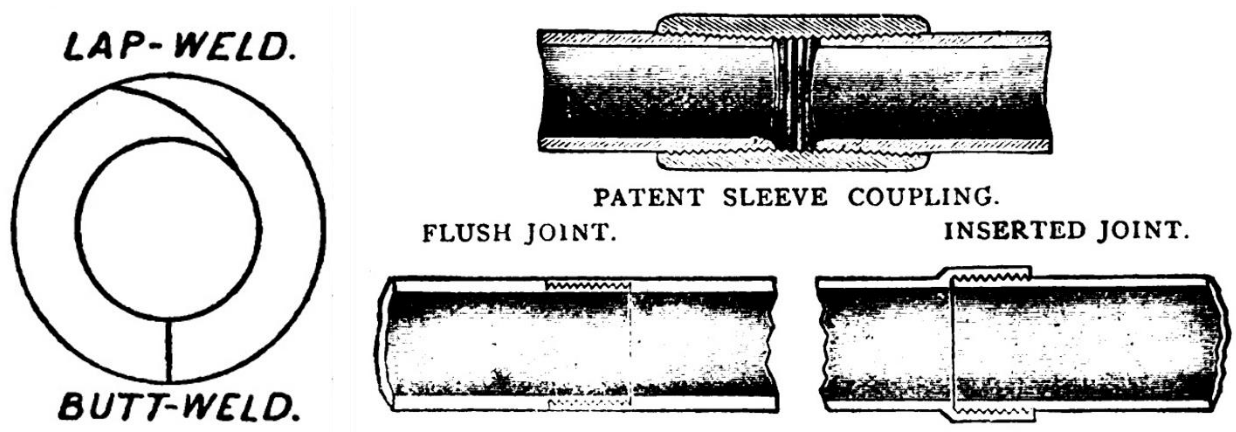

Figure 13. Drawing comparing lap-welds and butt-welds (left) and various forms of couple joints (right).

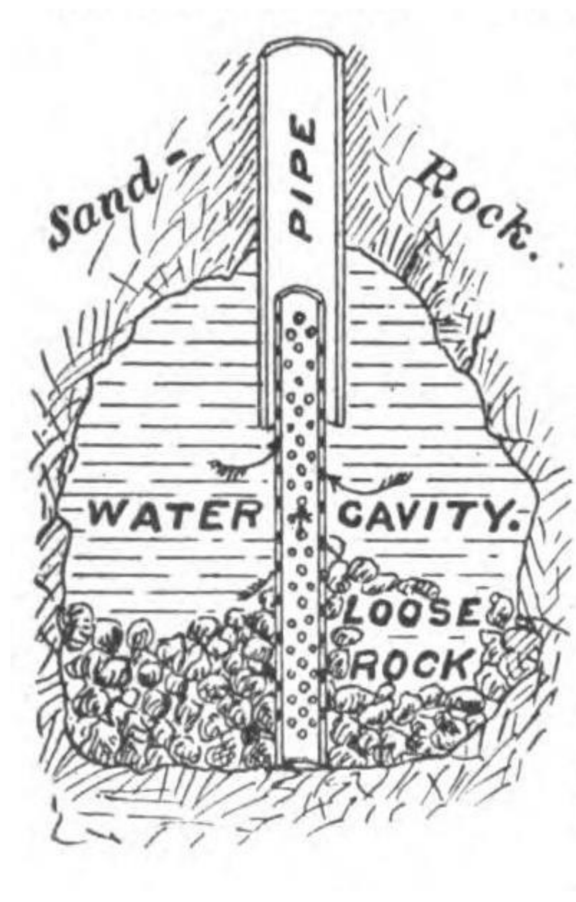

Figure 14. An illustration of “a perforated pipe in the bottom of a well.”

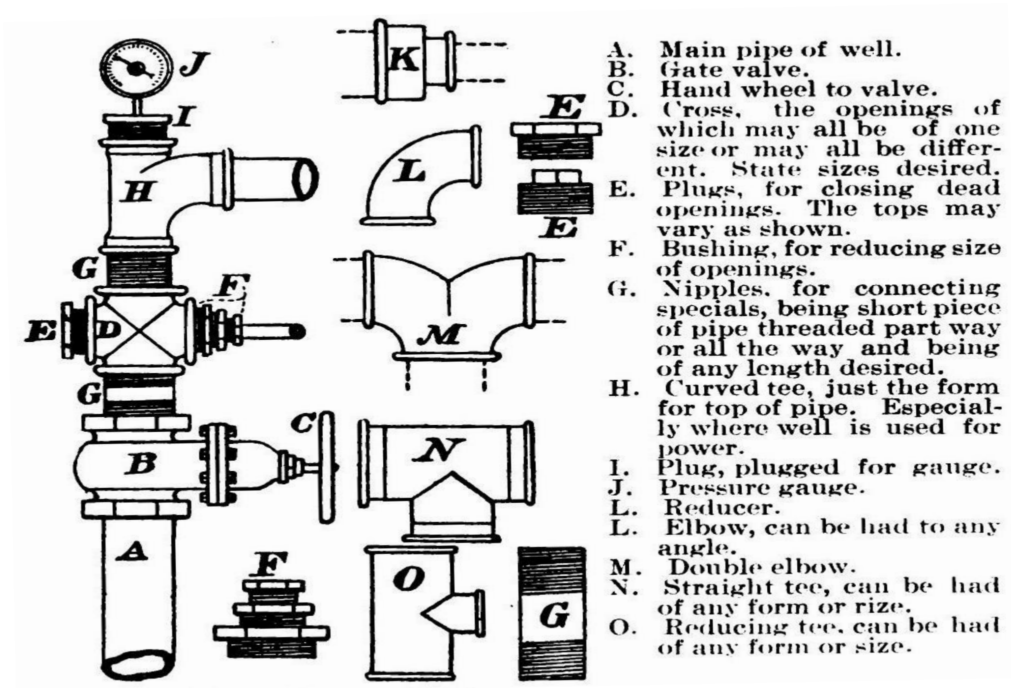

Figure 15. A diagram showing “special fittings for pipes” that comprise the visible aboveground portions of artesian wells.

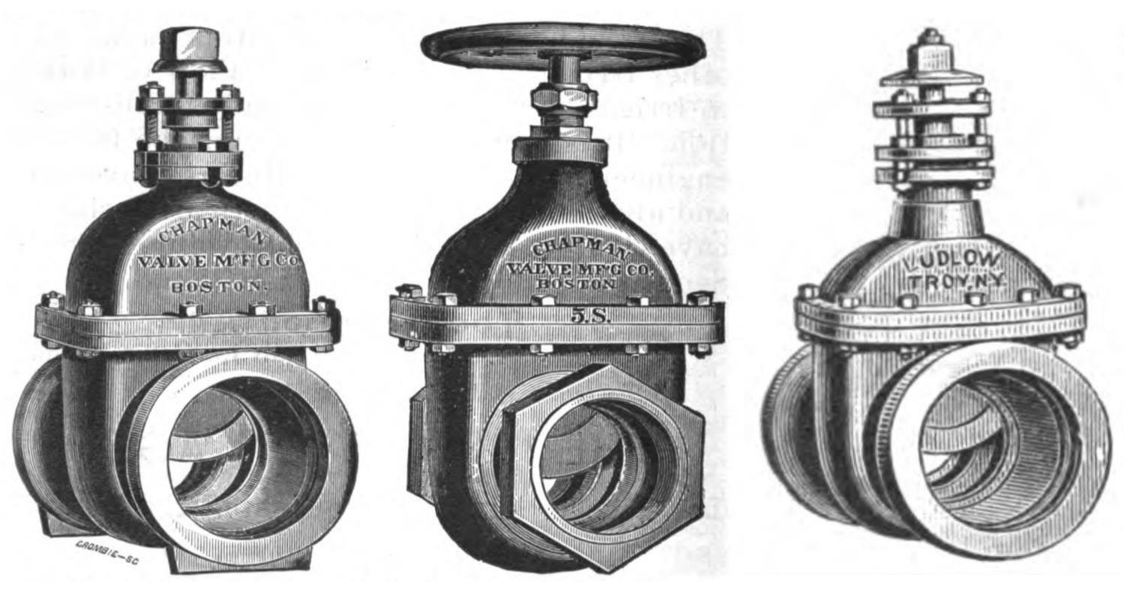

Figure 16. Examples of popular gate valves used to regulate the flow of artesian wells in South Dakota, manufactured by Chapman Valve Manufacturing Company (left and middle) and Ludlow Valve Manufacturing Company (right).

Artesian Wells for Milling and Hydroelectric Power

In addition to providing a source of water for irrigation, a number of early artesian wells were also put to use for milling and hydroelectric purposes. They were initially an attractive alternative to coal-powered boilers, promising safer working conditions and reduced milling costs to about one-third that of steam-powered operations.[105] The largest and earliest mill operated using artesian power was established in 1884 at Woonsocket, where a seven-inch well provided a 100-barrel-a-day milling capacity (Figure 17). Similar but smaller operations were later undertaken at the Fountain Mill and Excelsior Mill in Yankton in the early 1890s. [106] Some artesian well mills served multiple purposes, milling grain and watering crops by day, and generating electricity at night. This was the case for an artesian well sunk in 1890 in Springfield for Bonesteel and Turner, which had a milling capacity of 60 barrels a day and generated electricity at night. Similar operations emerged in Beadle County in 1891, where flour mills at Broadland were used for power and irrigation. During the day, the artesian well powered a 50-barrel roller mill, watered a 5-acre garden, and irrigated a 60-acre plot of wheat. At night, it supplied the town with power for electric light. Some mills were converted and devoted solely to hydroelectric power. The Chamberlain Mill used water pressure to power its milling operations and, in 1893, began to use artesian power to produce electricity for light at night (Figure 18). The use of artesian wells for milling and electricity soon fell out of favor, however. By 1903, only two artesian-powered mills were in use, one at Chamberlain.

Figure 17. An 1893 advertisement for flour mills in South Dakota featuring Northey & Duncan of Woonsocket, which claimed to be the "largest mill operated by artesian power in the world."

[105] Schell, *South Dakota Mining to 1900*.
[106] Schell, *South Dakota Mining to 1900*.

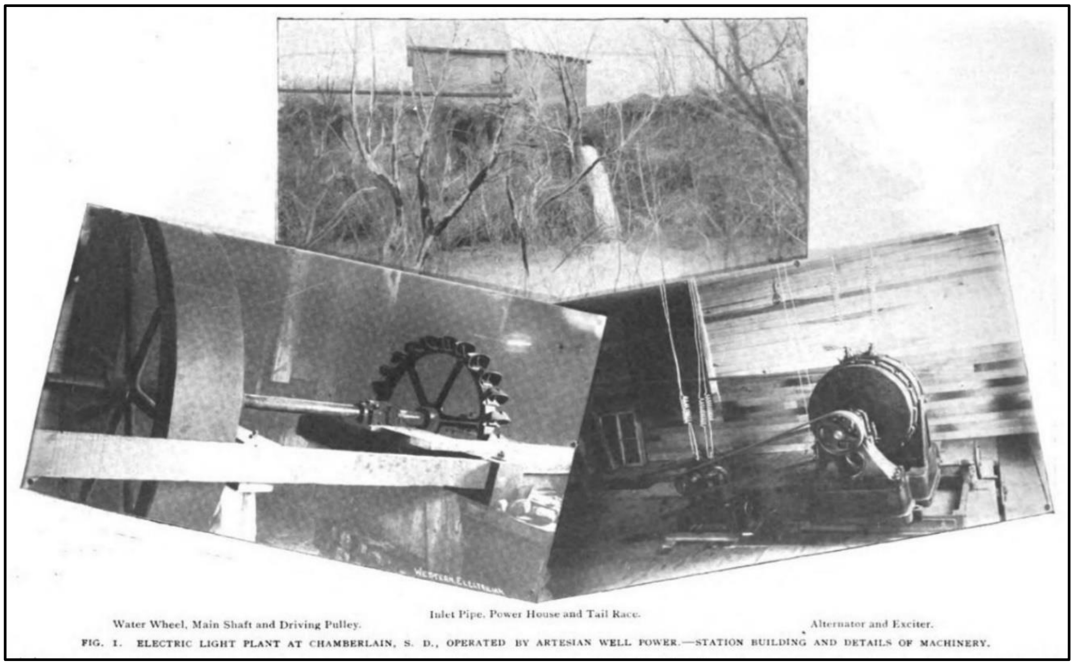

Figure 18. Images of machinery at the Chamberlain Mill published in Western Electrician in 1896, showing the water wheel, main shaft, and driving pulley (bottom left), inlet pipe, powerhouse, and tail race (top middle), and alternator and excitor (bottom right).

Artesian Wells on Reservations

Irrigation was an important component of federal Indian policy across the country and within Dakota Territory.[107] During the 1870s and 1880s, agricultural endeavors on reservations yielded suitable harvests only intermittently. Thousands of acres were planted year after year, but drought, grasshoppers, dry winds, and storms reduced or destroyed most crop yields substantially. Between 1895 and 1897, artesian wells were sunk on the Rosebud, Crow Creek, Yankton, and Cheyenne River Reservations for purposes of agricultural irrigation and domestic use. In 1895, near the height of the artesian well movement, nearly fourteen years after the first artesian well was successfully sunk in Dakota Territory, construction of an artesian well was initiated on the Rosebud Reservation. That year, in his annual report to the Commissioner of Indian Affairs, the Rosebud Reservation agent wrote:

> "As many of the streams where Indians are located and where many have taken their lands individually become entirely dry each season, necessitating their going elsewhere temporarily to find water for stock, an artesian well has recently been begun near the head of several streams, which if successful will aid in keeping them supplied with flowing water. This being the first artesian well undertaken in this section of country west

[107] Pisani, "Irrigation, Water Rights, and the Betrayal of Indian Allotment."

> of the Missouri River, the outcome is being watched with interest by those residing in adjoining white communities."[108]

The well was recorded by the USGS the following year as in progress at a depth of 2,075 feet and ultimately reached water-bearing strata more than 2,500 feet below the ground surface. [109] Within two years, an estimated 1,275 acres were under cultivation in small garden patches where corn, pumpkins, potatoes, and other vegetables were grown, but the main crop was hay, produced to support the reservation's principal industry, stock raising.[110]

Bureau of Indian Affairs agents stationed on the Yankton Reservation recommended the installation of an artesian well for the purpose of filling Lake Andes as early as 1890, but appropriations were not made until several years later.[111] Historically, the 4,000-acre glacial lake went dry during times of low precipitation and was known to revert to pasture at intervals of about twenty years.[112] The Bureau of Indian Affairs intervened to ensure that the lake was filled with water, even during times of drought. [113] In 1896, at a cost of $3.94 per foot, an eight-inch artesian well was sunk on the Yankton Reservation along the shore of Lake Andes by well driller A. E. Swan. [114] The artesian well had leakage problems immediately following construction, and failed two years later.[115] The well was later re-packed and a decent flow resumed. By that time, two additional artesian wells had been sunk for the purpose of filling Lake Andes.[116] The wells at Lake Andes were called "a great success, filling that once dry lake…the volume of water in this lake is increasing."[117] Two years later, the Lake Andes artesian wells were still in suitable working order as reservation residents shifted their focus toward stock raising over crop agriculture (Figures 19 and 20).[118]

At the Cheyenne River Reservation, an artesian well was sunk in 1896. Water was reached at a depth of 1,337 feet, and the well provided an output of 500 gallons per minute.[119] The following year, a waterworks system was installed, supplied by the artesian well, for irrigation and domestic purposes.[120] By 1900, however, the well had failed, and residents were forced to return "back to hauling buckets of water from the Missouri River."[121] By the 1890s, many farmers–both on and off reservations–had already shifted use of artesian waters from crop

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108 "Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1895," 295.
109 Darton, "Preliminary Report on Artesian Waters of a Portion of the Dakotas."
110 "Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1897," 263.
111 "Fifty-Ninth Annual Report of the Commissioner of Indian Affairs," 60.
112 Nesheim, "An Environmental Biography of Bde Ihanke-Lake Andes." 60.
113 Nesheim, "An Environmental Biography of Bde Ihanke-Lake Andes." 33.
114 Nesheim, "An Environmental Biography of Bde Ihanke-Lake Andes." 59.
115 "Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1896," 304; "Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1898," 289.
116 "Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1897," 282.
117 "Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1898," 289.
118 "Annual Reports of the Secretary of the Interior for the Fiscal Year Ended June 30, 1899" 348-349.
119 "Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1896," 284.
120 "Annual Reports of the Secretary of the Interior for the Fiscal Year Ended June 30, 1897," 262.
121 "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1900," 372; "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1901," 359.

growing to stock raising, where wells provided a consistent supply for cattle and sheep.[122] As the nineteenth century came to a close, stock raising became favored over irrigated agriculture on reservations, and the intended purpose of artesian wells shifted accordingly.

An artesian well was also sunk at the Crow Creek Reservation in 1896 and was considered "such an immense success" the sinking of a second well was also authorized.[123] "When this is done," the agent wrote, "the entire reservation will be made accessible for stock raising."[124] Within three years, however, the first well stopped flowing, and subsequent reports document repeated advocacy for the artesian wells for grazing purposes, apparently to no avail.[125]

Figure 19. Water from a wellhead filling a small pond created along Lake Andes in Charles Mix County. Courtesy of the SDSHS, South Dakota Digital Archives (2009-10-19-004).

[122] Schell, "Drought and Agriculture in Eastern South Dakota."
[123] "Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1896," 288.
[124] "Annual Reports of the Secretary of the Interior for the Fiscal Year Ended June 30, 1897," 266.
[125] "Annual Reports of the Secretary of the Interior for the Fiscal Year Ended June 30, 1898," 270; "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1900," 373.

Figure 20. Cattle grazing in the vicinity of Lake Andes, Charles Mix County. Courtesy of the SDSHS, South Dakota Digital Archives (2014-12-31-301).

Artesian Wells in Western South Dakota

Though most artesian wells were located between the Missouri and James River Valleys, a small number were also located in and around the Black Hills (Figure 21). During the early 1900s, artesian wells were sunk into various water-bearing strata underlying the Black Hills and surrounding areas, most notably at Belle Fourche, Edgemont, Spearfish, Sturgis, and Rapid City.[126] In general, artesian wells west of the Missouri River needed to be drilled deeper to reach water bearing strata of the Dakota and Lakota Formations, and unlike earlier artesian wells of west-central South Dakota, most of the later artesian wells of western South Dakota were used primarily for industrial purposes and/or municipal water supplies rather than irrigation. By 1913, an estimated 80 flowing artesian wells were present in the Black Hills and surrounding areas.[127]

Decline of the Artesian Well Movement

By the turn of the century, the fervor for artesian wells had waned. The State Engineer of Irrigation Office was disbanded, and the experiment station at the Agricultural College at Brookings shifted its focus to dryland farming of drought-tolerant crops and restoring native grasslands and forage crops without irrigation.[128] South Dakota's "artesian well craze" began in

[126] Darton, "Artesian Waters in the Vicinity of the Black Hills, South Dakota."
[127] O'Harra, *O'Harra's Handbook of the Black Hills*, 69.
[128] Schell, "Drought and Agriculture in Eastern South Dakota."

1881, peaked in 1896, and declined into the state's early onset of economic depression in 1919. Artesian wells "offered neither immediate relief nor permanent solution to the problems of Dakota wheat area,"[129] for a variety of reasons. Among artesian wells that provided water without fail, few were profitable. Many farmers could not pay back the interest due from sinking the well in the first place. Later innovations in well drilling made artesian waters accessible to the average South Dakota farmers and ranchers, but even those who had sunk cheaper and more durable small-bore wells often did not see a return on their investments; financial records even from well drillers who used jetting rigs show that significant credit was often extended to struggling farmers, but numerous lawsuits sought compensation for unpaid bills.[130]

Artesian wells were also prone to structural failure, making them a risky investment for farmers and ranchers who often found themselves in precarious financial situations.[131] In some cases, wells failed because of shoddy construction and the use of poor-quality materials. In others, wells stopped flowing because of diminished pressure within the larger aquifer.[132] While water within the basin was renewable–recharged by the percolation of precipitation–overuse could outpace the seemingly endless supply and reduce pressure to such a scale that water no longer reached the surface of some wells. Between 1886 and 1923, the western boundary of artesian flow moved east as the head pressure of the Dakota artesian basin declined (Figure 22).[133] Much of this decline occurred rapidly between 1902 and 1915 by an estimated rate of 12.7 feet annually—an amount that would have been appreciable and recognized by those who relied on water supplied by artesian wells.[134] By 1938, in Brown County, where wells had been drilled in greater numbers than anywhere else in the state, only about 477 of the 1,937 wells (25 percent) recorded by the South Dakota State Planning board were still functioning unaffected; 1117 (~58 percent) had declined, and 343 (~18 percent) had stopped flowing altogether.[135] Waste almost certainly contributed to the marked declines in pressure and availability. Many artesian wells flowed in a completely uncontrolled state and became known as "wild wells," ejecting enormous volumes of water that would not be put to use. It was not until 1939 that gate valves were required by state law to control or shut off the flow of water altogether.

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[129] Cleworth, "Artesian-Well Irrigation," 201.
[130] Fite, *Peter Norbeck: Prairie Statesman*.
[131] Cleworth, "Artesian-Well Irrigation," 195-201.
[132] Schell, "Drought and Agriculture in Eastern South Dakota."
[133] Wenzel and Sand, "Water Supply of the Dakota Sandstone in the Ellendale-Jamestown Area."
[134] Wenzel and Sand, "Water Supply of the Dakota Sandstone in the Ellendale-Jamestown Area."
[135] Davis, Dyer, and Powell, "Progress Report on Wells Penetrating Artesian Aquifers in South Dakota," 54.

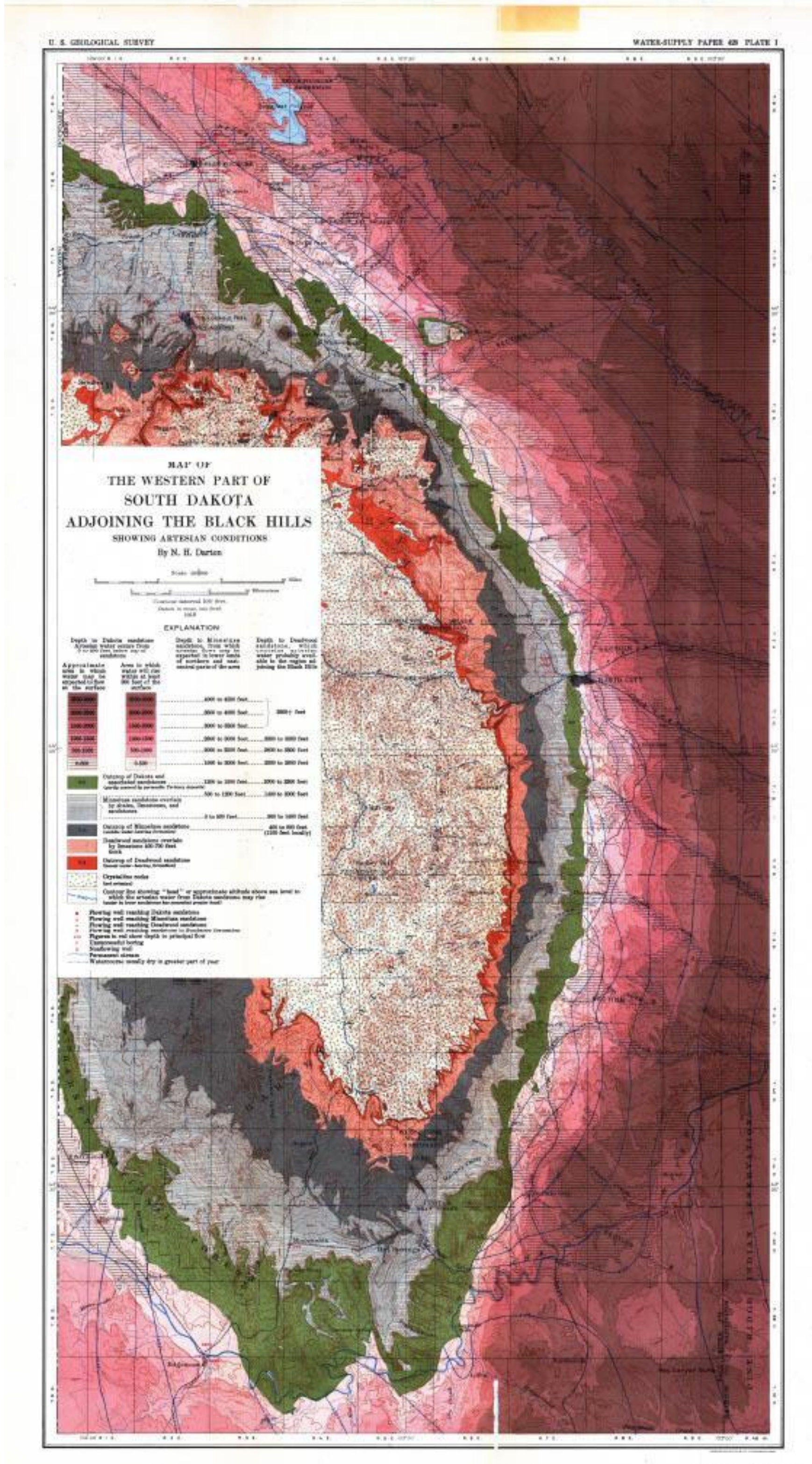

Figure 21. Map from Darton's (1918) *Artesian Waters in the Vicinity of the Black Hills, South Dakota* showing the locations of artesian wells drawing water from various sandstone formations.

By the 1940s, many functional artesian wells ceased to flow and as such were converted into pumped wells. In some cases, the pressure was sufficient to bring artesian water just a few feet below the ground surface, so surface pitcher pumps and other forms of suction pumps were used, often attached directly to the well casing. In other instances, water was far below the surface and deep well pumping systems were installed by cutting off the inner casing and lowering in pump cylinders.[136]

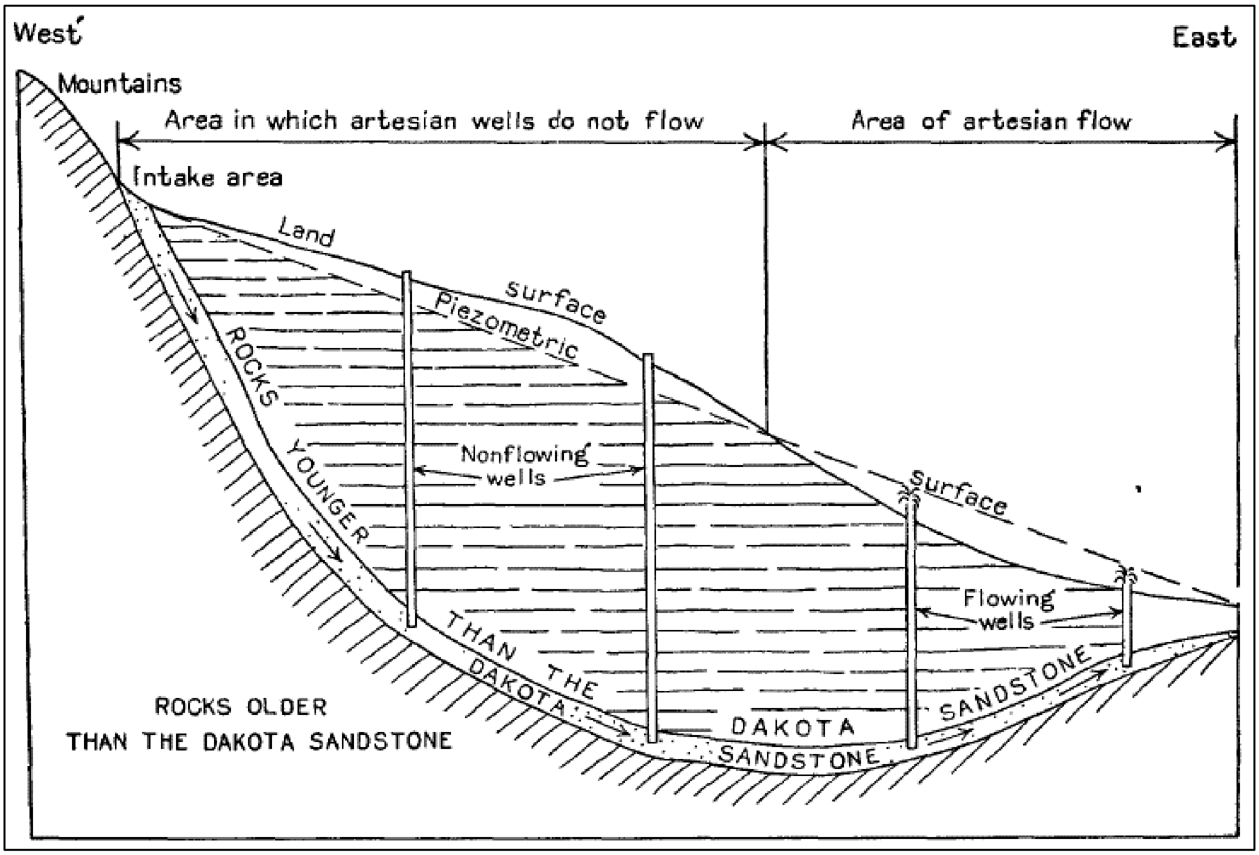

Figure 22. "Diagrammatic section across the Dakota artesian basin showing the general position of the Dakota sandstone and the hydrostatic head of the water in it."

Today, abandoned artesian wells are subject to the Administrative Rules of South Dakota, which stipulates those unused wells must be sealed. Abandoned artesian wells that are unsealed and still flowing may be located in depressions with aquatic vegetation in otherwise dry areas, and the South Dakota Department of Agriculture & Natural Resources suggests searching for the following kinds of records to locate artesian wells, especially those that are abandoned and/or unsealed: well completion reports and/or water rights permits filed with the Water Rights Program, historic photos showing building locations, county/city building permits, and fire insurance plan drawings, which may show the location of wells. Appropriate precautions should be taken, as abandoned wells of all kinds can be a safety hazard and may cause bodily harm to

[136] Wenzel and Sand, "Water Supply of the Dakota Sandstone in the Ellendale-Jamestown Area." 29.

people, wild animals, and/or livestock. They may also be a vector for pollution to enter groundwater systems and can reduce the artesian head pressure of other wells that tap into the same aquifer, which may affect their utility.

Stock Dams, Dugouts, and Stormwater Reservoirs for "Practical Irrigation"

As settlement expanded between the Black Hills and Missouri River after the breaking up of the Great Sioux Reservation in 1890, homesteaders and other early settlers excavated simple earthen reservoirs to collect rainfall in the summer months and snowmelt in the spring. These reservoirs fell primarily into two categories: stock dams and dugouts. Stock dams were built in the channels of dry draws, which are gullies on intermittent streams "caused by erosion that carry storm water to streams or creeks during and after rainfall." [137] Dugouts, in contrast, are isolated basins that are comparably smaller and shallower, described as "rectangular holes dug to intercept surface runoff or to expose the water table."[138] Both forms of water storage satisfied requirements for the irrigation of land acquired under the Desert Lands Act and provided a permanent or semi-permanent water supply, typically for livestock.[139] The construction of larger storage reservoirs was considered the only practical solution for irrigation, and many such structures, new and old, are still in use for irrigation and livestock watering today.[140]

The Beaver Creek Reservoir was an early attempt to impound water for irrigation in the state, built in 1896 by the Beaver Creek Irrigation and Canal Company in southwestern South Dakota. Located near South Dakota's border with Wyoming, the Beaver Creek Reservoir is notable for several reasons, including the fact that it was one of very few private reservoirs that was constructed with engineering supervision, nearly a decade before such oversight was required by state law. The reservoir had a 1,405-acre-foot capacity that could irrigate between 600 and 700 acres of land. The Farmers' Union Ditch conveyed the water to fields intended for irrigation.[141] Ultimately, however, the Beaver Creek Reservoir became "a source of expense instead of a benefit to the land."[142] It was set to divert water in Wyoming, but irrigated fields in South Dakota, and became embroiled in controversy and litigation over the appropriation of water from interstate streams. The matter was not settled until more than fifty years later, in 1948, when Wyoming and South Dakota signed the Cheyenne River Compact, reaching an agreement on interstate water rights.[143]

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[137] Whiteside, "A History of Irrigation in South Dakota," 22.
[138] Johnson et al., *Eastern South Dakota Wetlands*," 26.
[139] Johnson et al., *Eastern South Dakota Wetlands*; Johnson and Higgins, *Wetland Resources of Eastern South Dakota*.
[140] Samuel H. Lea, *Second Biennial Report of the State Engineer*, 89.
[141] Lea, *Irrigation in South Dakota*.
[142] Lea, *Irrigation in South Dakota*, 39.
[143]The matter was not settled until more than fifty years later, in 1948, when Wyoming and South Dakota signed the Cheyenne River Compact, reaching an agreement on interstate water rights.

The Barbour Reservoirs were more typical of those built in South Dakota for stormwater irrigation during the late nineteenth and early twentieth centuries.[144] In 1906, a series of three reservoirs were constructed by Louis Barbour on a homestead about five miles northeast of Belle Fourche on the west fork of Basin Creek (Figure 23).[145] Teams of horse-drawn scrapers were used to borrow earth from above and below the dam and dig a ditch about 100 feet long to provide water to fields.[146] The reservoirs measured between 100 and 150 feet long and spanned about 10 feet wide at the top, creating a total surface area of 7 acres.[147] The reservoirs held a combined capacity of 25 acre-feet, capable of irrigating 20 acres of land, dispersed through wooden box outlets with sliding wooden gates that could be moved from a footbridge above them.[148] A wasteway returned surplus water back to another reservoir by means of wooden box and culvert.[149]

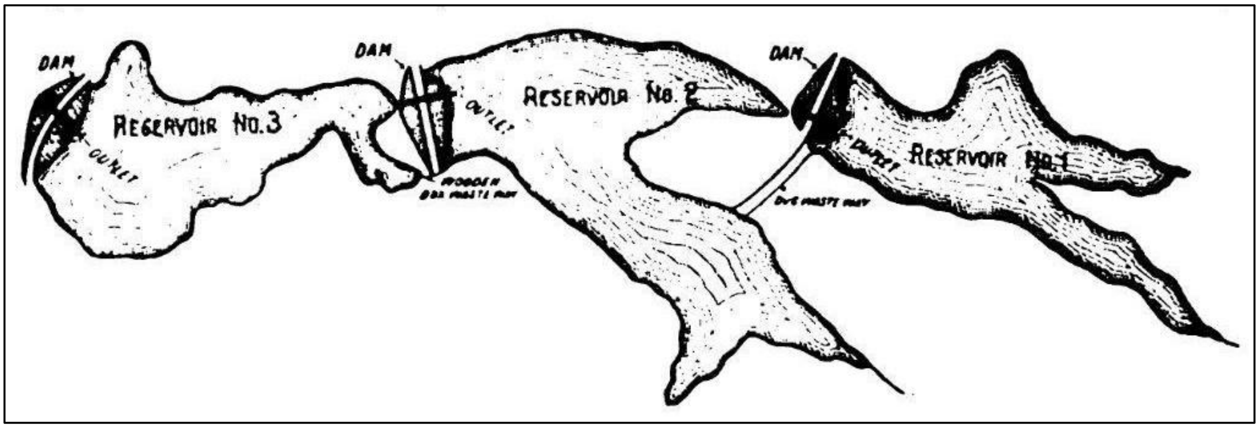

Figure 23. "Sketch showing the position of Barbour Reservoirs."

The earthen dams, made out of sticky clay "gumbo" soil and silt, were subject to deterioration from waves created by prevailing winds, so board fences were installed and cottonwood trees were planted as wave protection (Figure 24). These methods proved inadequate, however, to such an extent that the State Engineer clarified that the dams of the Barbour reservoirs "were evidently built without engineering supervision, and are not cited as examples of suitable construction for this class of work."[150] Though they were often the only building materials available, the combination of gumbo and silt was prone to failure.[151] The Water Laws of 1905 and 1907 enforced engineering specifications, including material

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144 Whiteside, "A History of Irrigation in South Dakota;" Lea, *Third Biennial Report of the State Engineer*; Lea, *Irrigation in South Dakota*.
145 Lea, *Irrigation in South Dakota*; Whiteside, "A History of Irrigation in South Dakota.
146 Herrmann, "Small Reservoirs in Wyoming, Montana, and South Dakota."
147 Lea, *Irrigation in South Dakota*.
148 Herrmann, "Small Reservoirs in Wyoming, Montana, and South Dakota."
149 Herrmann, "Small Reservoirs in Wyoming, Montana, and South Dakota."
150 Lea, *Irrigation in South Dakota*, 37.
151 Whiteside, "A History of Irrigation in South Dakota."

requirements, that effectively brought construction of earthen dams like the initial three Barbour reservoirs to a halt. [152]

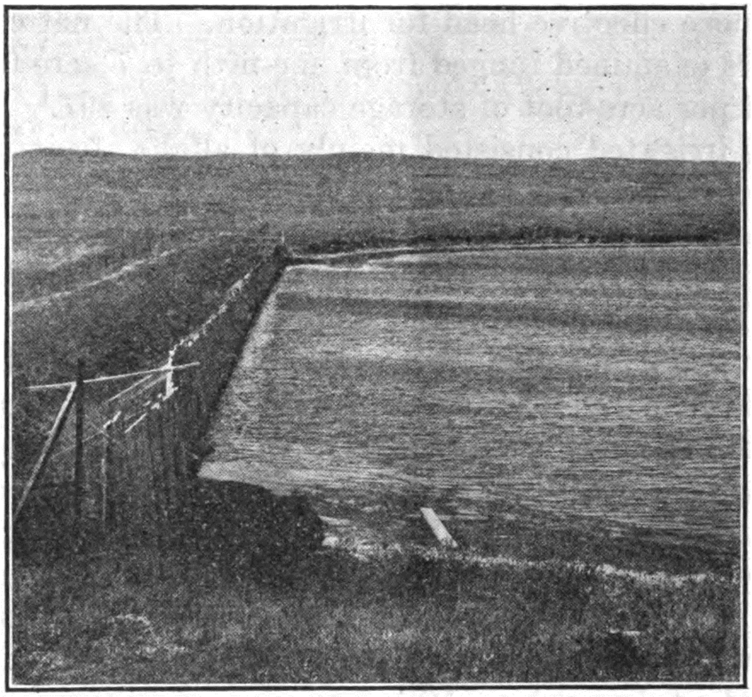

Figure 24. “Reservoir protected by a board fence, Belle Fourche.”

In 1906, Barbour installed three additional reservoirs along the east fork of Basin Creek with a combined storage capacity of 54 acre-feet that added 125 acres of irrigation capability.[153] The latter three were noted to be more substantial in their construction, with wider bases and stone riprap that protected against wave damage.[154] According to Barbour, construction of all six dams and associated ditches cost an estimated $1,500,[155] and they were considered as "a fair example of storm-water reservoirs and methods of irrigation therefrom in South Dakota."[156] “Comparable constructions were already in use in Butte county and elsewhere by the turn of the century, their reservoirs ranging in size from 40 to 200 acres.[157]

Stormwater collected in reservoirs was useful for so-called “practical irrigation” in areas of the state where water could not be supplied by running streams or artesian wells. Impounded water was most typically used for watering stock, but also allowed for the small-scale cultivation of vegetables and/or alfalfa.[158] By 1908, 75 storage reservoirs were documented across South

[152] Whiteside, “A History of Irrigation in South Dakota.”
[153] Whiteside, “A History of Irrigation in South Dakota.”
[154] Lea, *Irrigation in South Dakota*.
[155] Lea, *Irrigation in South Dakota*.
[156] Lea, *Irrigation in South Dakota*, 39.
[157] Lea, *Irrigation in South Dakota*; Lea, *Third Biennial Report of the State Engineer*.
[158] Lea, *Second Biennial Report of the State Engineer*.

Dakota, each holding an average of 43 acre-feet—enough to irrigate an average of 60 acres of land. [159]

Agricultural Drainage, c. 1880s-1928

Much like agricultural irrigation ditches, the earliest agricultural drainage ditches in South Dakota were dug during the territorial period, however most were small, provided insufficient drainage, and were short-lived. Earlier ditches are known primarily through discussions of their expansion as part of larger projects built during the first two decades of the 1900s documented by the Office of the State Engineer. Drainage efforts were focused predominantly in southeastern areas of the state along the James, Vermillion, Big Sioux, and Missouri Rivers, and within the Prairie Pothole Region of northeastern South Dakota. With the onset of dustbowl and drought conditions in the 1920s, drainage efforts waned until typical rainfall returned in the 1940s. Thereafter, wetland drainage accelerated through the 1940s and 1950s (see Wildlife Conservation and Management).

The State Irrigation Code enacted by the Session Laws of 1905 created the Office of the State Engineer, who, among other responsibilities (see Beginnings of the State Adjudication of Water, 1905-1909), was tasked with "locating, surveying and making estimates of the cost of drainage canals and ditches within the state to carry off the surplus water, caused by overflow of rivers or otherwise, preventing malarial diseases and damage to growing crops."[160] As State Engineer Samuel H. Lea noted in the inaugural report of his office, South Dakota was one of the only states west of the Missouri where the State Engineer was responsible for both irrigation *and* drainage. As amended in 1909, the State Engineer was also required to cooperate with boards of county commissioners and was responsible for supervision of all drainage projects in the state.[161]

Around the time that State Engineer Samuel H. Lea assumed office, eastern parts of South Dakota were experiencing unusually heavy rainfall and drainage works were in high demand.[162] Lea explained that "several successive years of abundant rainfall in this section [eastern South Dakota] resulted in the flooding and saturation of thousands of acres of fine agricultural land which was thus rendered unfit for cultivation."[163] In addition to agricultural problems, seasonal flooding also caused issues for roads, highways, and railroads, all of which were nearly impossible to improve and maintain without adequate drainage.[164]

In his *Second Biennial Report to the Governor of South Dakota*, Lea summarized the process by which drainage projects were administered. Communities in need of drainage works petitioned the Office of the State Engineer, who then conducted fieldwork. He visited sites, made

[159] Lea, *Second Biennial Report of the State Engineer*, 89.
[160] Lea, *First Biennial Report of the State Engineer*, 14.
[161] Lea, *Third Biennial Report of the State Engineer*, 157.
[162] Lea, *First Biennial Report of the State Engineer*, 73; Lea, *Third Biennial Report of the State Engineer*, 157.
[163] Lea, *Second Biennial Report of the State Engineer to the Governor*, 107.
[164] Lea, *Third Biennial Report of the State Engineer to the Governor*, 155.

recommendations, then conducted a preliminary survey and, if all was deemed practicable, then produced a report with the plan for drainage and its estimated cost.[165] By 1910, a total of 117 petitions for drainage works had been filed at the Office of the State Engineer. When combined, the petitions proposed the construction of 425 miles of ditch to drain 330,000 acres in 27 counties of eastern South Dakota.[166]

Only a small proportion of proposed drainage work were ever completed.[167] Early on, those that *were* built tended to be small; very few large drainage projects were constructed.[168] Despite their numbers, small drainage ditches were not discussed at length; noteworthy drainage ditches discussed in biennial reports of the State Engineer include the Minnehaha County Drainage Ditch No. 1 and No. 2, Clay Creek Drainage Ditch (Yankton and Clay Counties), Lewison Drainage Ditch (Union County), and Detroit-Crow Creek Drainage Ditch (Brown County).

Minnehaha County Drainage Ditch No. 1 and No. 2

Minnehaha County Drainage Ditch No. 1 was a 9.25-mile-long ditch intended to provide drainage for 1,280 acres of farmlands located in the Sioux Falls River Valley. It was "the first drainage project of magnitude in the state to be built under the provisions of the Drainage Code."[169] During the first decade of the 1900s, farmers located along the Big Sioux River Valley near Sioux Falls experienced repeated and devastating crop losses from annual floods. In 1907 and again in 1908, the Minnehaha County Commissioner requested that State Engineer Lea visit Sioux Falls to evaluate plans for a proposed drainage project. Construction of Drainage Ditch No. 1 began in 1908.

A five-person construction team dug a ditch six to seven feet deep and forty feet wide using buckets attached to revolving booms operated by dragline and hoist (Figure 25).[170] An outlet channel was constructed, and the bottom and sides of the ditch were lined with 6-8-inch-thick steel bar reinforced concrete to protect its steeply graded walls from erosion. When the Big Sioux Valley flooded again in the spring of 1909, Drainage Ditch No. 1 was not yet complete, but worked well enough to avoid another catastrophic season of crop losses.[171] When the Big Sioux Valley flooded that year, surplus water was rapidly removed from farmers' fields. In the nearby town of Baltic, farmers requested the ditch be extended northward. A fourteen-mile extension known as Drainage Ditch No. 2 was later added and helped to reduce property losses during another flood in 1912.[172]

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[165] Lea, *Second Biennial Report of the State Engineer*, 116.
[166] Lea, *Third Biennial Report of the State Engineer*, 157.
[167] John Berg, *Eighth Biennial Report of the State Engineer*, 31.
[168] Lea, *Fourth Biennial Report of the State Engineer*, 9.
[169] Lea, *Fourth Biennial Report of the State Engineer*, 153.
[170] Lea, *Second Biennial Report of the State Engineer*.
[171] Lea, *Third Biennial Report of the State Engineer*, 156.
[172] Lea, *Fourth Biennial Report of the State Engineer*, 153.

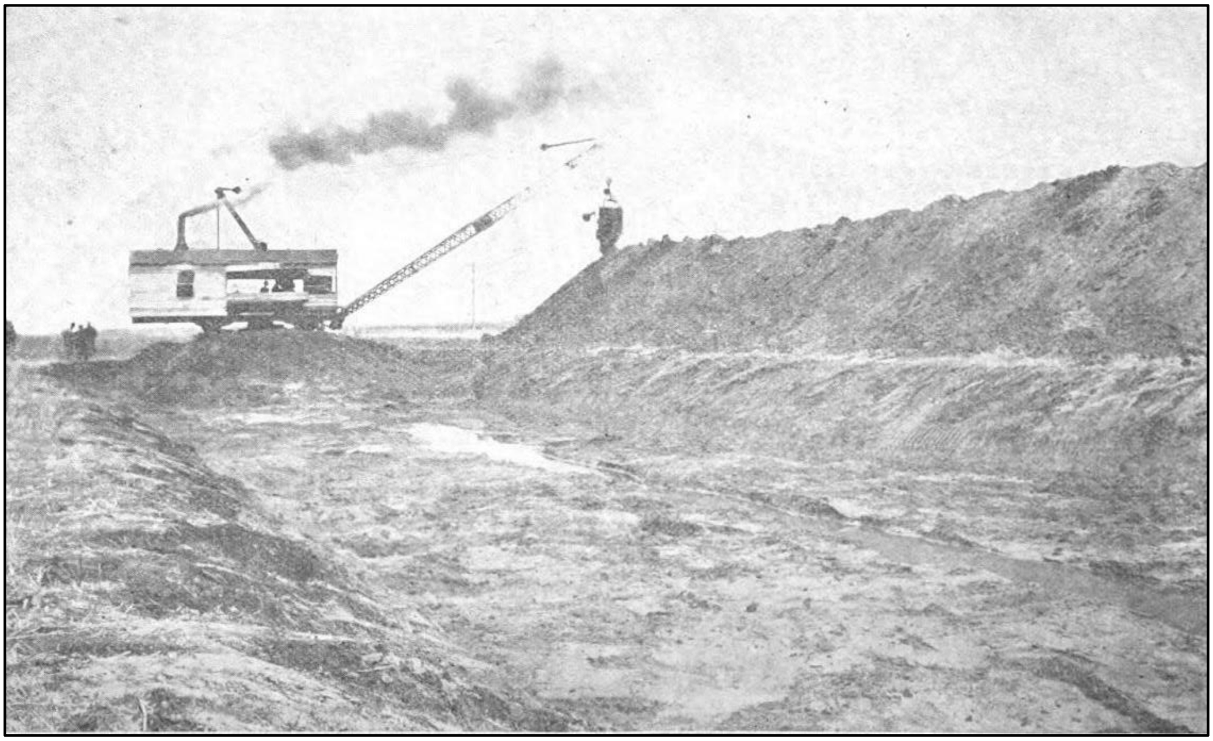

Figure 25. An "excavating machine at work" on Drainage Ditch No. 1 in Sioux Falls, Minnehaha County.

The ditch was later modified between 1929 and 1930, including the repair, reconstruction, and completion of spillway at outlet for both Minnehaha County ditches, and the addition of a silting basin built over the course of 1929 and 1930 to minimize ongoing erosion.[173] Problems with Drainage Ditch No. 1 and No. 2 recurred later. In 1945, both ditches were "left to function as at present with no authority left in charge for maintenance," because the ditch and spillway ceased to drain waters as expected.[174]

Clay Creek Drainage Ditch, Yankton and Clay Counties

Construction on the Clay Creek Drainage Ditch began in 1908 to provide agricultural drainage to an estimated 40,000 acres of cultivated areas in Meckling and Gayville.[175] The ditch followed the natural drainage course of Clay Creek into the Vermillion River, along the same path as a drainage ditch dug by farmers in 1887 that was too small and had filled with silt after just a few years in use. A larger ditch was built using two dredges that excavated an estimated 250 feet of ditch each day.[176] The drainage network was later expanded during the 1925-1926 biennium with excavation of Gayville Lateral Ditch No. 1, which drained an additional 1,600 acres in Yankton County.[177] A bridge that passes over it (SD Department of Transportation

[173] Trimmer, *Thirteenth Biennial Report of the State Engineer*, 20.
[174] Loucks, *Twentieth Report of the State Engineer*, *24*.
[175] Lea, *Second Biennial Report of the State Engineer*, 120.
[176] Lea, *Second Biennial Report of the State Engineer*, 120.
[177] Berg, *Eleventh Biennial Report of the State Engineer*, 14.

Bridge No. 14-088-170 19 314th Street over Clay Creek Ditch) is on the National Register of Historic Places.[178]

Lewison Drainage Ditch, Union County

The Lewison Drainage Ditch in Union County is another example of a dredged drainage ditch that expanded earlier and insufficient ditches. The original drainage ditch extended from the southern end of Norwegian Lake southward toward the Big Sioux River. The initial ditch from 1887 was a double ditch, where two channels were separated by a wide bench, but the ditch quickly filled with silt and sediment. Another ditch was built along the original ditch in 1894, at which time the excavated materials from one of the double ditches was placed in the other channel, filling it in. After about thirteen years in use, the ditch dug in 1894 again filled with sediment and provided insufficient drainage. In 1908, again following the line of former ditches from 1887 and 1894, another ditch was dug. Its total length was 8.96 miles long. For the first 5.5 miles, the ditch was trapezoidal, with a bottom width of 8 feet and depth of 14 feet, and its remaining length narrowed to a width of 4 feet. The Lewison Ditch had an additional eight laterals extending from it, totaling an additional 20 miles of ditches that had bottom widths that narrowed from 4-5 feet near the main canal and narrowed to about two feet near their outlets. Altogether, the Lewison Drainage Ditch provided agricultural drainage for 17,000 acres and drained the 92-acre Norwegian Lake.[179]

Detroit-Crow Creek Drainage Ditch, Brown County

The Detroit-Crow Creek Drainage Ditch was built in 1923 in Brown County, extending from the northern boundary of South Dakota southward to the confluence of Crow Creek and the James River. The drainage was installed to help farmers in the lowlands and sloughs north of Crow Creek who were negatively impacted during years of high precipitation. When it was completed in 1923, the Detroit-Crow Creek Drainage Ditch was one of the largest drainage works in the state.[180] The system was comprised of a main ditch that varied in size from 8 to 18 feet, and two eight-foot laterals that, all told, served 95,000 acres and required the construction of twenty-six bridges.[181] Experts were responsible for building most of the ditch, but common laborers also assisted, including "firemen for the small floating dredges and drag-line excavators, wagon drivers for the dike [embankment] construction, and the laborers on the concrete work and wooden bridge work."[182] Gates were present at both inlet and outlet points along the ditch. When the James River flooded in 1925, inlet gates were opened and the drainage system was

[178] Renewable Technologies and SD SHPO, "South Dakota Department of Transportation Bridge No. 14-088-170."
[179] Lea, *Second Biennial Report of the State Engineer*, 121.
[180] Berg, *Tenth Biennial Report of the State Engineer*.
[181] Egbert, "The Portage-Detroit-Crow Creek Drainage Project."
[182] Egbert, "The Portage-Detroit-Crow Creek Drainage Project," 25.

emptied within about twelve days, taking away most of the overflow waters, and the project was deemed a success.[183]

Onset of Drought and Decline in Drainage Works

During the early 1920s, drainage works were in high demand, but by the mid- to late-1920s, drought conditions returned.[184] Demand for drainage works peaked between 1919-1920, during which time the State Engineer's office received one hundred and twenty filings.[185] Average rainfall in eastern South Dakota declined thereafter, and so too did petitions for drainage works, which dropped to twenty-four filings between the 1921-1922 biennium, six between 1923-1924, two between 1925-1926, and two from 1927-1928.[186] During the drought, State Engineer John Berg explained that "A series of generally dry years in South Dakota have combined with unfavorable economic conditions to make drainage of agricultural lands, the drainage engineer, and the drainage attorney, most unpopular. In fact, the latter gentlemen, having been instrumental in the drainage of marshes and lowlands, share with the weather man the blame for the dry years," even though, he explained that "drainage does not affect rainfall to any appreciable extent."[187] No petitions were received between 1929 and 1930, and drainage was not discussed at length thereafter until post-World War II.[188]

Early Private Hydroelectric Power Facilities in South Dakota

During its first years of settlement, moving water sites and structures in South Dakota were devoted primarily to agricultural irrigation, mining, and milling. However, just seven years after the earliest Black Hills settlers dug farmer-owned irrigation ditches, and nine years after Thomas Edison's first successful demonstration of the newly invented electric light, the earliest hydroelectric power facilities in South Dakota began to deliver power in the Black Hills. Sparked by the needs of the mining industry in western South Dakota and constructed in flouring mills of eastern South Dakota, small-scale hydroelectric power facilities were already producing electricity throughout the state by the end of the nineteenth century.

Throughout much of the 1880s, electricity was transmitted using direct current technology, which had a limited range of about a mile from its point of generation. As a result, small hydroelectric power plants were built in close proximity to the mines and mills they were intended to power. In 1889, however, the invention of alternating current technology made it possible to transmit electricity across much greater distances, and hydroelectric power plants across the country began to consolidate and centralize. When companies merged, some

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183 Egbert, "The Portage-Detroit-Crow Creek Drainage Project," 34.
184 Berg, *Fourteenth Biennial Report of the State Engineer*, 5.
185 Berg, *Eighth Biennial Report of the State Engineer*.
186 Berg, *Tenth Biennial Report of the State Engineer*; Powell, "Eleventh Annual Report of the Director of the United States Geological Survey;" Berg, *Twelfth Biennial Report of the State Engineer*.
187 Berg, "Twelfth Biennial Report of the State Engineer," 9.
188 Trimmer, *Thirteenth Biennial Report of the State Engineer*, 20.

continued to operate the existing power plants of subsumed companies. In other cases, assets were relocated. Dynamos, the generators that convert mechanical energy into electrical energy, were frequently removed from their original locations and reinstalled at sites of the buyer's operations, either in new or existing powerhouses (Figure 26).[189] During consolidation, older machinery was routinely updated, upgraded, or otherwise replaced with newer and larger versions to keep pace with rapidly changing technology and in order to meet energy demands as they increased over time.[190]

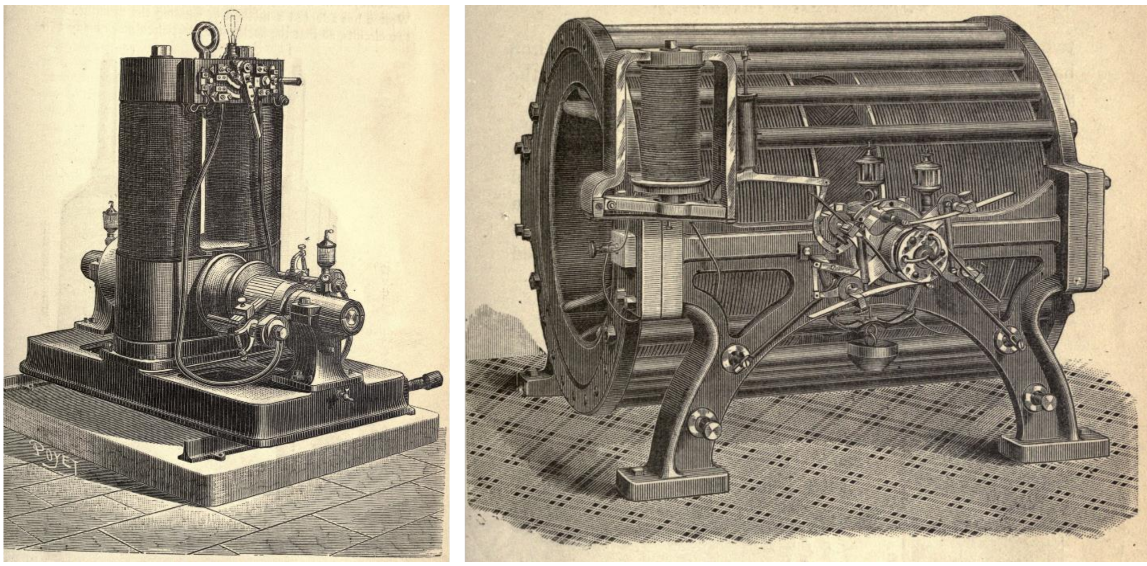

Figure 26. Examples of an Edison dynamo (left) and Thomson-Houston dynamo (right).

Hydroelectric Power Developments in the Black Hills

During the late 1800s and early 1900s, most electricity used in the Black Hills region of South Dakota was derived from water, and hydroelectric power facilities developed primarily in conjunction with mining activities in the region. The earliest known use of electric light occurred in 1883, when the Electric Light Company of Deadwood used wire, incandescent arc bulbs, globes, and an Edison dynamo to illuminate the city of Deadwood.[191] With the advent of electric light, the construction of small hydroelectric plants in the Black Hills was soon underway. Hydroelectric power was positioned as a means of producing energy to light gold mines, operate stamps and sawmills used in the industry, and provide power to the public for private use. In 1886, the city council of Rapid City awarded franchise rights to the Rapid City Light & Gas Company. At a nearby mill, the company installed a Thomas-Houston dynamo that could be powered by a combination of steam and/or waterpower and began to deliver power to customers in 1888.

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[189] "Reports of Electric Light & Power Companies."
[190] "Electrical History in the Black Hills."
[191] Abrahamson and Zimmer, *Expanding the Energy Horizon*, 22.

In 1894, former miner and rancher Henry Keets, along with twelve investors, formed the Black Hills Traction Company. They planned to construct a dam and hydroelectric plant on Redwater Creek in Spearfish, with the intention of generating electricity for an inter-city trolley network that would connect multiple towns throughout the Black Hills. The planned trolley system was never constructed, but the hydroelectric plant itself was completed in 1907.[192]

A State Engineer's report highlighted the Black Hills Traction Company's resulting hydroelectric plant as a prime example of waterpower development in the Black Hills.[193] Water was diverted from about 2¼ miles east of the boundary between South Dakota and Wyoming, approximately ten miles southwest of Belle Fourche in Butte County. Water was conveyed through five and a half miles of canals (Figures 27 and 28) and flumes to a temporary water storage location known as a forebay, then passed through wood-stave steel-banded pipes (Figure 29) before reaching the powerhouse, located above the reaches of the river at highwater on the bank of the river. Within the powerhouse, a Pelton water wheel, designed specifically for the rapidly-moving mountain streams found throughout western portions of the United States, converted the kinetic energy of moving water into electricity (Figure 30).[194] The Black Hills Traction Company's hydroelectric plant generated an estimated 1,600 horsepower, and electricity was transmitted through Spearfish to Deadwood and Lead for mining operations.[195] The plant was in operation for fifty years.[196]

Centralization of Early Hydroelectric Power Companies in Western South Dakota

The advent of alternating current technology in 1889 meant that power could be transmitted across much greater distances, and hydroelectric power plants across the country soon began to centralize. During the first decades of the 1900s, the hydroelectric industry in the Black Hills consolidated and centralized until two entities emerged at the forefront of hydroelectric works: Consolidated Power & Light Company and the Dakota Power Company. These companies began to purchase other regional companies with hydroelectric capacities and, between 1905 and the late 1920s, had consolidated all other independent electrical companies in the region.[197]

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[192] Abrahamson and Zimmer, *Expanding the Energy Horizon*.
[193] Lea, *Second Biennial Report of the State Engineer to the Governor of South Dakota*.
[194] Wiggert, "Development of the Homestake Electrical System."
[195] Lea, *Second Biennial Report of the State Engineer to the Governor of South Dakota*.
[196] Wiggert, "Development of the Homestake Electrical System."
[197] Abrahamson and Zimmer, *Expanding the Energy Horizon*, 42.

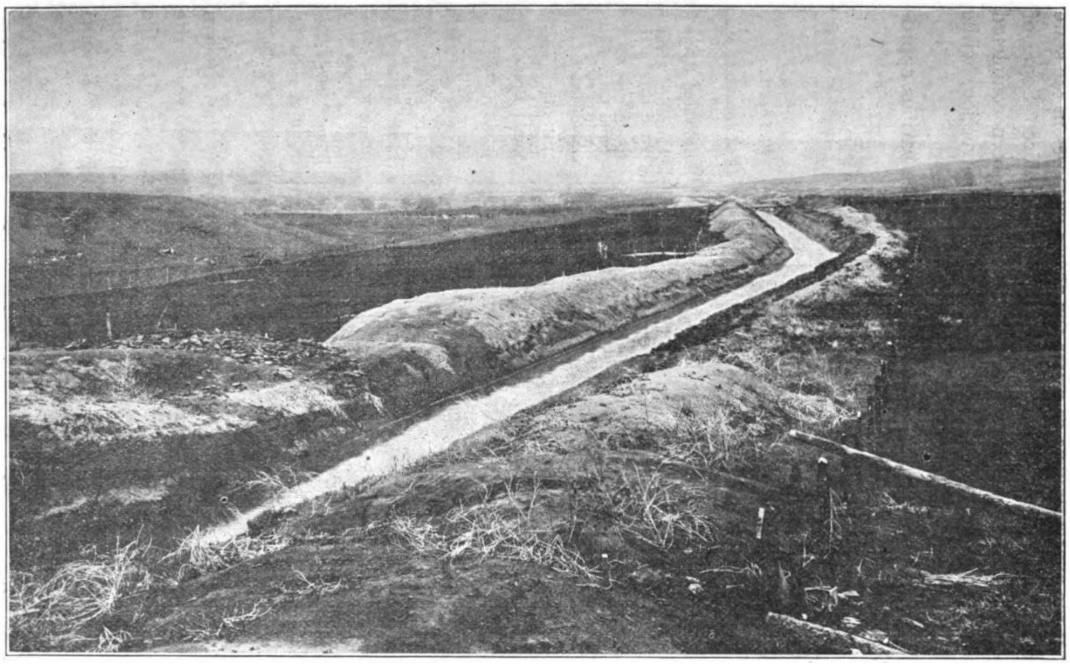

Figure 27. Canal to the Black Hills Traction Company's hydroelectric plant.

Figure 28. A photograph of the canal, forebay, and dam of the Black Hills Traction Company. Courtesy of the Leland D. Case Library for Western Historical Studies, Black Hills State University (BHSU) (Identifier BHA20220003).

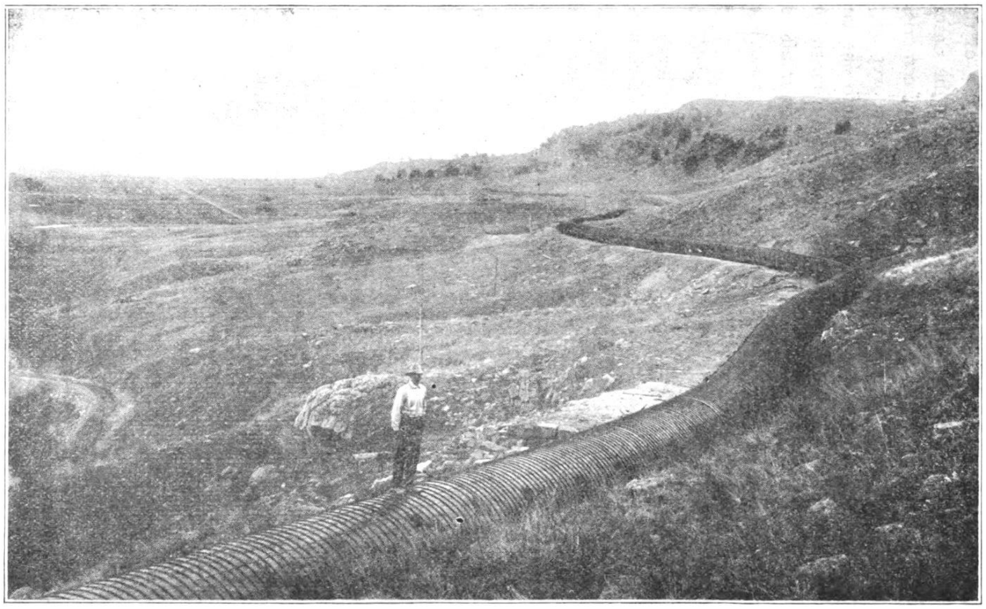

Figure 29. The wood-stave pipeline of the Black Hills Traction Company.[198]

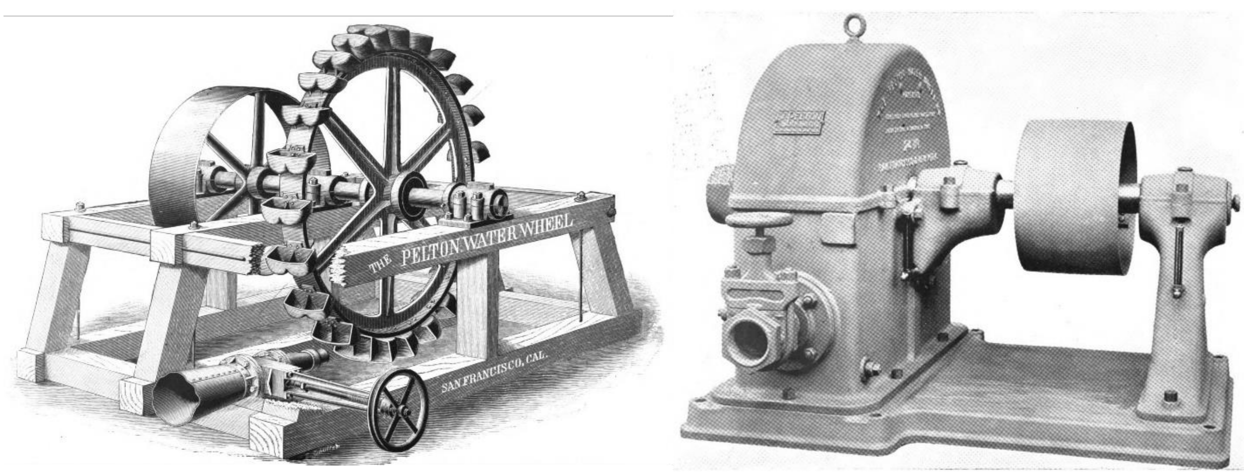

Figure 30. A standard Pelton water wheel, mounted on a wooden frame, shown with housing removed (left) and an iron-mounted Pelton water wheel (right).

Consolidated Power & Light Company of South Dakota formed as a merger of the Black Hills Electric Light Company at Deadwood and the Belt Light & Power Company in 1905. Black Hills Electric Light Company, organized in 1881, was the first company to attempt commercial electrical light generation in the region. When the company changed hands in 1884, its dynamo was moved to the Star Flour Mill, where it ground grain during day and produced steam for light plant at night. In 1886, improvements were made to the outfit, where an arc-light generator and small incandescent machine were added. In 1889, the company began to replace old equipment

[198] Lea, *Second Biennial Report of the State Engineer to the Governor of South Dakota*, 98.

and install newer and larger versions. By 1893, Black Hills Electric Light Company had built a plant at Pluma, in which they installed the first steam turbine generator in the Black Hills in 1904. When Consolidated Power & Light Company was formed, it took over the resources of both the Black Hills Electric Light Company and Belt Light & Power Company. Consolidated then began to reconstruct the plant at Pluma, installing the latest modern machinery, and took the Deadwood plant offline. After 1905, virtually all the electric light used in Deadwood and Lead was generated at the Pluma plant, which was considered "one of the most complete and best equipped west of the Missouri River."[199] Consolidated Power & Light Company continued to subsume companies across the region, acquiring the Black Hills Traction Company and Black Hills Water & Power Company in 1910, the Belle Fourche Electric Light, Heat & Power Company in 1912, and the Sturgis Light & Power Company in 1916, and with these companies, water rights, ditches, pipes, flumes, and powerhouses. By that point, Consolidated provided electricity to over 32,000 people throughout the Black Hills.[200]

Dakota Power formed in 1907 and purchased water rights, ditches, and flumes from a defunct mining company in 1908, converting the existing infrastructure for use as a hydroelectric plant. The Dakota Power Company's team of engineers and mechanics extended the flumes, built supporting trestles, and excavated a 700-foot-long tunnel through the hillside. By 1910, the hydroelectric plant was completed near Halley Park, and the Dakota Power Company continued to expand. In 1910, they acquired the Rapid City Light & Gas Company, and in 1912, completed construction on another hydroelectric facility at the "Big Bend" along Rapid Creek, which transported electricity across more than ten miles of wire to Rapid City.

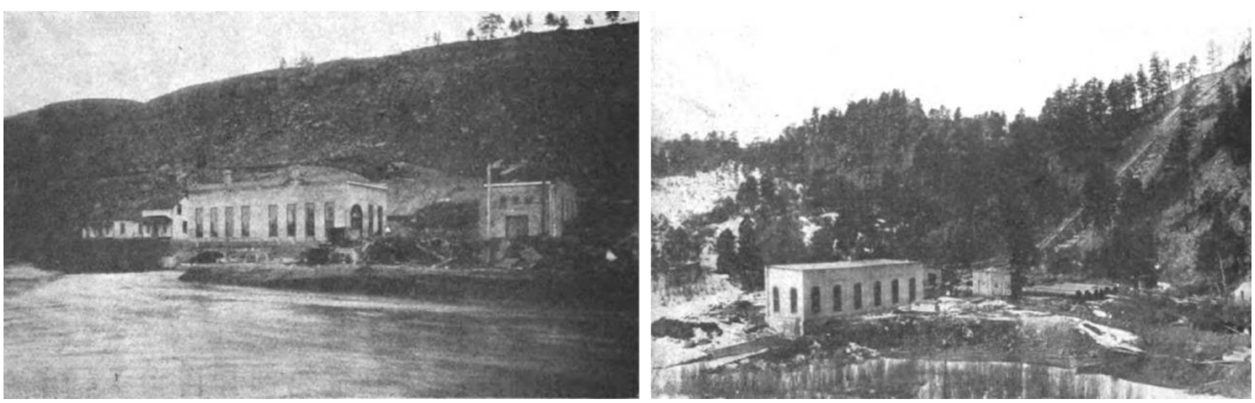

Figure 31. "Consolidated Hydro-electric Plant on Redwater Creek" (left) and "Dakota Power Company's Hydro-electric Plant on Rapid Creek" (right).

As the first decade of the 1900s drew to a close, hydroelectric energy in South Dakota was produced predominantly in the Black Hills, although a few small hydroelectric facilities produced small amounts of power elsewhere (see "Small-Scale Hydroelectric Power Facilities in

[199] "Electrical History in the Black Hills."
[200] Abrahamson and Zimmer, *Expanding the Energy Horizon*.

Eastern South Dakota”). The industry was dominated by Consolidated Power & Light Company of South Dakota and the Dakota Power Company (Figure 31), who also collaborated and mutually benefited from shared infrastructure.[201] Around this time, the Homestake Mining Company undertook construction of hydroelectric facilities along Spearfish Creek, which would ultimately become the highest horsepower producing hydroelectric power network of the early twentieth century in South Dakota.

Hydroelectric Power Facilities of the Homestake Mining Company

The most energetically productive private hydroelectric works in the state of South Dakota were built by the Homestake Mining Company in Spearfish during the early 1900s. Water had long been a central part of mining activities in the Black Hills, used extensively in placer mining operations, and in 1881, Homestake Mining Company purchased water rights, and in 1890, began diverting water from Spearfish Creek.[202] Water was carried across twelve miles of ditch to the vicinity of Whitewood Creek, initially for use in mining-related activities. The company soon expanded water use to include hydroelectric power to illuminate and operate equipment at mines in Lead and sawmill in Spearfish.

About five years after the Electric Light Company first illuminated Deadwood, a holiday scene from 1888 is said to have inspired the electrification of Homestake’s operation using hydroelectric power. George Hearst, part owner of the Homestake Mining Company, installed a dynamo at one of Homestake’s mills to provide electricity to the Hearst Mercantile Company, illuminating their store by electric light for the first time that Christmas Eve, which became an "occasion for quite a celebration.”[203] Considering its benefits to mining efficiency, previously conducted by candlelight, and its broader benefits to the town, Homestake Mining Company founder George Hearst ordered additional dynamos to light Homestake’s sawmills and stamp mills, which provided timber for mining operations and crushed ore, respectively.

Homestake first purchased a hydro plant built by the Spearfish Electric Light and Power Company in 1893 that had previously generated electricity for commercial and residential customers. In 1899, they built the wood- and coal-powered Hanna Pump Station, located about ten miles from Lead, which could siphon an estimated 6,750 gallons of water per minute using five centrifugal pumps.[204] Pressure pipes were constructed across a distance of three miles to convey water from the Hanna Pump Station and the nearby Peak Ditch to a hydro plant constructed at Englewood.

Built in 1906, the Englewood Hydro Plant enabled Homestake to generate, transmit, and use alternating current.[205] Mine superintendent, Thomas Grier supervised construction of the

[201] Abrahamson and Zimmer, *Expanding the Energy Horizon*, 48.
[202] Twitty and Fell, “Context for Historic Mining Resources in the Black Hills and South Dakota.”
[203] Wiggert, “Development of the Homestake Electrical System," 183.
[204] Wiggert, “Development of the Homestake Electrical System."; Henris, “Spearfish.”
[205] Wiggert, “Development of the Homestake Electrical System," 184.

Englewood Pump Station, and envisioned hydroelectric power not only as a source that could light the way for miners in dark tunnels, but also as an innovation that could eliminate the need for coal-fired steam engines in Homestake mines and mills. Englewood was considered a prototype hydroelectric plant of sorts, located four miles south of Lead at Englewood. At a time when many were skeptical about the reliability of hydroelectric power, the Englewood Station demonstrated its consistency, running 18 months without a single interruption.[206]

In 1908, Homestake announced that it would convert its steam-powered mines and mills over to hydroelectric power. In 1909, construction began on Hydro No. 1, under the leadership of Chief Engineer Richard Blackstone. At the time, flumes, ditches, and aboveground pipes were common sights on the landscape across the Black Hills, but Blackstone determined that, to ensure the longevity of the plant in an ever-changing landscape subject to erosion, rockslides, and mudflows, a more resilient method of moving water would be ideal: an underground tunnel carved through solid rock (Figure 32). A workforce of an estimated 225 to 250 people—engineers, electricians, and laborers—began to tunnel through the walls of Spearfish Canyon, starting from opposite ends and meeting in the middle. Teams worked in three shifts, eight hours a day, seven days a week, excavating a tunnel 6.5 feet wide and 5 feet tall, with an arched ceiling that added an additional 3.5 feet of vertical space. The average team accomplished 9-10 feet of horizontal distance each day.[207] The tunnel's floors, walls, and ceiling were coated with concrete, making the system watertight. After a year of construction, the tunnel was finished, extending about 24,000 feet (4.5 miles) through the canyon.[208]

The lower portion of the Hydro No. 1 diversion system, along with the hydroelectric power plant itself, were built in 1911. Water was diverted from Spearfish Creek about seven miles south of Spearfish and channeled into the tunnel before passing through 1,200 feet of wood stave pipes. From there, water was discharged into a steel header, where four open-ended standpipes, each three feet in diameter and 54 feet tall, allowed excess air to escape, equalizing the pressure (Figure 33).[209] Water was then divided into three pipes (penstocks) that narrowed from 34 to six inches during the final 4,000-foot descent. The powerful force created was captured by a Pelton water wheel. A substation was established in Lead so that switchboards could send electricity to wherever Homestake deemed it necessary. At first, three Westinghouse generators were installed at Hydro No. 1, but this number ultimately proved excessive; two were left, and continued to produce electricity, and the third was removed and later installed in Hydro No. 2. In 1912, Hydro No. 1 started to produce electricity. The electricity produced by moving water at Hydro No. 1 not only lit mines deep underground, but also powered equipment like lifts and crushers.[210]

[206] Wiggert, "Development of the Homestake Electrical System," 182-202.
[207] Higbee, *Powering Homestake.*
[208] Higbee, *Powering Homestake.*
[209] Higbee, *Powering Homestake*.
[210] Higbee, *Powering Homestake*.

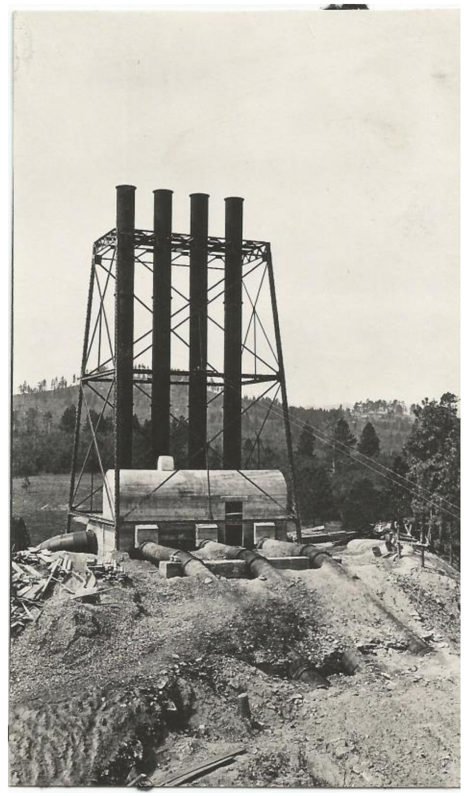

Figure 32. LEFT: Teams standing at the entrance of a tunnel under construction. Approximate length of tunnel 24,000 feet, approximate dimensions 6'6" wide by 9' high. Courtesy of Deadwood History, Inc. (Identifier 13-2). RIGHT: Four standpipes at Hydro No. 1. Courtesy of Deadwood History, Inc. (Identifier 10-5).

Even though water from Homestake's hydroelectric power plants were ultimately returned to the creek, the company's appropriations caused public outcry during the 1910s. Downstream Spearfish residents noted diminished waters since Homestake's appropriations had begun.[211] In 1916, droughts led to low water levels in Spearfish Creek, sparking Homestake's interest in the possibilities of maximizing Spearfish Creek's power generating capacities by using the water twice over. Blackstone proposed the construction of Hydro No. 2, a smaller plant downstream from Hydro No. 1.[212] The proposal for the installation of Homestake's Hydro No. 2, however, was met with cost-saving concerns. In a bid to save money, the board rejected Blackstone's natural-disaster-minded plans for subterranean pipes, opting instead for cheaper aboveground redwood pipe for the smaller hydroelectric plant. In 1917, Hydro No. 2 was built, and began to generate electricity the following year using the third generator originally intended for Hydro No. 1. By 1919, Homestake Mining Company's hydroelectric facilities generated 6,000 horsepower, which was 2.5 times more power than any other individual hydroelectric operation in the Black Hills, and 2.5 times greater than all power produced by hydroelectric plants east of the Missouri River *combined*.[213]

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[211] Henris, "Spearfish."
[212] Higbee, *Powering Homestake*.
[213] Mead and Seastone, "Report on the Feasibility of the Development of Hydro Electric Power."

For nearly ninety years, Hydro No 1. and Hydro No. 2 powered mining operations and, from 1940 to 1980, Hydro No. 1 also powered a new Homestake sawmill. Innovations led to plant modernization in 1968, making remote monitoring possible instead of 24 hour a day onsite staffing. Further modernizations, including the installation of a wastewater treatment plant, were initiated in response to the National Environmental Protection Act in 1970. By the end of the 1970s, Hydro No.1 and No. 2 were producing about one-third of Homestake's electricity consumption. The Westinghouse generators at Hydro No. 1 and Hydro No. 2 ultimately outlived the Homestake Mining Company. In 2000, Homestake announced plans to end its mining operations in Spearfish. Hydro No. 2 was closed, but Hydro No. 1, still producing energy as reliably as ever, was purchased by the City of Spearfish in 2004. Doing so enabled the City of Spearfish to ensure water flow and continued access for downstream users.[214]

Small-Scale Hydroelectric Power Facilities in Eastern South Dakota

Similar to early small-scale power plants in the Black Hills, hydroelectric developments in eastern parts of the state were interwoven with industry. A small number of out-of-business grist mills in eastern South Dakota were transformed to produce hydroelectric power during the early twentieth century, and additional facilities with dual milling and hydroelectric capacities utilized water power from artesian wells (see Artesian Wells for Milling and Hydroelectric Power).[215] In 1908, most hydroelectric plants generated small amounts of power, between 10 and 400 horsepower, sold for domestic use.[216] The only plant east of the Missouri River that exceeded this range was the Sioux Falls Light and Power Company. [217]

In 1908, State Engineer Samuel Lea remarked on "a growing disposition to make use of the natural resources of the state by the development of waterpower on our flowing streams. This movement has taken concrete form in the construction of water power plants in the Black Hills, and notably, in the eastern part of the state, by the construction of the magnificent power plant of the Sioux Falls Light and Power Company on the Big Sioux river [sic] at Sioux Falls," at the previous site of the Queen Bee Mill (Figure 33).[218] The Sioux Falls Light and Power Company had also purchased the Cascade Mill, a flour milling operation with a dam located across the river north of Eighth Street in Sioux Falls. [219] The electric light plant along the Big Sioux River in Sioux Falls had produced electricity since 1884 for manufacturing purposes. The waterpower was typically sufficient to operate both the mill and electric light machinery and was noted to have supplied hundreds of customers who used the electricity to light streetlamps and illuminate

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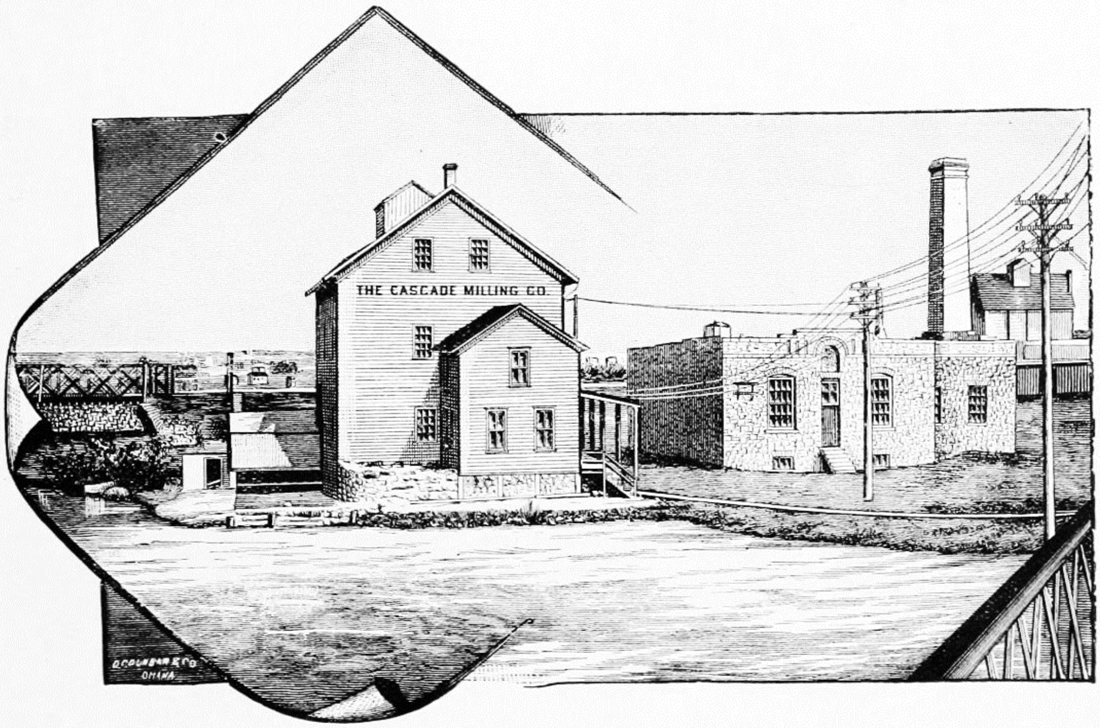
[214] Hydro Plant No 2 was listed in the National Register of Historic Places in February 2023. Higbee, *Powering Homestake*.
[215] Gristmills are beyond the scope of work for this historic context. However, their function as "the cell around which the town was built" during South Dakota's territorial period and early statehood merits consideration for a historic context of their own.
[216] Lea, *Second Biennial Report of the State Engineer to the Governor of South Dakota*," 100.
[217] Lea, *Second Biennial Report of the State Engineer to the Governor of South Dakota*," 100.
[218] Lea, *Second Biennial Report of the State Engineer to the Governor of South Dakota*," 12.
[219] Olson, "The Queen Bee Mill Legend," 228-243.

the interiors of homes and businesses.[220]



CASCADE MILLS AND ELECTRIC LIGHT PLANT.

Figure 33. The Cascade Milling Company's mill and powerhouse in Sioux Falls, Minnehaha County.

The Queen Bee Mill was built in 1879 above quartzite outcrops of the Big Sioux River for the purposes of flour milling. A canal was blasted through underlying rock, directing water through an iron pipe seven feet in diameter for delivery to water turbines that powered wheat grinding equipment.[221] The Queen Bee operated as a flour mill for just three years, from 1881 until it went bankrupt in 1883. While insufficient water power is often cited in local and state histories as a reason for the Queen Bee's closure, recent historians have suggested the mill was simply too large of an establishment for the scale of local wheat production at the time.[222] The six-story tall Queen Bee Mill sat idle until 1906, at which time it was purchased by the Sioux Falls Light and Power Company and converted it over to hydroelectric power production by building a massive concrete dam, millrace (Figure 34), and quartzite powerhouse with a reinforced concrete foundation (Figure 35).[223] A seven-foot steel flume supplied water to the hydroelectric turbines that were located in the powerhouse basement until 1950 (Figure 36)[224] In 1911, the company offered power on a commercial basis for manufacturing, residential, and farming operations. In 1911, Sioux Falls Light and Power Company changed its name to

220 Caldwell, *Sioux Falls Illustrated*."
221 Bailey, *History of Minnehaha County, South Dakota*, 382.
222 Olson, "The Queen Bee Mill Legend," 232.
223 "Power from the Big Sioux River," 44; Seten and Dirr, "Sioux Falls Hydroelectric Plant."
224 Seten and Dirr, "Sioux Falls Hydroelectric Plant."

Consumers Power Company, and later became known as the Northern States Power Company, under which it expanded hydroelectric capacities by constructing a steam plant in 1913.[225] In 1915, hydroelectric operations at the former site of Cascade Milling company were taken out of operation, but several components of the hydroelectric facilities around the Queen Bee Mill remain, including two buildings that are listed in the National Register of Historic Places: remnants of the Queen Bee Mill, and the Sioux quartzite powerhouse, which has operated as the Falls Overlook Cafe since 2005.[226]

Figure 34. The dam and millrace for the Queen Bee Flour Mill in Sioux Falls, Minnehaha County. Courtesy of the SDSHS, South Dakota Digital Archives (2010-06-18-016).

[225] Seten and Dirr, “Sioux Falls Hydroelectric Plant.”
[226] Odland, *Sioux Falls (Images of Modern America*, 13; Lubeck and Torma, “Queen Bee Mill;" Seten and Dirr, “Sioux Falls Hydroelectric Plant.”

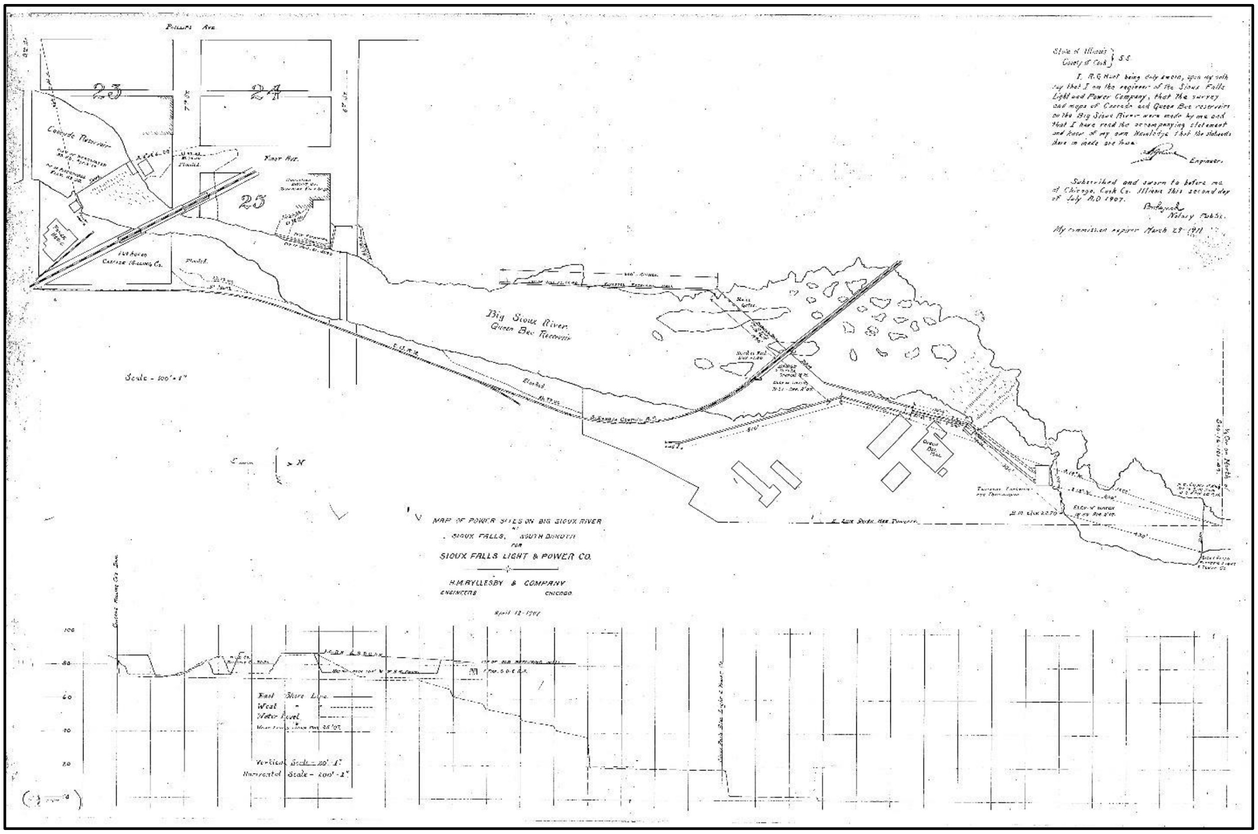


Figure 35. This 1907 map of power sites on the Big Sioux River at Sioux Falls shows water conveyance sites and structures of the Cascade Milling Company and the location of the Queen Bee Mill, including the Sioux Falls Light and Power Company’s proposed powerhouse location.

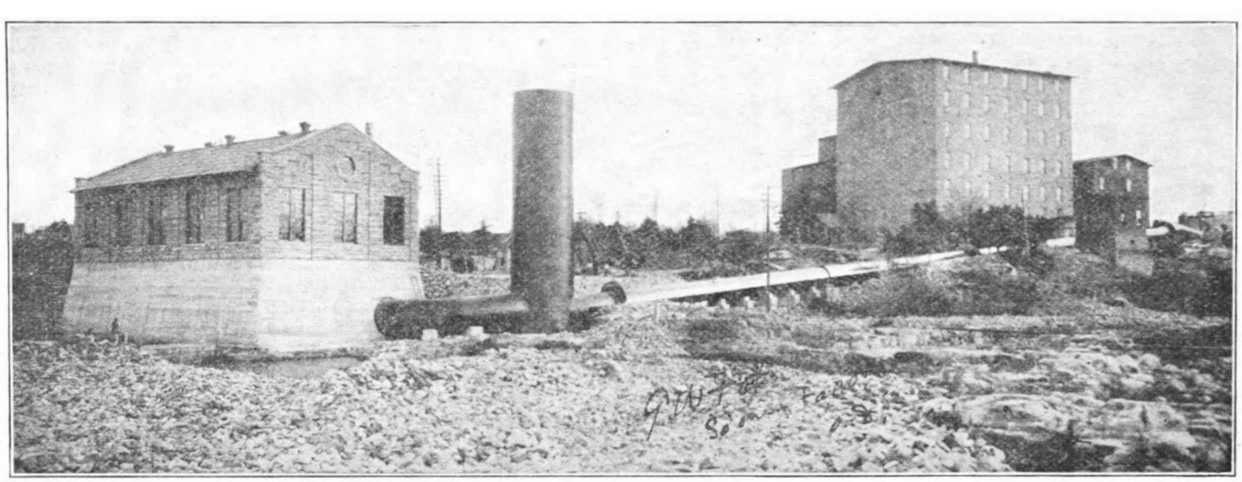


Figure 36. The “Power plant of Sioux Falls Light and Power,” adjacent to the original Queen Bee Mill.

Legislation on Hydroelectric Power, c. 1918-1922

In 1918, during Peter Norbeck's first term as governor, South Dakota voters approved a legislatively referred constitutional amendment allowing for the state ownership and operation of hydroelectric power facilities. Norbeck recommended appropriations for the survey of potential dam sites enacted into law in 1919.[227] That year, consulting engineers Daniel W. Mead and Charles V. Seastone were tasked with reconnaissance for the purposes of locating a feasible site for developing hydroelectric power on the Missouri River. The resulting report deemed Mobridge a suitable site and proposed to build a dam and hydroelectric facility.[228] In 1922, voters rejected state plans to develop the Missouri River for public power. According to historians, this reflected a "growing reaction against public ownership principles."[229]

Though the recommended Mobridge dam and hydroelectric plant never came to be, the state-funded survey of potential hydroelectric dam sites included research on existing hydroelectric power facilities throughout the state. Mead and Seastone's report indicated that, by the 1920s, most power east of the Missouri River was generated with coal, oil, or gas, and only four water power development companies were reported: Consumer Power (Sioux Falls), Electric Light and Power (Sioux Falls), Dell Rapids Light & Power (Baltic), and Flandreau Light & Power (Flandreau).[230]

West of the Missouri, most electricity was derived from water, and hydroelectric power facilities were developed primarily in the Black Hills mining region. The report lists the following companies in operation in western South Dakota: Centerville Mining (Centerville), Consolidated Power & Light (Spearfish), Dakota Power (Rapid City and vicinity), Gordelia Mining Company (Rockford), Homestake Mining (Spearfish), Water, Light and Power (Hot Springs), Spearfish Electric (Spearfish), Hot Springs Irrigation and Live Stock (Cascade Creek), and Rapid River Milling (Rapid City).[231]

Early Fish Conservation and Management in South Dakota

The history of fish conservation and management in South Dakota is inseparable from histories of industry, agricultural irrigation, hydroelectric power, tourism, and recreation. By the 1880s, irrigation had already changed stream habitats in the Black Hills dramatically. In 1883, the Dakota Territory Legislature issued new laws that required the installation of fishways on all dams located within the Sioux, Cheyenne, and Dakota rivers.[232] Fishways, also known as fish ladders, fish steps, or fish passages, are structures that allow fish to pass around a dam or other anthropogenic obstruction within a waterway and are particularly important for migratory species. New laws on constructions, however, were not enforced for the most part, leading to declines in fish populations.

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[227] Schell, *History of South Dakota*, 268.
[228] Mead and Seastone, "Report on the Feasibility of the Development of Hydro Electric Power."
[229] Schell, *History of South Dakota*, 275.
[230] Mead and Seastone, "Report on the Feasibility of the Development of Hydro Electric Power," 51.
[231] Mead and Seastone, "Report on the Feasibility of the Development of Hydro Electric Power," 52.
[232] Scarnecchia, Martling, and Barnes, "The Evolution of Trout Stream Management in the Black Hills."

Beyond legislation on fishways, Native freshwater fish like chub, suckers, and dace that were abundant prior to colonization were not prioritized in early conservation efforts.[233] Early fish culture focused almost exclusively on the introduction of non-native species that could provide a supplemental food supply and, in some cases, attract fishing-based tourism. The 1883 Legislature had also appointed a fish commissioner and six fish wardens, tasked with distributing fry (juvenile) fish. These activities occurred in conjunction with those of private citizens and the United States Fish Commission, who transported fry fish from out-of-state spawning locations to their intended destinations via railroad car.

One well-known example of private fish stocking activities occurred in 1886 when Richard Hughes, a former goldminer and journalist, and Samuel Scott, one of Rapid City's founders, transported brook trout from Leadville, Colorado to the Black Hills. Hughes and Scott set the trout free at Cleghorn Springs outside of Rapid City in the hopes of creating a naturally reproducing population. The original land patent holder, Dan Cleghorn, built ponds next to the spring during the 1890s to facilitate common carp raising. Other individual farmers, ranchers, and miners introduced non-native fish species to Black Hills springs, ice ponds, and irrigation ditches under similar circumstances during the 1880s and 1890s. Flooding eventually transported them into larger bodies of water, contributing to the displacement of native species.[234]

The U.S. Fish Commission[235] also played an early role in stocking fry in the region. Beginning in 1886, the U.S. Fish Commission introduced carp into eastern lakes, rivers, and streams. Black bass, crappies, rock bass, and sunfish were introduced to Lake Kampeska, and fish were also stocked in a variety of other locations, including Turkey Creek near Yankton, Turkey Creek near Wakonda, Collins Springs near Dell Rapids, Lake Hendricks, and Big Stone Lake. The U.S. Fish Commission was also involved in fish stocking activities west of the Missouri River. In 1890, the U.S. Fish Commission initiated trout stocking in Spearfish Creek. After two successful stocking seasons, construction of a federal fish hatchery at Spearfish received Congressional authorization in 1896.[236]

South Dakota's first fish hatchery was established near the mouth of Spearfish Canyon in 1899, where homesteader John S. Johnston had already been stocking "troutlets" for several years (Figure 37). The Spearfish Fish Cultural Station, later known as the Spearfish National Fish Hatchery, and today as the D. C. Booth Historic National Fish Hatchery, began its operations as a subsidiary of a federal hatchery in Leadville, Colorado and soon became essential to U.S. Fish Commission operations in the western United States. Under the leadership of the hatchery's first superintendent, DeWitt Clinton (D. C.) Booth, workers built three large fish rearing pools and used concrete to build spring-fed trout runs or "races" designed to hold

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[233] Henris, "'No Finer Trout-Stream in the World than These," 278.
[234] Henris, "'No Finer Trout-Stream in the World than These," 278-279.
[235] The U.S. Fish Commission became known as the U.S. Bureau of Fisheries in 1903, and the U.S. Fish and Wildlife Service starting in 1940.
[236] Barnes, "Fish Hatcheries and Stocking Practices: Past and Present; Berry, Jr. et al., eds., *History of Fisheries and Fishing in South Dakota*," 267-294.

juvenile fish so they could be fed and maintained until they were large enough to be transferred to streams.[237] Construction of the hatchery made major hydrological changes to the canyon, as a limestone retaining wall was built to divert water away from the hatchery in the event that Spearfish Creek flooded.[238] Between 1900 to 1911, the Spearfish National Fish Hatchery stocked over 17.7 million trout in the Black Hills, including German brown, black-spotted, and rainbow varieties.[239] Its facilities were later expanded by the Works Progress Administration (WPA) in the 1930s (see Federal Work Relief Program Construction, 1929-1941).

Figure 37. An undated photograph of Spearfish National Fish Hatchery, now known as the D. C. Booth Historic National Fish Hatchery, in Lawrence County. The coupled raceways shown in the foreground were built by the WPA in the mid-1930s. Courtesy of the Cook Photograph Collection, Leland D. Case Library for Western Historical Studies, BHSU (Cook20220038).

Trout were seen as a boon to Black Hills tourism, as the species was not just familiar, but prized among eastern settlers and tourists.[240] Even so, during the first decades of the 1900s, the ineffective enforcement of game and fish law, coupled with the expansion of anthropogenic pollution and industrially driven alterations to natural hydrology presented numerous challenges to fish stocking activities. The Homestake Mining Company's Hydroelectric Plants went online

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[237] Henris, "'No Finer Trout-Stream in the World than These," 284.
[238] Henris, "'No Finer Trout-Stream in the World than These," 284.
[239] Scarnecchia, Martling, and Barnes, "The Evolution of Trout Stream Management in the Black Hills," 424; Booth, "Fish Culture of the Black Hills."
[240] Scarnecchia, Martling, and Barnes, "The Evolution of Trout Stream Management in the Black Hills."

in 1911 and 1917, they drained some viable trout streams and degraded others.[241] Wastewater and industrial spillage also regularly killed large numbers of trout during the early 1900s. Further conservation measures were put into effect in 1909 with state fish and game laws that instituted both a state game warden and individual county game wardens to oversee conservation and management activities. In 1912, new interagency corporations were established between foresters and game wardens to further deter poaching, stymy overfishing, and stabilize trout populations in the Black Hills.

State Fish Hatcheries of South Dakota

The state of South Dakota became involved in fish propagation in 1909 when the newly formed Game and Fish Commission was authorized to spend $200 on fish trapping and relocation activities. The first state fish hatchery was later established in 1916 at Lake Kampeska near Watertown for the propagation of pike. The Lake Kampeska State Fish Hatchery struggled to produce fish reliably during the late 1910s and early 1920s but remained in operation until 1945. In the meantime, the state established a secondary hatchery at Pickerel Lake in 1929, which became the primary site for walleye and northern pike production. [242]

In 1918, the state built a cold-water hatchery in Rapid City, but the location was almost immediately destroyed by fire. After attempting to establish a replacement in Custer State Park (at the time still known as the State Game Park), the hatchery encountered issues with water quality and availability. South Dakota Game, Fish and Parks then established a permanent trout hatchery at Cleghorn Springs in 1928. The Cleghorn Springs State Fish Hatchery was built in the same area where settlers Hughes and Scott had first stocked trout decades earlier.

Original hatchery structures included a brick hatchery house with and twelve rectangular earthen ponds, and additional infrastructure was built during the 1940s (see Early Fish Conservation and Management in South Dakota).[243] Other state fish hatcheries established during the 1920s include the fish rearing pond and hatchery manager cottage built at Lake Andes in 1923, as well as facilities at Lakeside near Redfield which raised fish and produced game birds (waterfowl and pheasants) beginning in 1926.

[241] Henris, "'No Finer Trout-Stream in the World than These," 296.
[242] Barnes, "Fish Hatcheries and Stocking Practices: Past and Present."
[243] Barnes, "Fish Hatcheries and Stocking Practices: Past and Present," 276.

Federal Reclamation and Relief Construction of Moving Water Sites and Structures, 1902-1941

During the first half of the twentieth century, the federal government introduced multiple pieces of legislation that had a profound impact on the history of South Dakota's moving water resources. Programs generated through this legislation provided an influx of millions of dollars to South Dakota's economy and directly resulted in the completion of thousands of water-related infrastructure projects throughout the state. The earliest of these projects began as a result of the Reclamation Act of 1902. Subsequent projects were initiated through the various work programs established under Franklin Delano Roosevelt's New Deal, and the Flood Control Act of 1944, which authorized the Pick-Sloan Missouri Basin Program. Properties associated with these major federal reclamation and relief efforts from the first half of the twentieth century are located across the entirety of South Dakota. Many are directly associated with moving water, or they incorporate related infrastructure components.

The majority of federal water-related infrastructure projects in South Dakota are well-studied with existing state and/or federal historic context documents and evaluation guidance. Most significantly for moving water sites and structures associated with federal reclamation and relief construction are the U.S. Bureau of Reclamation Water Conveyance Systems in the West Context and Evaluation Guidance, the South Dakota State Historic Preservation Office Federal Relief Construction in South Dakota, 1929-1941 historic context document, and the corresponding National Register of Historic Places Multiple Property Documentation Form for Federal Relief Construction in South Dakota, 1929-1941. The U.S. Department of the Interior (1983) also published a history of *South Dakota Bureau of Reclamation Projects*.[244] In light of the already extensive documentation of moving water infrastructure built as part of federal reclamation and relief programs, and per the scope of work for this historic context in particular, this section provides a brief overview of extensively documented projects, providing citations and, where possible, links to relevant publicly available resources.

Reclamation Act of 1902 & the Belle Fourche Project

The Reclamation Act of 1902 is recognized as one of the most consequential pieces of legislation in the history of water infrastructure development in the western United States. The Act formed the Interior Department's Reclamation Service (subsequently designated the Bureau of Reclamation) and authorized the Secretary of the Interior to construct irrigation works in 16 states located west of the 100th meridian.[245] The legislation was enacted for the purpose of "reclaiming" arid and semiarid lands for human use, primarily to facilitate the expansion of

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[244] Phillips and Stallings, "U.S. Bureau of Reclamation Water Conveyance Systems;" Dennis, "Federal Relief Construction in South Dakota;" US Department of the Interior, *South Dakota Bureau of Reclamation Projects*.
[245] US Department of the Interior, *South Dakota Bureau of Reclamation Projects*.

agriculture and homemaking. Federal reclamation provided funds and interest-free loans for the construction of water retention and irrigation work, centered as the main vehicle for the reclamation of arid and semiarid lands that characterized the western United States, which was the only way to make sustained agriculture viable in these regions. During its first five years, about 30 projects were initiated under the Reclamation Act of 1902, including the Belle Fourche Project in Butte and Meade Counties in South Dakota (alt. names: Belle Fourche Irrigation Project or Belle Fourche Irrigation District). The Belle Fourche was the first and only major reclamation project completed in South Dakota before United States involvement in World War II. Later Bureau of Reclamation projects were completed in conjunction with the Corps of Engineers as part of the Pick-Sloan Missouri River Basin Program authorized by the Flood Control Act of 1944.

The Belle Fourche Project was the first reclamation project in South Dakota built under the authorization of the Reclamation Act of 1902 (Figure 38). The year following its passage, investigations began to identify a viable site for a project capable of irrigating thousands of acres of semi-arid Plains lands north of the Black Hills. The Belle Fourche Project plan included the construction of a dam, reservoir, and a system of irrigation canals and laterals to bring water from the reservoir to individual farms.[246] By 1905, construction efforts had begun on the Belle Fourche Dam, then known as the Orman Dam, and work proceeded intermittently on the structure until its completion in 1911. Limited areas began to receive water for irrigation purposes as early as 1908, and the Belle Fourche Project ultimately irrigated 57,086 acres. Its reservoir provided important but often overlooked recreation areas as early as the early 1910s (Figure 39), which were expanded and improved at various points during the 1960s and 1970s.[247]

Figure 38. An irrigation canal at Belle Fourche Dam in Butte County. Courtesy of the SDSHS, South Dakota Digital Archives (2009-06-15-003).

[246] US Department of the Interior, *South Dakota Bureau of Reclamation Projects*, 6.
[247] McCune, "Belle Fourche Project."

The Belle Fourche Project has been identified as "a classic example of an early Reclamation project," important as much for its tumultuous yet informative history as it is for its tangible contributions to Reclamation infrastructure and the economy in South Dakota.[248] The Belle Fourche Dam and Reservoir, and associated diversion dam, inlet canal, canals, and ditches are well-documented. The Belle Fourche Dam, Ditchrider House, and Belle Fourche Experiment Farm at Newell are included in the National Register of Historic Places.[249] In addition, the Bureau of Reclamation has published a comprehensive historic context focused specifically on the Belle Fourche Project.[250]

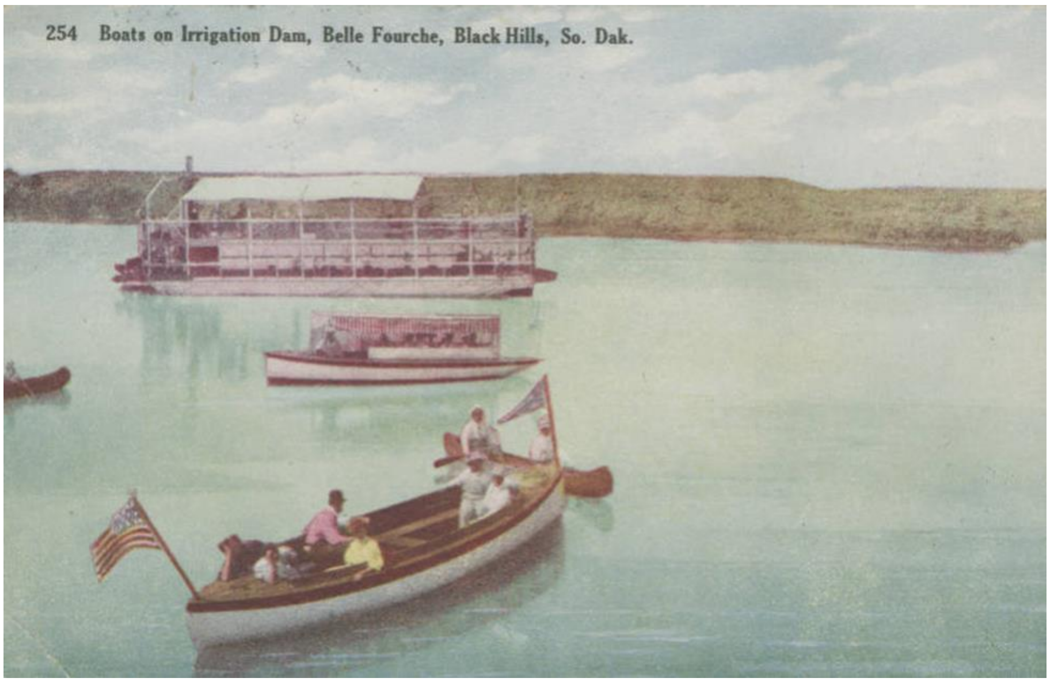

Figure 39. A 1909 postcard showing recreational boating activities on the Belle Fourche Reservoir. Courtesy of the SDSHS, South Dakota Digital Archives (2008-02-28-042).

Irrigation on South Dakota Reservations, c. 1902-1908

During the early 1900s, the Bureau of Indian Affairs and its reservation agents made efforts to develop irrigation on tribal lands. These projects were most extensive on reservations west of the Missouri River, particularly at Rosebud and Pine Ridge Reservations, but smaller projects were also implemented at reservations along the Missouri River, including Crow Creek and Lower Brule Reservations.[251]

[248] McCune, “Belle Fourche Project,” 32.
[249] Ninke, “Belle Fourche Dam;" Goode, “Ditchrider House.”
[250] McCune, “Belle Fourche Project.”
[251] Annual Reports of the Commissioner of Indian Affairs written between 1902 and 1907 follow the same format as those of the nineteenth century—a compilation of letter reports that summarize conditions and improvements made on reservations, written by overseeing non-Native agents. These reports provide some insights into the final years of reservation irrigation projects administered solely under the authority of the Indian Service.

From 1902 to 1903, construction was underway on a series of bridges, dams, and reservoirs at Rosebud Reservation.[252] The 38 dams for reservoirs built that single year necessitated the movement of 150,000 cubic yards of earth.[253] "The dams that are being put in on the streams to divert the water are built to last," wrote the agent that year. He explained: "We had our mechanics build a pile driver, and it is now being used in driving piles for all the dams." [254] In addition to dams, 25 new bridges were constructed to cross streams throughout the reservation and plans for the construction of irrigation ditches of various sizes were in progress.[255]

Similar endeavors were underway at Pine Ridge Reservation between 1902 and 1904. Even though reservation lands were not well suited for irrigated farming on account of low rainfall and few flowing streams, significant gardening took place in creek bottomlands, and plans were in place to build a series of dams and ditches for stock watering and to promote the growth of hay for livestock.[256] By 1904, an unreported number of stone irrigation dams and earthwork reservoirs were in place, connected by 13.5 miles of irrigation ditch. Smaller ditches at Medicine Root Creek and Bear in the Lodge Creek irrigated 20 acres and 100 acres, respectively, while those along White Clay Creek irrigated 200 acres, and diversions from Wounded Knee and American Horse Creeks irrigated 500 acres each.[257] All told, the dams, reservoirs, and ditches were completed under the direction of the Office of Indian Affairs agent at a cost of $80,471.[258] Construction made use of local materials and emphasized the structural integrity and longevity of projects. Wood used to build irrigation dams and headgates was sawed at the agency sawmill and hauled to construction sites by reservation residents.[259] Pile drivers were used during the construction of all dam foundations, creating structures that were "built to stay."[260]

Irrigation infrastructure of a smaller scale was under construction at reservations located in central South Dakota along the Missouri River. In 1903, three large dams and reservoirs were built at Crow Creek Reservation, including stone dams on Campbell and Soldier Creeks that provided "ample water for livestock" and in 1904, an additional 6 large reservoirs and 2 miles of irrigation ditches built.[261] At Lower Brule, 5 large dams and reservoirs were constructed in 1905. The reservoirs were "situated some considerable distance back from the river and in the roughest part of the country, which makes them of great benefit to the reservation for stock purposes, the

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252 "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1902," 343.
253 "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1903," 308.
254 "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1903," 308.
255 "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1903," 308.
256 "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1902," 338.
257 "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1904," 329.
258 "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1904," 329.
259 "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1904," 329.
260 "Annual Reports of the Department of the Interior, 1906," 353.
261 "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1903," 301; "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1904," 324.

grazing system being now inaugurated," and an unspecified number of additional dams were built for the same purpose in 1906.[262]

Changes in the Administration of Irrigation of Reservations, 1908

In 1908, administrative reorganization of the Indian Service changed how irrigation developments on Tribal lands were implemented. Until that point, the Office of Indian Affairs "maintained a little reclamation service, a little forestry branch, and several other minor organizations," as Commissioner and Secretary of the Interior Francis E. Leupp put it, "for work along lines commonly cared for, and presumptively better cared for, by special bureaus established by law for the benefit of the American people at large."[263] Reorganization of the Indian Service was implemented to reduce waste and redundancy, and beginning in 1908, Congress empowered the Secretary of the Interior with the authority to build, maintain, and oversee operations of water projects on Tribal lands. From that point forward, responsibility for the construction of irrigation projects on Tribal lands became a joint effort between the Indian Service and Reclamation Service.[264]

At a time when federal Indian policies emphasized assimilation, the federal government believed that investments in irrigation would simultaneously keep Indians from leaving reservation lands while at the same time instilling Western attitudes toward individualism, labor, and private property.[265] In financial terms, they also expected irrigation projects to be economically lucrative, as they would raise the value of Indian lands and increase available Tribal funds, thereby reducing the federal spending on reservations. [266] The resulting Indian Projects involved collaboration of two federal agencies: the Reclamation Service and the Indian Service. The Reclamation Service was put in charge of providing materials, organizing labor, and supervising technical aspects of irrigation projects, while the Indian Service was responsible for payment.[267]

Reorganization put the Reclamation Service in charge of "the handling of those irrigation projects into which both white and Indian interests enter, reserving for the Indian Office those which are purely Indian propositions; but even in the latter class the irrigationists of the Indian Service have the benefit of the expert advice and assistance of the consulting engineers of the sister service (Figure 40). Such a combination procures for the Indians the best the Government can command in the way of irrigation plans and work, and reduced the chance of serious mistakes to a minimum."[268] Details about irrigation infrastructure, Leupp presumed, would be

[262] "Annual Reports of the Department of the Interior for the Fiscal Year Ended June 30, 1905," 337; "Annual Reports of the Department of the Interior, 1906," 351.
[263] "Report of the Commissioner of Indian Affairs to the Secretary of the Interior, 1908," 2.
[264] Voggesser, "The Indian Projects," 3.
[265] Voggesser, "The Indian Projects," 2-5.
[266] Voggesser, "The Indian Projects," 4.
[267] Voggesser, "The Indian Projects," 4.
[268] "Report of the Commissioner of Indian Affairs to the Secretary of the Interior, 1908," 3.

recorded by the director of the Reclamation Service; however, subsequent annual reports from the Bureau of Reclamation do not include details of moving water sites and structures built on South Dakota reservations thereafter.

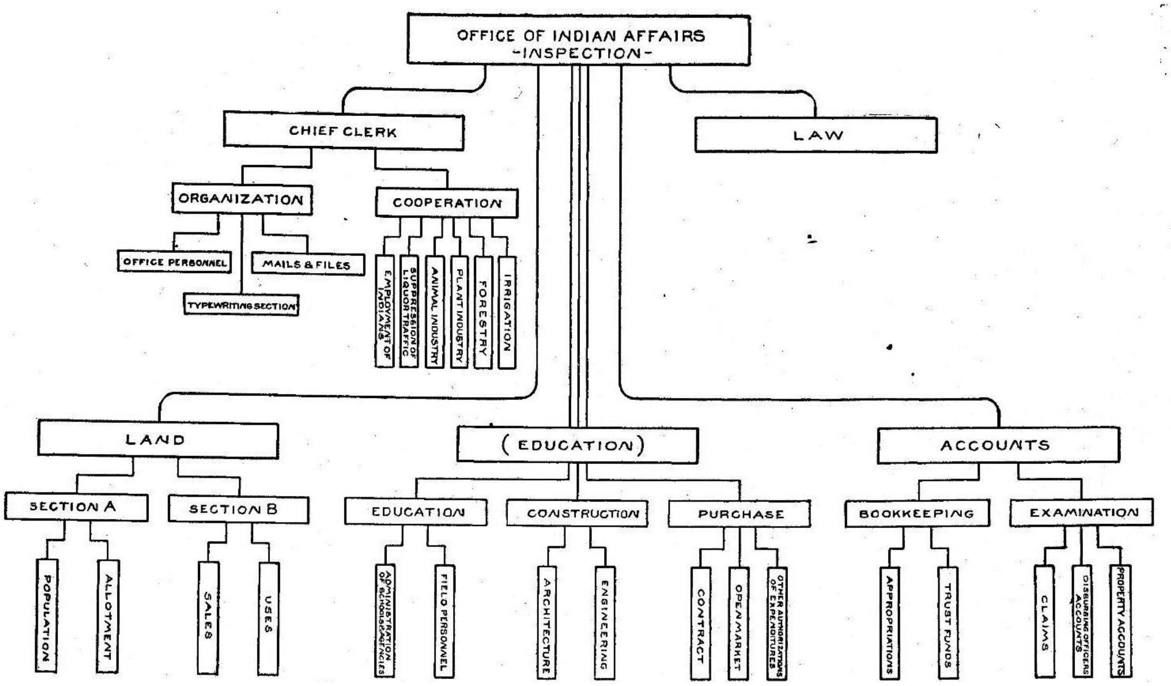

Figure 40. Diagram included in the 1908 Annual Report of the Commissioner of Indian Affairs showing new changes made to the organization of the Office of Indian Affairs. Irrigation came under the Chief Clerk's oversight as part of cooperative projects with other agencies.

Federal Work Relief Program Construction, 1929-1941

The economic effects of the Great Depression hit South Dakota in the immediate aftermath of World War I, nearly a decade *before* its impacts were felt in other parts of the country. Falling crop prices led farmers to default on debts, and between 1920 and 1934, 71% of banks failed in South Dakota.[269] Economic declines were exacerbated by severe and recurring droughts between 1926 and 1935 that destroyed crops and killed entire herds of livestock. Dustbowl conditions wrought havoc across the state and, by 1934, an estimated 95 percent of South Dakota's arable acreage was damaged.[270]

Between 1933 and 1938, President Franklin Delano Roosevelt enacted a series of programs, public work projects, regulations, and reforms collectively known as the New Deal.[271] While some programs provided direct relief, others were designed to provide employment opportunities through the construction of public buildings, sites, and structures (for a complete

[269] Lee, *A New Deal for South Dakota*, 26.
[270] Hendrickson, "The Civilian Conservation Corps in South Dakota," 1.
[271] Lee, *A New Deal for South Dakota: Drought, Depression, and Relief, 1920-1941*.

review, see *A New Deal for South Dakota: Drought, Depression, and Relief, 1920-1941*).[272] Also see existing documentation from the South Dakota State Historical Preservation Office, including *Federal Relief Construction in South Dakota, 1929-1941* and *Steel Water Towers Associated with South Dakota Water Systems, 1894-1967: An Historic Context*).[273] In addition to those focused on direct aid, a number of New Deal programs employed South Dakotans in work relief programs and built public works, many of which have endured to the present day (Figure 41). Two New Deal programs that were particularly consequential for water conveyance sites and structures related to irrigation, flood control, wildlife conservation and management, and recreation in South Dakota were the Civilian Conservation Corps (CCC) and the Works Progress Administration (WPA).

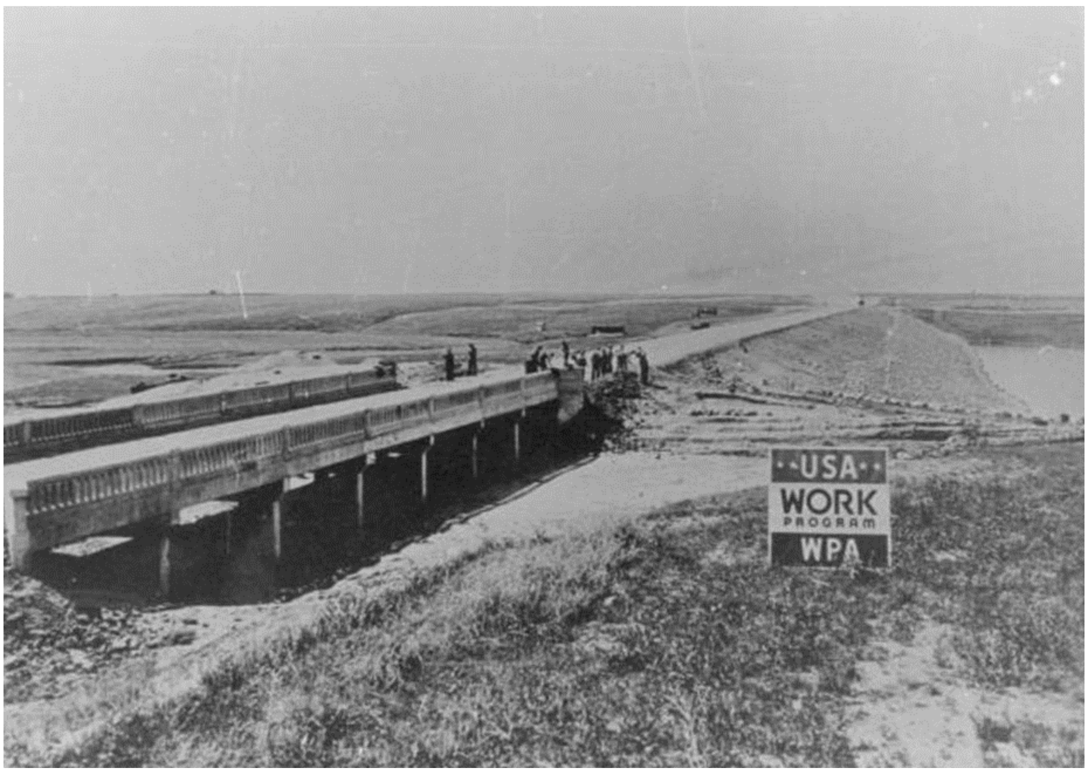

Figure 41. Drought-stricken farmers working on a dam to mitigate the impacts of future droughts in Aberdeen, Brown County, South Dakota. Note the "USA Work Program WPA" sign in the foreground. Courtesy of the SDSHS, South Dakota Digital Archives (2017-08-07-318).

Between 1933 and 1942, South Dakota had fifty-two CCC camps, including four CCC-Indian Division (CCC-ID) camps in Pine Ridge, Rosebud, Lower Brule, and Crow Creek Reservations (see Stock Dams, Dugouts, Wells, and Spring Improvements). The CCC employed roughly 32,000 men in South Dakota, of whom 26,000 were residents of the state. CCC enrollees, also known as CCs, "worked in virtually all national forests and parks, in state forest

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[272] Lee, *A New Deal for South Dakota: Drought, Depression, and Relief, 1920-1941*.
[273] Dennis, "Federal Relief Construction in South Dakota, 1929-1941;" Mathis and Hendrickson, "Steel Water Towers Associated with South Dakota Water Systems, 1894-1967.

and park areas, on farmlands, on the public domain, in wildlife refuges, along stream beds, and in the arid areas of the west."[274] The CCC engaged in many different types of work and routinely collaborated with other New Deal programs like the WPA, in addition to the National Park Service, U.S. Forest Service, Bureau of Biological Survey, and U.S. Bureau of Fisheries, among others.[275] Many CCC projects involved moving water sites and structures, including camps focused on erosion control, flood control, landscaping and recreation, range, and wildlife.[276] They built check dams, terraced landscapes, planted vegetative covering, implemented flood control measures, installed drainage, dug ditches, built channel works, and constructed riprapping.[277]

Similarly, and often in collaboration with the CCC, the WPA became key to South Dakota's economic recovery by helping state and local governments to improve existing infrastructure and build new public works.[278] Ultimately, New Deal programs invested about $100 million in South Dakota—an exceptionally high expenditure in light of the relatively small population of the state.[279] The New Deal simultaneously stimulated the state economy while creating public works of lasting value, including many that contributed to agricultural irrigation, drainage, flood control, wildlife conservation and management, and recreation.

Stock Dams, Dugouts, Wells, and Spring Improvements

The CCC built numerous small dams and stock ponds, dugouts, wells, and spring improvements, creating small bodies of water that could be used for livestock to drink.[280] CCC workers made improvements to naturally occurring springs by "digging it out, 'rocking up' the opening, putting a pole or wire fence around it, and installing a pipe to conduct the water to a trough. Sometimes a hewn out log was used as a trough." [281] The creation of new small bodies of water expanded livestock access to drinking water, improving graze management throughout the region.[282] In 1935 alone, the CCC built 66 stock watering reservoirs, 4 wells, and 105 springs in the Black Hills and Harney National Forests.[283] An estimated 100 small dams were built on creeks to create stock dams in national forests and the counties of Beadle, Buffalo, Lincoln, Lyman, Meade, Harding, Spink, and Union.[284]

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[274] Derscheid, "The Civilian Conservation Corps in South Dakota," 20.
[275] Fechner, "The Civilian Conservation Corps."
[276] Derscheid, "The Civilian Conservation Corps in South Dakota," 19-20.
[277] Dennis, "Federal Relief Construction in South Dakota, 1929-1941," 14.
[278] Lee, *A New Deal for South Dakota: Drought, Depression, and Relief, 1920-1941*.
[279] Hendrickson, "The Civilian Conservation Corps in South Dakota," 4.
[280] Dennis, "Federal Relief Construction in South Dakota, 1929-1941," 53.
[281] Dennis, "Federal Relief Construction in South Dakota, 1929-1941," 53.
[282] Dennis, "Federal Relief Construction in South Dakota, 1929-1941," 3.
[283] In 1954, Harney National Forest became part of Black Hills National Forest. Dennis, "Federal Relief Construction in South Dakota, 1929-1941," 53.
[284] Derscheid, "The Civilian Conservation Corps in South Dakota," 2.

Figure 42. A well built by the CCC at Roubaix in Lawrence County between 1938 and 1939. Courtesy of the SDSHS, South Dakota Digital Archives (2023-10-25-306).

Figure 43. A stock dam and ranch in Pennington County in 1936. Courtesy of the SDSHS, South Dakota Digital Archives (2010-09-22-016).

Multi-Purpose Dams, Lake Creation, and Lake Modifications

A total of twenty-nine CCC camps–more than half of all such camps in South Dakota–were located in the Black Hills, where the construction of dams that created recreational lakes are considered among their most significant accomplishments.[285] Multi-purpose dams and the lakes that they created conserved water, reduced flooding, and provided new recreation opportunities that quickly became popular with local residents.[286] In coordination with the WPA and other New Deal programs, the CCC is credited with building at least 20 multi-purpose dams throughout South Dakota, the majority of which were in and around the Black Hills.[287] Most such multi-purpose dams were earthen, classified as "earth fill with core trench," or "earth fill with bentonite base."[288] The "earth fill with bentonite base" approach marked the development of a new technique that was quickly adopted and adapted for use in other regions. This novel approach made use of bentonite, a hydrous aluminum silicate, as a form of waterproofing. At locations where underlying geological substrates were porous and otherwise unsuitable for typical "earth fill with core trench" style dams, "earth fill with bentonite base" were used. To build an earthen dam, CCs stripped vegetation and excavated trenches to underlying bedrock, which was then filled with a bentonite solution, which swells in the presence of water, is resistant to erosion, and makes the underlying substrate impervious to water flow. Concrete walls were constructed to bond the earthen fill to the basal rock, and layers of moist clay were added and compacted to form a water-tight core. The visible aboveground part of the dam had sloped sides and included features like spillways and rip rap laid on a gravel cushion to protect against erosion. [289] This new method of dam construction was soon adopted in other states and opened up national markets for bentonite mined in northwestern South Dakota and eastern Wyoming.

The Black Hills are entirely devoid of natural lakes; all waterbodies there are artificial impoundments built through the construction of dams. The CCC played a role, in full or in part, in the majority of these projects, although there are exceptions like the earlier Sylvan Lake, the later Pactola Reservoir, and smaller privately constructed stock dams.

New Deal-era programs were responsible for constructing hundreds of small dams throughout the state.[290] Many of the dams constructed in the Black Hills were of the small stock dam variety for use in livestock watering. The CCC also constructed a multitude of fish-rearing ponds in the Black Hills, completing work on roughly 200 such structures by 1940.[291] Larger Black Hills dam/reservoir projects that the CCC completed or assisted with include Lakes Mitchell, Glen Erin, Major, Dalton, Roubaix, Deerfield, Stockade, Bear Butte, Slate Creek, and Victoria.

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[285] Dennis, "Federal Relief Construction in South Dakota, 1929-1941," 20.
[286] Derscheid, "The Civilian Conservation Corps in South Dakota," 2.
[287] Derscheid, "The Civilian Conservation Corps in South Dakota," 2.
[288] Derscheid, "The Civilian Conservation Corps in South Dakota," 55.
[289] Derscheid, "The Civilian Conservation Corps in South Dakota," 55.
[290] Dennis, "Federal Relief Construction in South Dakota, 1929-1941," 35.
[291] Derscheid, "The Civilian Conservation Corps in South Dakota," 53.

During the peak period of CCC program activity in South Dakota (c. 1937-1941), numerous enduring structures were built, including the Lake of the Pines Dam on Spring Creek in the Black Hills, now known as Sheridan Lake. The 850-foot-long dam was built as a joint project of the CCC and WPA and was the largest earthen dam built by both organizations in South Dakota.[292] Its construction created a 400-acre recreational lake "enjoyed by hundreds of thousands of outdoor enthusiasts."[293] The region quickly became a hub for recreation by the late 1930s, largely because of the improvement and development of campgrounds around the lake.[294]

Although many of the aforementioned structures remain extant, others did not survive. Examples include the concrete dams that previously impounded Glen Erin Lake and Victoria Lake (Figures 44 and 45). The Victoria dam was damaged in 1972 during the Rapid City flood and subsequently removed; the Glen Erin Dam was removed in 1978 after it was determined unsafe.[295] As the vast majority of CCC-constructed dams in the Black Hills were earthen structures, many of the smaller stock dams lack diagnostic or characteristic marks to assist field researchers in their identification. Nevertheless, should investigators happen across any dam-related infrastructure in the Black Hills, there is a good chance that the CCC played a role in its construction.

Figure 44. Downstream side of the Victoria Dam, under construction in 1937. Photograph by C. C. Averill. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20220684).

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292 "Living New Deal, 'Sheridan Lake - Black Hills National Forest SD."
293 Hendrickson, "The Civilian Conservation Corps in South Dakota," 17.
294 Derscheid, "The Civilian Conservation Corps in South Dakota," 2.
295 Dennis, "Federal Relief Construction in South Dakota, 1929-1941," 15.

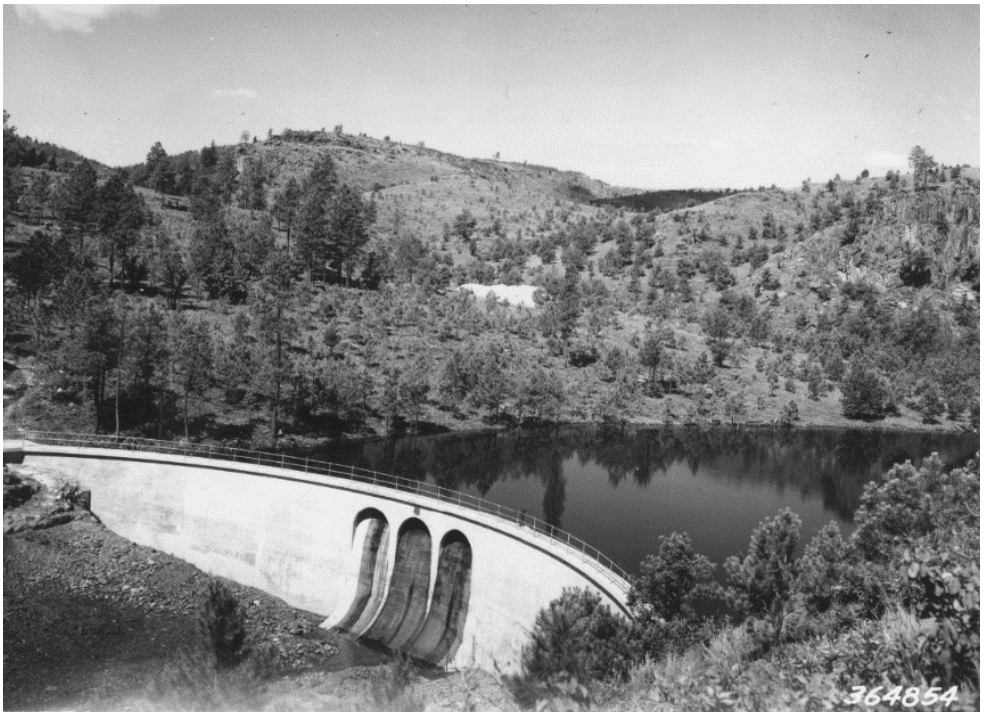

Figure 45. Victoria Dam in 1938. Photograph by C. C. Averill. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20070095).

South Dakota boasted over 50 CCC camps during the Program's tenure. While the majority of the CCC's efforts focused on the Black Hills area, they completed a number of water-related construction projects further east in the state as well, many of which were undertaken in cooperation with the WPA. Beyond the Black Hills, other notable large multi-purpose dams include the Third Street Dam in Huron; Fate, Brakke, and Byre Dams in Lyman County; Crow Creek Dam and its associated reservoir, Lake Bedashosho, in Buffalo County; Dakotah Dam in Hand County; and Dudley Dam in Spink County.[296]

Creation of New Recreation Areas

While many of the lakes created by CCC dams were multi-purpose, their use in recreation was emphasized, especially for boating, fishing, swimming, picnicking, and camping.[297] Swimming facilities could include diving piers, wading pools for toddlers, sand beaches, and bathhouses (Figures 46 and 47).[298] In Black Hills National Forest, recreation areas were built near Horse Thief Lake and Bismarck Lake.[299] At Custer State Park, recreation facilities were constructed at Stockade Lake and Center Lake. CCs also built 17 cabins at Sylvan

[296] Dennis, "Federal Relief Construction in South Dakota, 1929-1941," 26.
[297] Derscheid, "The Civilian Conservation Corps in South Dakota," 54.
[298] Derscheid, "The Civilian Conservation Corps in South Dakota," 54.
[299] Derscheid, "The Civilian Conservation Corps in South Dakota," 56.

Lake, itself created by the damming of Gulch Creek in 1891, and most of the buildings at Blue Bell Lodge within Custer State Park.[300]

Figure 46. The diving pier at Roubaix Lake in 1937. Photograph by C.C. Averill. Courtesy of the Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20220489).

Figure 47. Diving pier at Roubaix Lake looking toward the diving tower. Courtesy of the Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20143007).

300 Derscheid, "The Civilian Conservation Corps in South Dakota," 56-57.

Wildlife Conservation and Management: Fish and Wildlife Developments

Other important CCC contributions to South Dakota were made by creating sites and structures of water conveyance intended for fish, waterfowl, and other aquatic species. CCs did conservation work at Sand Lake (Brown County), La Creek National Wildlife Refuge (Bennett County), Lake Andes (Charles Mix County), and Waubay Migratory Waterfowl Refuge (Day County), rehabilitating and creating new habitats for endemic and migratory species.[301] The CCC built fish-rearing and retaining ponds along streams and stocked them with young fish for both conservation and recreational purposes.[302] By 1940, about 200 fish-rearing ponds were in use, and an estimated 3.3 million game fish had been stocked or transplanted.[303]

Despite the establishment of several state fish hatcheries during the first half of the 1920s (see State Fish Hatcheries of South Dakota), fish stocking activities stagnated during the Great Depression. By 1933, water levels were so low that half of South Dakota's lakes were completely devoid of fish, and by 1936, only six natural lakes had extant fish game populations remaining.[304] State fisheries focused on salvage operations, transporting fish from lakes with low water levels to lakes with high water levels where fish had a better chance of survival.

In the Black Hills, Spearfish National Fish Hatchery changed water sources in response to insufficient supply, installing an artesian well in 1935 on nearby land that became known as the McGuigan substation. A year later, the substation was demolished, and a diversion channel was dug to ensure a steady supply of water for the hatchery. A stone building was also erected nearby for trout egg incubation in 1936.[305] Additional improvements were implemented by the WPA, which built two small fish rearing pools and four raceways. The fish rearing pools are spherically shaped, built out of granite cut stone walls, with gateways to other pools. Four of the fish rearing pools measure about three feet wide and three feet deep, while the fifth is described as a larger and deeper pond-like pool. The cement raceways, built by the WPA in 1939, measure approximately sixty feet in length and two feet in depth. The 1936 diversion channel is still in use, as are all four 1939 raceways.

State fish hatcheries were also expanded and improved. At Cleghorn Springs State Fish Hatchery, the CCC assisted in the construction of seven earthen ponds and twenty-nine stone-walled earthen-bottom ponds built during the 1940s.[306] When typical rainfall conditions returned in the 1940s, Cleghorn Springs and other state fish hatcheries had a critical role in repopulating South Dakota's waterways with gamefish. More than 50 million fish, predominantly from Pickerel Lake and Cleghorn Springs State Fish Hatcheries, were distributed in 1940 alone. Thousands of impoundments built by the WPA during the 1930s were stocked with fish propagated at the Twin Lakes Bass Hatchery, which began operating near Woonsocket in 1939.

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301 Derscheid, "The Civilian Conservation Corps in South Dakota," 59.
302 Derscheid, "The Civilian Conservation Corps in South Dakota," 53.
303 Derscheid, "The Civilian Conservation Corps in South Dakota," 53.
304 Barnes, "Fish Hatcheries and Stocking Practices: Past and Present," 278.
305 Barnes, "Fish Hatcheries and Stocking Practices: Past and Present," 278.
306 Barnes, "Fish Hatcheries and Stocking Practices: Past and Present," 276.

The U.S. Fish and Wildlife Service, in conjunction with the Soil Conservation Service, also initiated fish stocking activities in stock ponds of western South Dakota, operating a farm pond program from 1934-1973 directed toward ranchers and other private citizens, who received largemouth bass and panfish for introduction to stock ponds.

Belle Fourche Irrigation Project Improvements with Bureau of Reclamation

One of South Dakota's CCC camps, located in Butte County, was assigned to the Bureau of Reclamation and assisted with the improvement, repair, and expansion of existing federal infrastructure in Belle Fourche, South Dakota.[307] CCC workers made renovations to the Belle Fourche Dam, then known as the Orman Dam, and improved its 654-mile water distribution system. They rebuilt a dam outlet, lined canals with concrete, cleared vegetation, and built over 1,000 structures, including culverts, drops, checks, and spillways (Figures 48-50).[308] *See also reference materials noted in the previous section on Reclamation Projects.*

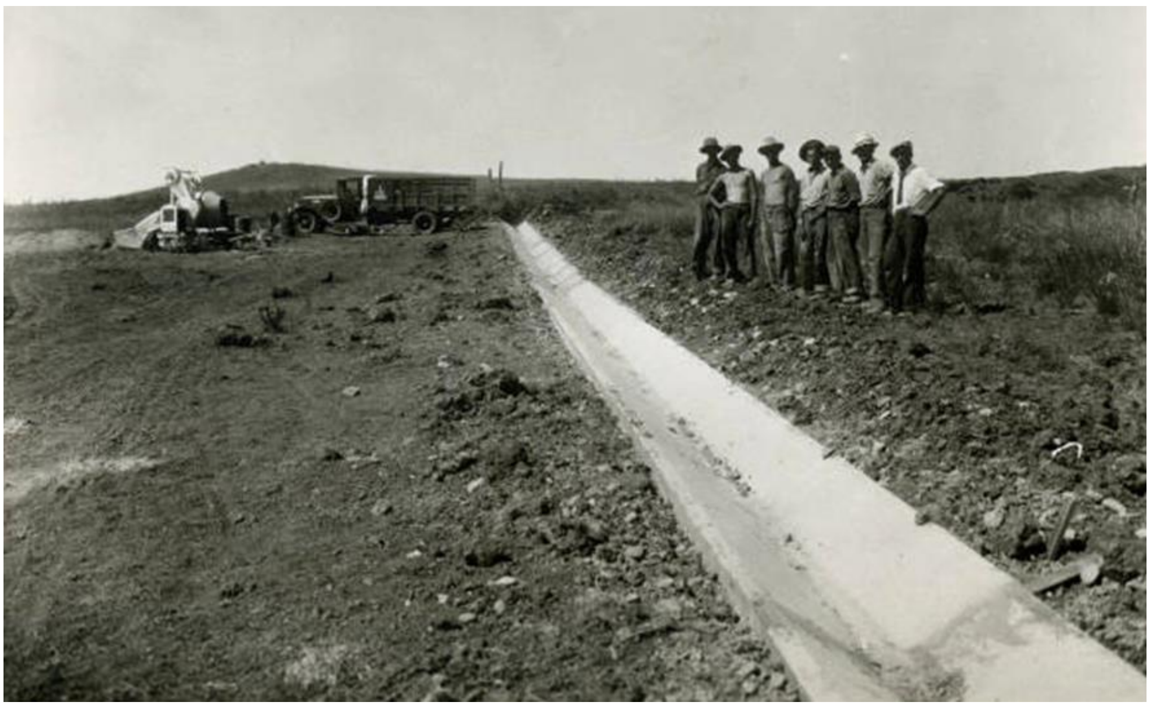

Figure 48. A CCC construction in 1935 crew near a V-shaped concrete water chute for the Belle Fourche Dam. Courtesy of the SDSHS, South Dakota Digital Archives (2010-08-30-018).

[307] Derscheid, "The Civilian Conservation Corps in South Dakota," 2.
[308] Derscheid, "The Civilian Conservation Corps in South Dakota," 3.

Figure 49. CCs working on the Belle Fourche Dam. An inscription indicates this photo was taken after a canal gate was built at the end of a siphon and shows enrollees standing near a finished gate and ditch cleared out by the crew. Courtesy of the SDSHS, South Dakota Digital Archives (2010-08-31-018).

Figure 50. CCC enrollees working on flumes near Newell, Butte County in 1935. Courtesy of the SDSHS, South Dakota Digital Archives (2010-08-30-023).

The Indian New Deal and the CCC-Indian Division, 1934-1942

Shortly after Congress created the Emergency Conservation Work program (ECW, later CCC) in 1933, President Roosevelt authorized the Indian Emergency Conservation Work (IECW), which later became known as the CCC-Indian Division (CCC-ID). The Bureau of

Indian Affairs was responsible for the administration of the CCC-ID, and tribal councils were part of the decision-making process for works on reservations. This was possible because of changes in federal policy after the Indian Reorganization Act of 1934 that prioritized self-governance through new tribal councils. [309]

The Civilian Conservation Corps-Indian Division (CCC-ID) in South Dakota

Nationwide, the CCC-ID employed 85,200 Tribal members who lived and worked on their own reservations as part of 77 CCC-ID camps (Figures 51-56).[310] Reports of the number of CCC-ID enrollees in South Dakota vary from 4,554 to 8,405.[311] Projects on West River reservations focused primarily on water development and irrigation projects. On East River reservations, where soils tended to be more productive and rainfall was greater than 20 inches annually, irrigation projects tended to be smaller and focused on the construction of fences, roads, and telephone lines.[312]

Figure 51. CCC-ID workers at the Lake Traverse Reservation (Sisseton-Wahpeton Oyate) c.1935. Courtesy of the National Archives (Identifier 285788).

[309] Bromert, "The Sioux and the Indian-CCC," 347; Biolsi, *Organizing the Lakota*..
[310] Derscheid, "The Civilian Conservation Corps in South Dakota," 40.
[311] Derscheid, "The Civilian Conservation Corps in South Dakota," 40.
[312] Bromert, "The Sioux and the Indian-CCC," 348.

Figure 52. A CCC-ID sign maker on the Pine Ridge Indian Reservation (Oglala Sioux Tribe). Courtesy of the National Archives (Identifier 12467733).

Figure 53. CCC-ID enrollees at work on an unspecified dam site located on the Rosebud Indian Reservation (Rosebud Sioux Tribe). Courtesy of the National Archives (Identifier 12577763).

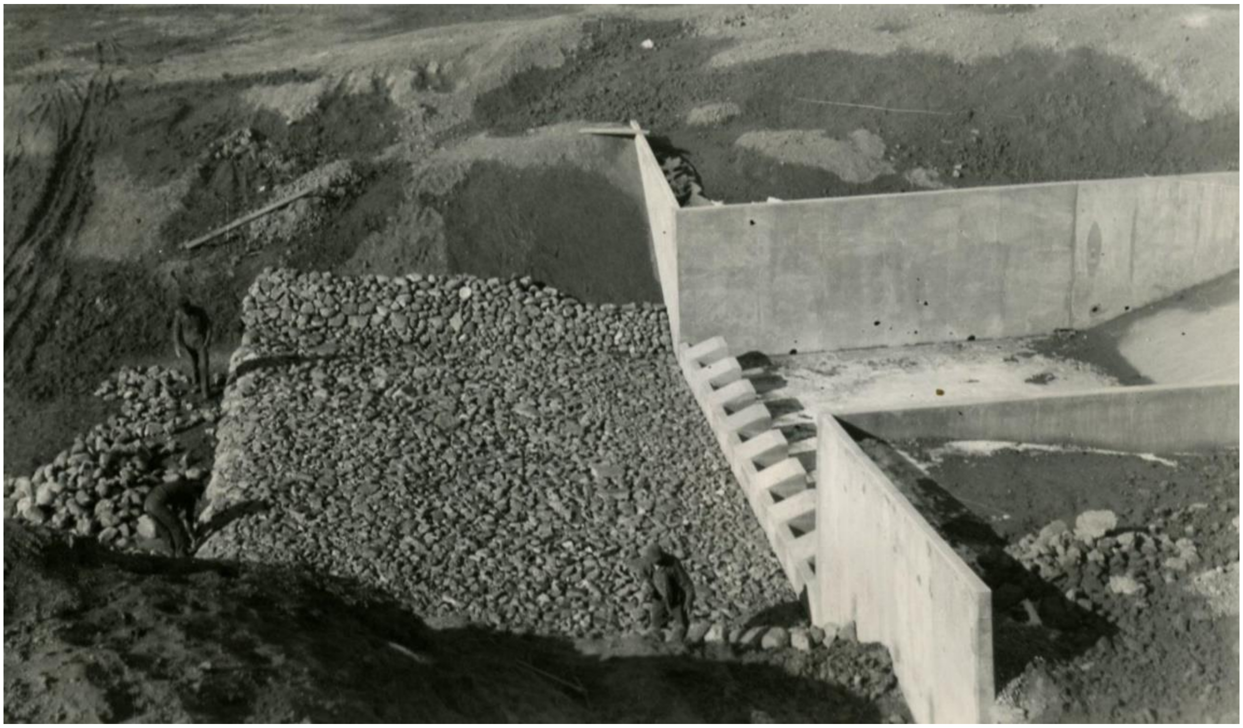

Figure 54. CCC-ID workers installing riprap below a weir ca. 1940 on the Standing Rock Indian Reservation (Standing Rock Sioux Tribe). Courtesy of the National Archives (Identifier 32204483).

Figure 55. CCC-ID workers digging lateral at Soldier Creek on the Rosebud Indian Reservation (Rosebud Sioux Tribe). Courtesy of the National Archives (Identifier 12080193).

Figure 56. Soldier Creek lateral irrigation ditch in use on the Rosebud Indian Reservation. Courtesy of the National Archives (Identifier 12080169).

Available documents suggest that, especially in the early days of the CCC-ID, many projects were not completed as planned. Initially, few Native people had experience working with the large construction equipment used in road and dam construction, so "as a consequence hundreds of small earth dams had to be rebuilt."[313] However, enrollees' skill sets developed and expanded over time and, by 1936, larger projects like concrete spillways "became a regular addition to the larger dams constructed on the Red Earth and Cheyenne rivers."[314] Some of the heavy equipment jobs and skilled labor jobs went to non-Natives, especially as the scale of projects expanded and the need for specialized machinery increased. It helped to make progress on projects but did not contribute to Indian employment.

In 1936, the CCC-ID began to work more intensively on irrigation projects. CCs worked toward developing new irrigation facilities for small gardens and, by the end of 1936, small, irrigated gardens between 2 and 15 acres had been constructed on every reservation in South Dakota.[315] These projects were directed by the Irrigation Division, who selected the site, designed the system, and furnished the pump equipment, and the resulting gardens fell under the jurisdiction of reservation superintendents. The gardens were typically small and used pumps located along the Missouri River to secure water. Gardens were operated at family scales mostly but in some rarer cases as community gardens in co-op fashion. The storage dams provided water

[313] Bromert, "The Sioux and the Indian-CCC," 348.
[314] Bromert, "The Sioux and the Indian-CCC," 348.
[315] Bromert, "The Sioux and the Indian-CCC," 348-350.

not just for agricultural irrigation, but also for domestic and stock purposes. They also helped to improve health and sanitation across reservations.[316]

Water infrastructure developed by the CCC-ID was criticized at the time for benefitting few Indians, instead truly serving cattle ranchers who leased the land, and for excessive spending on machinery that required skilled non-Native labor. Despite these valid critiques, the CCC-ID is still considered to have made substantial accomplishments, particularly in expanding water infrastructure on reservations.[317] The National Inventory of Dams documents twelve extant dams built in South Dakota by the Bureau of Indian Affairs between 1933 and 1942, all of which were built for irrigation, stock watering, fish and wildlife protection, recreation, or a combination of purposes.[318]

[316] Bromert, "The Sioux and the Indian-CCC," 350.
[317] Bromert, "The Sioux and the Indian-CCC," 129.
[318] US Army Corps of Engineers, "National Inventory of Dams."

Post-War Moving Water Site and Structure Developments, 1945-1980

The Pick-Sloan Missouri River Basin Program

Severe and prolonged droughts during the 1930s were followed by repeated, extensive, and deadly flooding along the Missouri River and its tributaries in the early 1940s. In response, Congress took action, authorizing the Pick-Sloan Missouri Basin Program (PSMBP) under the Flood Control Act of 1944. The Program brought together plans developed by the United States Army Corps of Engineers and the Department of the Interior's Bureau of Reclamation to improve and provide new flood control, irrigation, navigation, and hydroelectric power facilities within the Missouri River Basin.[319] Four of the five Missouri mainstem dams and their resulting reservoirs were planned for South Dakota.

Representatives of South Dakota looked favorably upon the Program and its potential to counteract demographic declines that occurred prior to World War II. Dryland farmers had suffered through years of unprecedented aridity and dust storms, and a considerable number of South Dakotans had sought opportunities elsewhere, migrating out-of-state in pursuit of employment in wartime industries. South Dakota politicians recognized the Pick-Sloan Program's potential to address both immediate and long-term needs. In the short-term, the program would create a multitude of construction jobs to bring veterans and former industrial workers to South Dakota. Broader-reaching goals of the program included flood control, irrigation of farmlands, recreation opportunities, and hydroelectric power generation. Ultimately, it was hoped that the program would revitalize communities across the state. [320]

The "Big Dam Era" irrevocably transformed the Missouri River and adjacent lands. Between 1946 and 1963, construction of the four mainstem dams and their component hydroelectric power plants essentially turned the river into a "chain of lakes."[321] While the Upper Missouri reservoirs in South and North Dakota provided flood protection to over 809,000 hectares of floodplains further downstream on the Missouri River, an estimated 611,642 acres of land were ultimately flooded by the reservoirs themselves. Federal construction agencies and states were "preoccupied with the engineering aspects of the vast development plan" and "gave virtually no consideration to the people whose farms and ranches, homes and communities were in the sacrifice area."[322]

The PSMBP was further reaching than just the Missouri River mainstem, however, and in South Dakota, work on multiple additional localities was ultimately incorporated underneath the

[319] Campbell, "The Pick-Sloan Program: A Case of Bureaucratic Economic Power;" Linenberger, "Overview: Pick-Sloan Missouri Basin Program;" Otstot, "An Overview of the Pick-Sloan Missouri Basin Program: Sharpe, "Pick-Sloan Plan: Retrospects and Prospects."
[320] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 309.
[321] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 331.
[322] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 314.

program's umbrella. Projects completed beyond the Missouri River trench under the auspices of the PSMBP include the Rapid Valley Unit, Angostura Unit, Shadehill Unit, Oahe Unit, and the James Diversion Dam.

For historical context on the engineering, administration, labor, and construction, see U.S. Army Corps of Engineers documentation of the Oahe Dam (Lake Oahe),[323] Big Bend Dam (Lake Sharpe),[324] Fort Randall Dam (Lake Francis Case),[325] and Gavins Point Dam (Lewis and Clark Lake).[326] Information on the Angostura,[327] Rapid Valley,[328] Shadehill,[329] and Oahe[330] units are also available from the Bureau of Reclamation.

Angostura Unit

See additional information in: Linea Sundstrom, (2019) "'A Land Where Life is Written in Water': History of the Angostura Irrigation Project, Fall River County, South Dakota." Bureau of Reclamation, Rapid City, SD.

Angostura Dam and Reservoir represents the first PSMBP project initiated and completed.[331] Construction of project facilities began in 1946, and the dam was completed by 1949. Irrigation water was first delivered to project lands in 1953.[332] The dam and reservoir were built along the Cheyenne River near the mouth of Red Canyon at the southeastern edge of the Black Hills. The reservoir extends for about 17 miles along the Cheyenne River, with an additional arm extending some 7.5 miles up the valley of Horsehead Creek. In total, the reservoir holds a capacity of 130,000-acre feet.

Facilities associated with the Angostura Unit include the reservoir, combination concrete/earthen embankment dam, gated spillway, and outlet with high pressure gate. Water for irrigation is supplied via a 30-mile-long primary canal. The primary canal, in turn, distributes water through another 39 miles of laterals and 21 miles of open and closed drains that serve individual farms.

Angostura Dam and Reservoir provided flood control, fish and water conservation, and recreation opportunities. Additionally, the dam briefly provided hydroelectric power between

[323] US Army Corps of Engineers, "Final Oahe Dam/Lake Oahe Master Plan."
[324] US Army Corps of Engineers, "Big Bend Dam/Lake Sharpe Master Plan."
[325] US Army Corps of Engineers, "Final Fort Randall Dam/Lake Francis Case Master Plan."
[326] U.S. Army Corps of Engineers, 'Gavins Point Dam/Lewis and Clark Lake Master Plan."
[327] Autobee, *The Rapid Valley Unit*.
[328] Bureau of Reclamation, "Pick-Sloan Missouri Basin Program, Rapid Valley Unit;" McCune, 'Rapid Valley Unit: Pick-Sloan Missouri Basin Program."
[329] Bureau of Reclamation, "Pick-Sloan Missouri Basin Program, Shadehill Unit."
[330] Bureau of Reclamation, "Pick-Sloan Missouri Basin Program, Oahe Unit (Initial Stage);" Bureau of Reclamation, "Pick-Sloan Missouri Basin Program, James Diversion Dam, Oahe Unit." .
[331] Autobee, *The Rapid Valley Unit*, 2.
[332] Autobee, *The Rapid Valley Unit*, 8-12.

1951 and the end of the decade; however, the powerplant was ultimately shut down after a reduction in flow rates due to an extended stretch of arid conditions.[333]

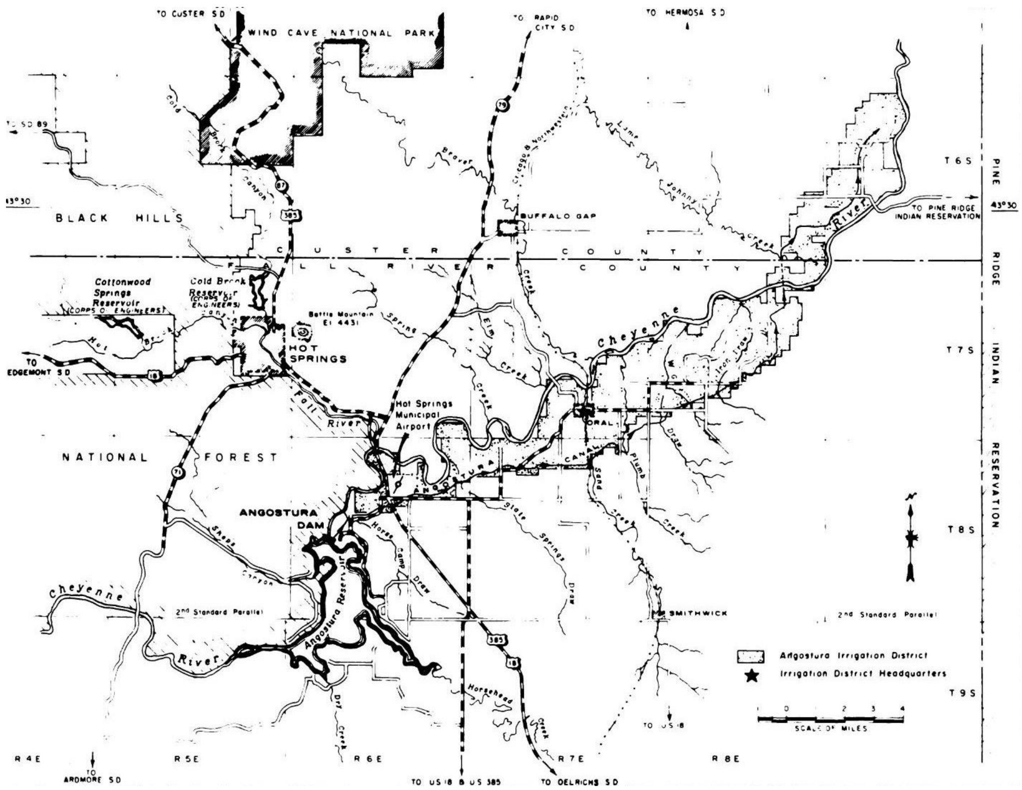

Figure 57. Angostura Dam and Reservoir southeast of Hot Springs. Courtesy of the Bureau of Reclamation.

Shadehill Unit

The Shadehill Unit consists of Shadehill Dam and Reservoir. It is located immediately downstream from the confluence of the North and South Forks of the Grand River some 12 miles south of Lemmon in northwestern South Dakota. Construction of the Shadehill Dam began in 1949. The first impoundment of water occurred the following year and, by August of 1951, the Shadehill Unit project was complete.[334]

Primary facilities comprising the Shadehill Unit include the reservoir and the dam. The reservoir impounds water sufficient for 6,700 acres of irrigation with an active capacity of 81,443 acre-feet. The dam and its associated dikes are rolled-fill earth structures. Ancillary components include a concrete spillway, an open-cut, unlined emergency spillway, and a controlled, gated outlet.[335] The unit provides recreation, fish and wildlife enhancement, and flood control benefits, as well as irrigation water.[336]

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[333] Autobee, *The Rapid Valley Unit*, 15.
[334] Bureau of Reclamation, 3.
[335] Bureau of Reclamation, 1.
[336] Bureau of Reclamation, 9.

Figure 58. Shadehill Dam and Reservoir. Courtesy of the Bureau of Reclamation.

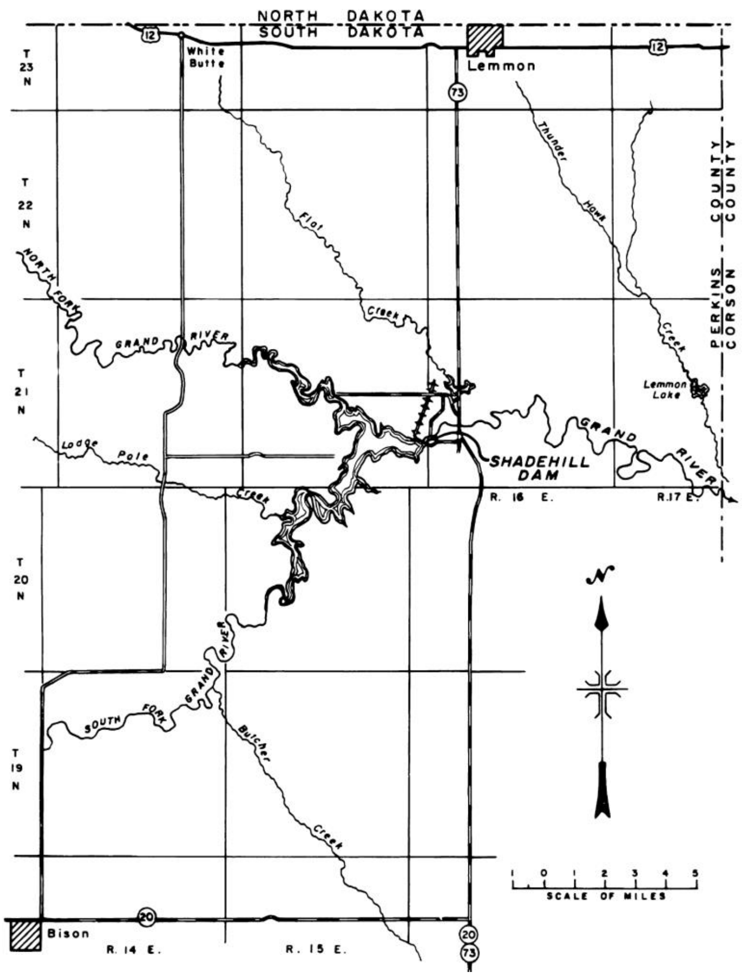

Figure 59. Shadehill Dam and Reservoir in northwestern South Dakota. Courtesy of the Bureau of Reclamation.

Rapid Valley Unit

Rapid City and surrounding farmers petitioned BOR to build additional facilities in response to the strain on local water supplies caused by Rapid City Army Air Base (later Ellsworth Air Force Base) that had been established in early 1942 and grew in the postwar era. Construction of Pactola Dam began in 1952 for this purpose.[337] The roughly 430-acre dam/reservoir site was located along Rapid Creek about 15 miles west of Rapid City (Figures 65-66). Construction of Pactola Dam was completed in 1956 and the first irrigation water was supplied by 1958.[338]

Facilities at Pactola include the 430-acre reservoir, dam embankment and dikes, spillway, outlet with high-pressure slide gates, stilling basin, and other minor components. In 1968, a perforated toe drain was added to the dam. In 1982, the dam underwent significant modifications. The dam and dikes were raised 15 feet in elevation and the spillway was expanded from an original width of 185 feet to 425 feet. Work on these major modifications was completed in 1985.[339] Recreation facilities have been constructed around the reservoir, and water supplies downstream irrigation efforts, though its primary purpose is to furnish drinking water to the communities of Rapid City and Ellsworth AFB.

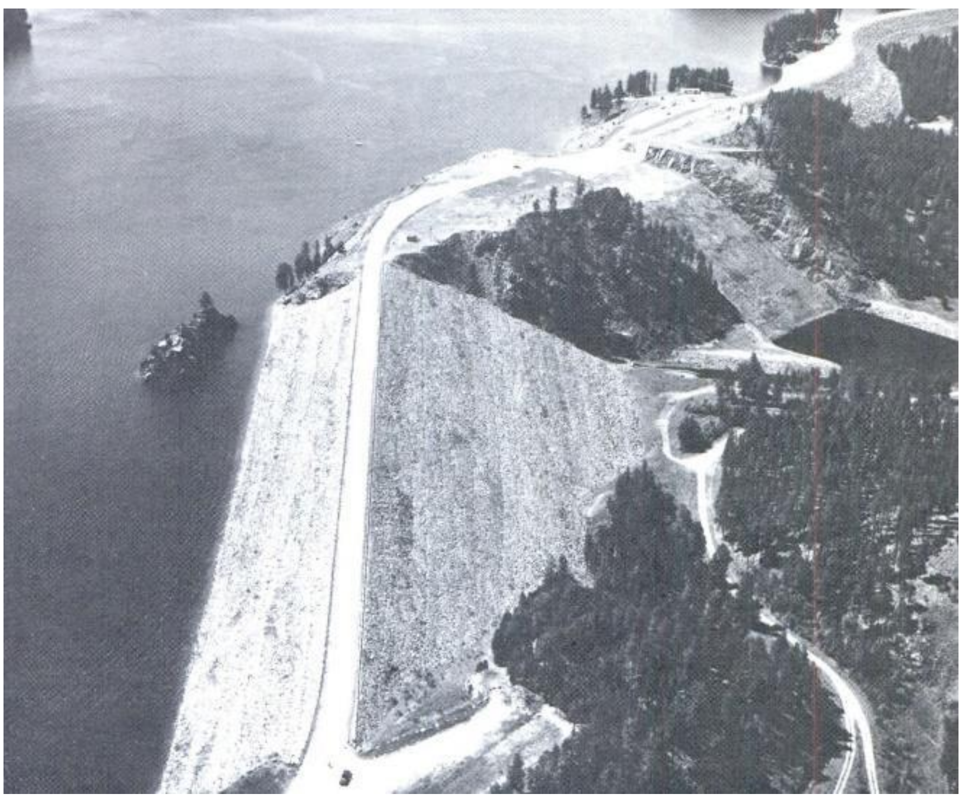

Figure 60. Pactola Dam and Reservoir. Courtesy of the Bureau of Reclamation.

337 Bureau of Reclamation, "Pick-Sloan Missouri Basin Program, Shadehill Unit," 9.
338 Autobee, *The Rapid Valley Unit*, 14.
339 Autobee, *The Rapid Valley Unit*, 15.

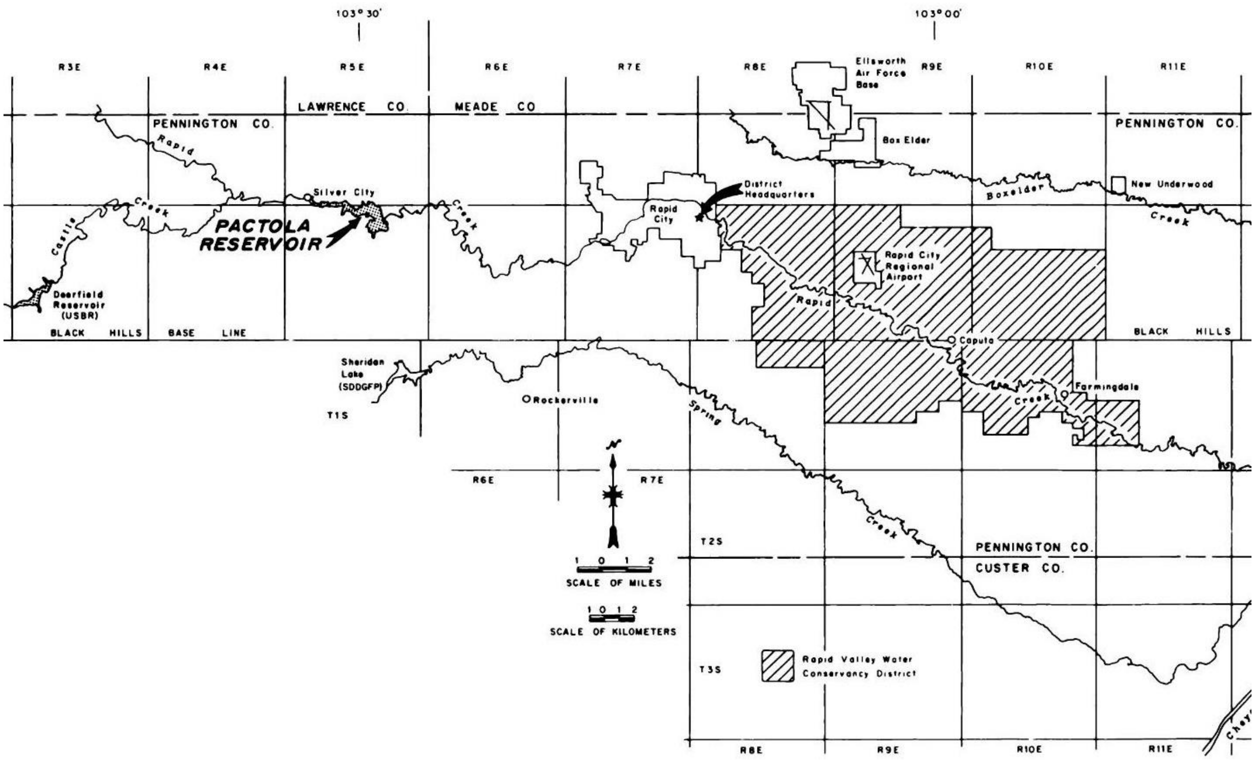

Figure 61. Pactola Reservoir on Rapid Creek west of Rapid City. Courtesy of the Bureau of Reclamation.

Oahe Unit

The Oahe Unit represents an ambitious plan that was never fully realized. Originally, the plan was developed to provide water from the Missouri River to farmers in the James River valley. The substantial distance between the Missouri and James valleys complicated matters and necessitated the pumping of water through canal systems that would have spanned portions of eight different counties (Figure 64). The authorized plan envisioned three regulating reservoirs (Oahe, James, and Byron reservoirs) and affiliated pumping plants, a diversion dam and reservoir along the James River, electrical distribution facilities, 214 miles of main canals, 955 miles of distribution laterals, 935 miles of open drains, and 2,970 miles of closed drains infrastructure.[341] While the James River Diversion Dam and Reservoir were completed and are still operational, construction of other project components was never completed. Ultimately, much of the Oahe Unit infrastructure like the Pierre Canal (Figure 63) was never completed and work on the project was halted (see below).[342] The Oahe Unit was primarily intended to supply irrigation for roughly 190,000 acres in north-central South Dakota; however, municipal and industrial water supplies, fish and wildlife conservation, recreation, and flood control were included as ancillary components of the plan.[343] The principal water supply for the unit was to be the Oahe Reservoir, though impounded water from the James Diversion Dam represents a current supply source.

James Diversion Dam

The James Diversion Dam and Reservoir are located along the James River in east-central South Dakota, approximately 17 miles north of the City of Huron (Figures 62 and 65). Work on the James Diversion Dam and its impoundment was authorized under the 1944 Flood Control Act to provide supplemental municipal water to Huron. Intended to have been part of the larger Oahe Unit, the James Diversion Dam was constructed between 1963 and 1964.[344]

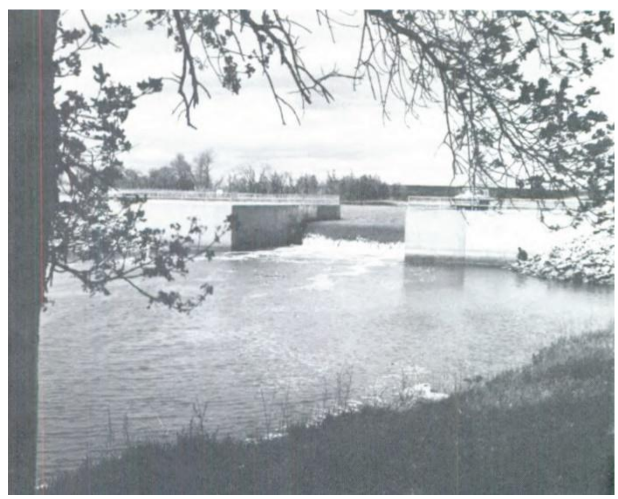

Figure 62. James Diversion Dam and spillway.[340] Courtesy of the Bureau of Reclamation.

Facilities comprising the James Diversion Dam include the concrete dam and flanking earthen dikes, approximately 960-

[340]Bureau of Reclamation, "Pick-Sloan Missouri Basin Program, James Diversion Dam, Oahe Unit."
[341] Bureau of Reclamation, "Pick-Sloan Missouri Basin Program, James Diversion Dam, Oahe Unit" (Bureau of Reclamation, 1983), 1, https://hdl.handle.net/2027/umn.31951002913331q.
[342] Bureau of Reclamation, "Pick-Sloan Missouri Basin Program, James Diversion Dam, Oahe Unit," 1; Eastman, "Oahe Unit: James Division," 1.
[343] Bureau of Reclamation, "Pick-Sloan Missouri Basin Program, James Diversion Dam, Oahe Unit," 1.
[344] Bureau of Reclamation, "Pick-Sloan Missouri Basin Program, James Diversion Dam, Oahe Unit.

acre reservoir, spillway, parking areas, and operation and maintenance access roads.[345] While the dam and reservoir are operated and maintained by the city of Huron specifically for municipal water storage purposes,[346] private landowners irrigate cropland directly out of the river up and downstream from the dam. In addition to the water supplied for municipal use, the facilities provide for fish and wildlife enhancement, as well as recreation development associated with the reservoir.

Figure 63. Part of the completed portion of the Pierre Canal. Courtesy of the Bureau of Reclamation. Courtesy of the Bureau of Reclamation.

345 Bureau of Reclamation, "Pick-Sloan Missouri Basin Program, James Diversion Dam, Oahe Unit," 1.
346 Bureau of Reclamation, "Pick-Sloan Missouri Basin Program, James Diversion Dam, Oahe Unit," 3.

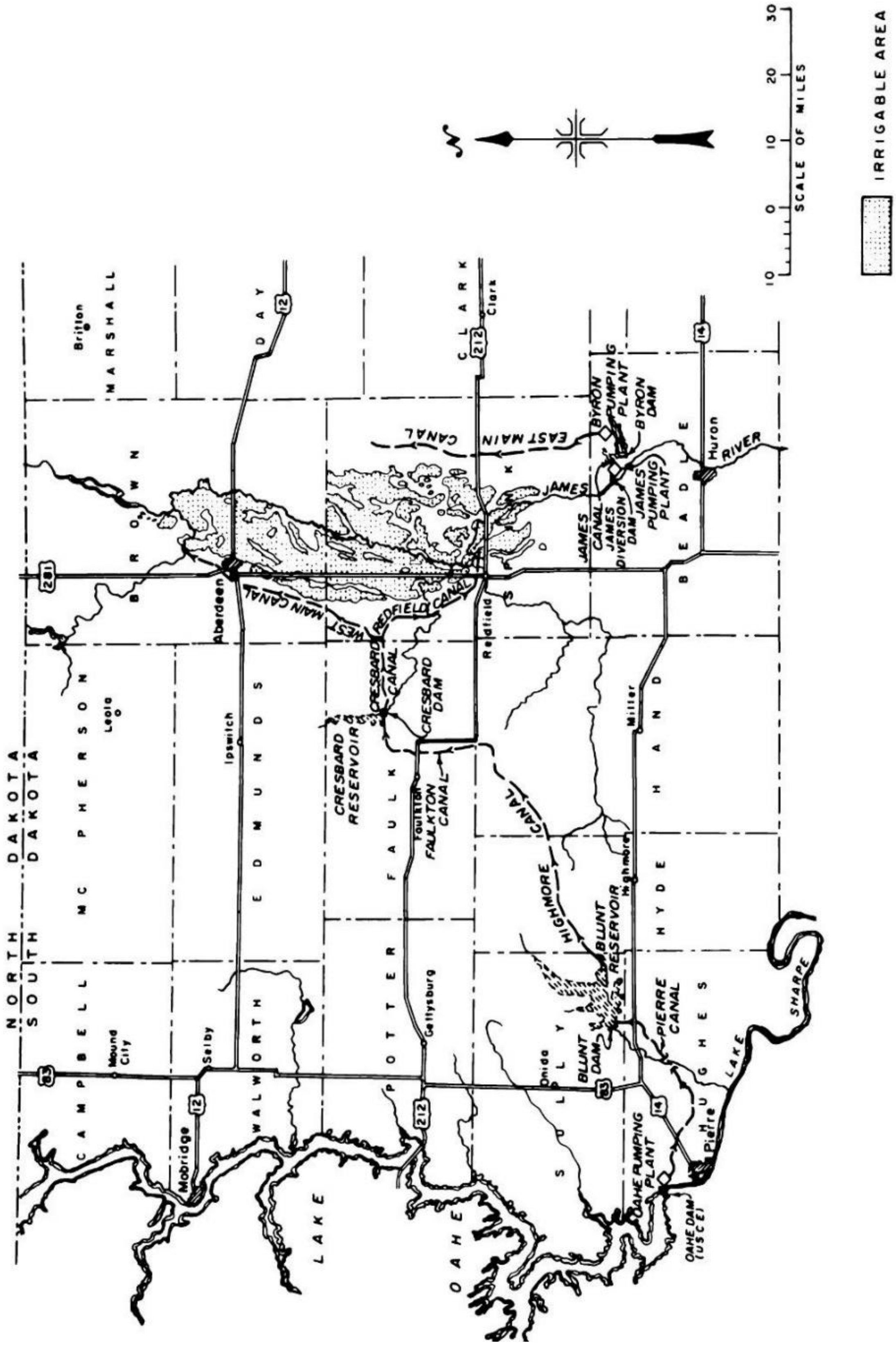

Figure 64. Oahe Unit components as originally planned. Courtesy of the Bureau of Reclamation.

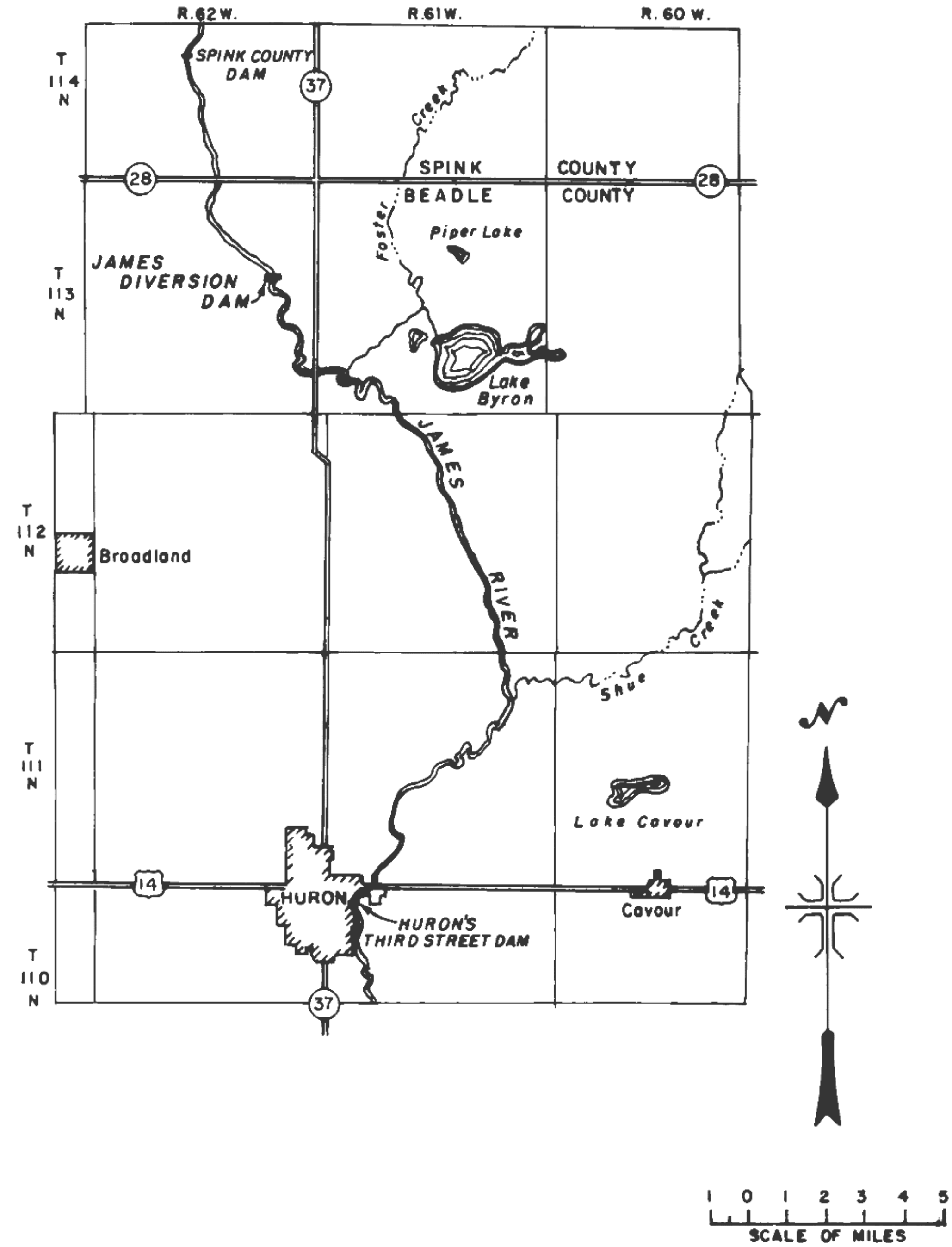

Figure 65. James Diversion Dam north of Huron along the James River. Courtesy of the Bureau of Reclamation.

Inundation of Tribal Lands

Of all those who lived and had land along the Missouri River, American Indians were disproportionately adversely affected by the impacts of the Pick-Sloan Missouri River Basin Program.[347] Life changed dramatically for the Standing Rock Sioux, Cheyenne River Sioux, Lower Brule Sioux, and Crow Creek Sioux Tribes whose reservation lands bordered the Missouri River. Over 600 families were displaced, and about 309,584 acres of Tribal lands were inundated, representing more than half of all acreage lost to the four mainstem dams in South Dakota. The inundation of Tribal lands flooded an array of river bottomland ecosystems essential to Native lives and livelihoods. Many traditional plant foods and medicines simply did not grow on higher ground, and game animals traditionally hunted in adjacent wildlife habitats could not be found on the benchlands. Grazing and feeding regimes for cattle and other livestock were radically altered, and water, once easily accessible, needed to be hauled long distances or secured from deep wells.[348] The rising waters of the Missouri River also disturbed traditional burial grounds and necessitated the disinterment and reburial of ancestors on higher ground.

South Dakota Tribes received $34 million in compensation–less than half of what negotiators believed was fair. Negotiating as an organized interest group, affected Tribes were paid more per acre for inundated lands compared to non-Indian families, but ultimately, monetary payment was not considered equitable compensation.[349] Author and activist Vine Deloria Jr. (Standing Rock Sioux) identified the Pick-Sloan Plan as "the single most destructive act ever perpetrated on any tribe by the United States."[350] The Standing Rock Sioux Tribe's challenge to the federal government's right of eminent domain over Tribal lands, which was upheld in court in 1958, and Tribes' demands for "full irrigation development, the retention of mineral rights, free shoreline access, and the ability to purchase a reserve block of hydroelectric power at the cooperative-rate level"[351] have been part of negotiations that have continued into the present day.[352] These demands have gone largely unanswered as Congress deauthorized most of the Pick-Sloan irrigation projects in 1964. As a result, the promised Pick-Sloan benefit of reservoir water supply for domestic, industrial, and municipal use was not realized on reservation lands. Instead, many of the Missouri River reservations remained dependent on well-based ground water, which frequently failed to meet federal standards for safe human consumption.[353]

In terms of irrigation, the Lower Brule Sioux Tribe's development of the Grass Rope Unit in 1976 experienced perhaps the greatest degree of success. With grant funding secured from the Economic Development Administration, the Lower Brule Tribe installed a center-pivot

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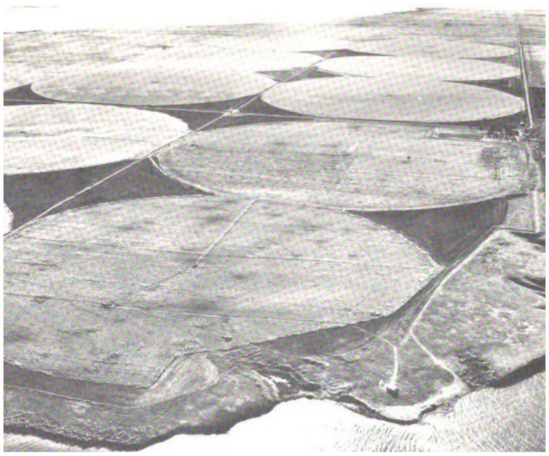
[347] Lawson, *Dammed Indians Revisited*; Lawson, *Dammed Indians*; Capossela, "Impacts of the Army Corps of Engineers' Pick- Sloan Program."
[348] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 314-316.
[349] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 366.
[350] Lawson, *Dammed Indians Revisited*, xv.
[351] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 319.
[352] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 317-319.
[353] Lawson, *Dammed Indians Revisited*, 33.

system designed to irrigate approximately 1,400 acres of reservation land (Figure 66, left).[354] The Grass Rope Unit was established on lands inside the bend of the “Big Bend” (Figure 66, right), as geology and soils there were well-suited to irrigation. The Grass Rope Unit system consisted of a series of pressurized pipes that utilized sprinkler application to deliver irrigation water pumped from Lake Sharpe via a pumping plant facility (Figure 67).



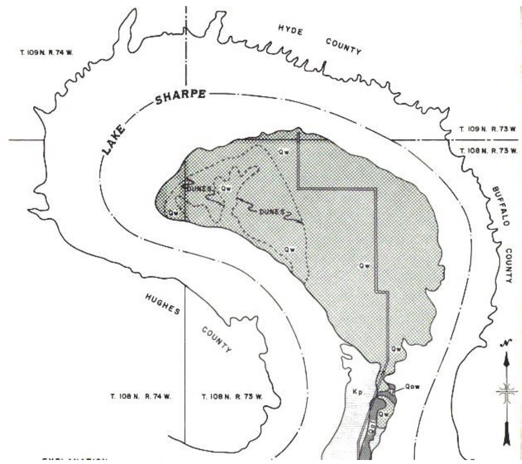


Figure 66. Aerial view of Grass Rope Unit depicting center-pivot irrigation (left) and generalized geologic map of the area within the Big Bend.[355]

Figure 67. Pumping plant at Grass Rope Unit. From Missouri-Oahe Projects Office, “Feasibility Report on Grass Rope Unit," 70, 100.

[354] Missouri-Oahe Projects Office, “Feasibility Report on Grass Rope Unit.”
[355] Missouri-Oahe Projects Office, “Feasibility Report on Grass Rope Unit," 70, 100.

The Grass Rope Unit was more an exception rather than the rule, however, as most reservation-based irrigation projects were private endeavors. One such example is the Northwest Irrigation District, a 3,250-acre area established across the river east of the Grass Rope Unit by private farmers for mainstem diversion irrigation.[356]

Irrigation Outcomes of the Pick-Sloan Missouri Basin Program

Like early federal reclamation projects in arid lands of the western United States, irrigation was a major focus of the Pick-Sloan Missouri Basin Program.[357] Reservoirs created by damming the Missouri River were expected to provide water for numerous federal irrigation projects, however most of the planned projects were never constructed, and irrigation occurred mostly as a result of privately funded projects (Erickson et al. 2008:124). Ultimately, the Missouri River Basin Program expanded irrigation and allowed for the delivery of water to 3 million previously undeveloped acres of land, but irrigation developments in the upper basin, which extends from the Missouri's confluence with the Platte River near Omaha, Nebraska upstream to its headwaters (including all of South Dakota), lagged behind those of the lower basin.[358] By 1973, a total of 25,000 acres of land was irrigated in the counties surrounding four mainstem dams in South Dakota, about 16,000 acres of which were irrigated with water from the resulting reservoirs–less than 10 percent of the acreage originally classified as irrigable under the Program.[359] Furthermore, the additional income generated by farmers using reservoir irrigation represented just 0.2 percent of their income.[360]

The Oahe Irrigation Unit was intended to divert water from the Missouri River to farmers in the James River Valley; however, as early as 1952, the program experienced problems.[361] Over time, federally sponsored irrigation lost favor. In South Dakota, this was most readily apparent with respect to the Oahe Unit, where work operations were officially suspended in 1977. In 1978, the South Dakota legislature passed a moratorium on further Oahe Unit irrigation construction; however, this was short-lived. Thereafter, interest in nearly all other proposed projects waned and was effectively brought to a halt "because of economic or financial infeasibility, lack of local or political support, and other reasons."[362]

Hydroelectric Power Generation in the Big Dam Era

Even though South Dakotans received fewer irrigation benefits than originally promised, residents benefited from the development of hydroelectric power generation in quantities greater

[356] Missouri-Oahe Projects Office, "Feasibility Report on Grass Rope Unit," 30-31.
[357] Campbell, "The Pick-Sloan Program: A Case of Bureaucratic Economic Power," 451.
[358] Linenberger, "Overview: PickSloan Missouri Basin Program," 15.
[359] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 331.
[360] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 326.
[361] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 324.
[362] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 340.

than initially anticipated.[363] By the time that all four dams, reservoirs, and hydroelectric power facilities were fully operational in 1968, they produced a total of 10.2 billion kilowatt-hours of power, generating $40 million in revenue for the United States Treasury.[364] In other terms, the Program's hydroelectric power facilities generated an amount of energy annually that was roughly equivalent to that which could be produced by burning 22 million tons of coal.[365]

Hydroelectric facilities of the Pick-Sloan Missouri River Basin Program effectively expanded access to lower-cost power and aided the proliferation of rural electrical transmission systems across the state. Shortly after construction began on the first of South Dakota's four Missouri mainstem dams, the state legislature passed the South Dakota Electric Cooperative Act of 1947, which regulated electric cooperatives and made the construction of transmission lines across the state possible. The resulting expansion of power systems did not occur until decades later, however, when Pick-Sloan facilities began to generate electricity. By the mid-1980s, nearly 62,000 miles of transmission lines had been built across over 34,000 acres of easement for Pick-Sloan transmission systems. Estimates suggest that, without federal hydroelectric infrastructure, consumers' electrical rates may have been as much as 30 percent more costly in the early 1980s. By that time, a total of 35 rural electric cooperatives were operating in South Dakota, serving more than 80,000 customers. [366]

Wildlife Conservation and Management

The environmental impacts of the Pick-Sloan Missouri River Basin Program were mixed in South Dakota, destroying some ecosystems while also creating and preserving others. The rising banks of the Missouri River led to the loss of important wetland, riverine, and terrestrial habitats that have detrimental effects to birds, mammals, and fish.[367] The dams and associated infrastructure are structural impediments to fish migration, and fluctuations in reservoir levels can harm fish and birds alike.[368] However, other unintended consequences—like the accumulation of silt upstream—formed deltas and wetland habitats that were well suited as rearing grounds for some species of fish and wildlife. Other factors, like the depths of reservoirs and improved water quality, have been beneficial. For instance, deep reservoirs are unlikely to completely dry-up in extended droughts and can provide habitat for a broader range of fish species. More purposeful mitigation strategies have emerged as cooperative endeavors between state and federal agencies and include stocking reservoirs for their use as fish spawning grounds.[369]

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[363] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 340-341.
[364] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 326.
[365] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 330-331.
[366] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 330.
[367] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 331.
[368] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 331.
[369] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 331.

Recreation and Tourism

Construction associated with the Pick-Sloan Missouri River Basin Program had significant implications for recreation and tourism in South Dakota. The Flood Control Act of 1944 included the first congressional authorization for the Army Corps of Engineers to "build, maintain, and operate park and recreation facilities for the public at water resource development projects and make the water areas of such projects available for public use."[370] Even so, Congress authorized few expenditures for recreation until passage of the Federal Water Project Recreation Act of 1965. This legislation emphasized the improvement of outdoor recreation, fish, and wildlife projects, requiring a non-federal public body to take on half the cost of developments and assume responsibilities for operation and management. In practice, most public-access areas associated with the Missouri River reservoirs in South Dakota were developed and managed exclusively by the Army Corps of Engineers or the Bureau of Reclamation, which maintain similar policies about recreation development.[371] Nowadays, South Dakota Department of Game, Fish & Parks (SDGF&P) administers many of the access and recreation areas along the reservoirs.

The inundation of lands along the Missouri River changed whether or how people could access subsistence and recreational activities such as boating, fishing, riparian hunting, wildlife observation, and swimming.[372] Control of dams and reservoirs by the Corps of Engineers meant that access was formalized through infrastructure developed by the Corps, the state park system, and various municipal park to accommodate these recreational activities. The infrastructure included boat ramps and docks, shoreline modification for beaches and boat ramps, fishing docks and cleaning stations, comfort stations, picnic grounds, and parking lots.

In 1982, tourists spent an estimated 6 million visitor-days at reservoirs associated with mainstem projects in South Dakota.[373] Visitors spent about $117 million, $57 million of which came from out-of-state visitors. In total, about $34 million in revenue was generated as income for South Dakotans or was collected as state and local taxes.[374] In terms of job creation, outcomes from fishing, hunting, and other forms of recreation were comparably minor. A 1978 study demonstrated that only about 2 percent of total employment in the sixteen counties surrounding Pick-Sloan reservoirs could be attributed directly to federal projects.[375]

Archaeological Legacies of the Pick-Sloan Plan in South Dakota

The Flood Control Act of 1944 and subsequent construction of the Pick-Sloan Missouri River Basin Program dams and reservoirs sparked the largest salvage archaeology project

[370] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 332-333.
[371] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 333.
[372] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 332.
[373] Philips, "Economic Value of Recreation and Fisheries Development at Missouri River Reservoirs in South Dakota."
[374] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan," 333.
[375] Vertrees, "Some Economic Effects of Irrigation with Water from the Missouri River Reservoir."

conducted in the United States: the Smithsonian Institution's River Basin Surveys (RBS) and the Interagency Archaeological and Paleontological Salvage Program (IAPSP).[376] Between 1946 and 1969, the RBS conducted archaeological investigations throughout the United States, emphasizing work in western states where water infrastructure would inundate, damage, and/or destroy archaeological and historic sites.[377] Much emphasis was placed on the upper Missouri River basin, including South Dakota. At the time, few systematic investigations had been carried out in this region, and as a result, little was known about the archaeology of Montana, North Dakota, and South Dakota.[378] About $4,256,860–nearly one-third of total River Basin Surveys expenditures–was put toward investigations in the upper Missouri River basin. By the end of 1969, the RBS had documented over 800 archaeological and historic sites, excavated 90 major sites, and cataloged more than 1.5 million artifacts from the Missouri River basin. [379]

At a regional level, archaeological investigations conducted in advance of Pick-Sloan Missouri River Basin Program dam and reservoir construction had some positive and lasting impacts on archaeological practice. Among Plains archaeologists, beneficial outcomes have been characterized thematically as methodological (i.e., use of aerial photography in reconnaissance surveys, standardizations in terminology and recordation, and the adoption of the Smithsonian trinomial system), theoretical (i.e., establishment of chronologies elaborated and refined in more recent decades), and historical (i.e., amplifying knowledge and appreciation for northern Plains archaeology and emphasizing the importance of historical sites).[380]

Despite some positive outcomes, construction of the Missouri mainstem dams and reservoirs caused irreversible damage to archaeological heritage in South Dakota. From an archaeological standpoint, the circumstances under which the RBS operated led to notable underestimations of sites in the region, and a skewed understanding of its archaeological history resulting from the preferential excavation of earthlodge villages. Similarly, many historical sites of early Euro-American exploration and colonization, which relied on transportation via the Missouri River and its tributaries, were inundated without investigation. Critically, publication of MBS project results lagged far behind the completion of surveys and excavations, relegating many projects to remain as "gray literature" or altogether unpublished. [381]

Furthermore, many archaeological sites simply could not be "saved" by the RBS, leaving gaping holes in the archaeological record of the Middle Missouri region. [382] The inundation of Middle Missouri sites represented a loss not only to archaeologists and the field of archaeology, but most substantially to indigenous tribes throughout and beyond South Dakota, whose heritage,

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[376] Banks, Snortland, and Czaplicki, "The Price We've Paid."
[377] Banks and Czaplicki, eds., *Dam Projects and the Growth of American Archaeology*; Thiessen, "Emergency Archeology in the Missouri River Basin; Thiessen and Roberts, "The River Basin Surveys Collections: A Legacy for American Archaeology;" Banks, Snortland, and Czaplicki, "The Price We've Paid."
[378] Banks, Snortland, and Czaplicki, "The Price We've Paid," 375.
[379] Banks, Snortland, and Czaplicki, "The Price We've Paid," 374.
[380] Banks, Snortland, and Czaplicki, "The Price We've Paid," 375-377.
[381] Banks, Snortland, and Czaplicki, "The Price We've Paid," 376-377.
[382] Banks, Snortland, and Czaplicki, "The Price We've Paid," 382.

material record, and legacy was in part destroyed by inundation. Dam construction and the reservoirs damaged or destroyed many unexcavated archaeological sites that the RBS could not cover. Many sites face continued harm from wave action, erosion, and looting.[383]

At a national scale, the Pick-Sloan Missouri River Basin Program and archaeological investigations conducted by the Smithsonian Institution's RBS brought about the modern era of cultural resource management archaeology and resulted in legislation that is still relevant for federal agencies today.[384] Four consequential pieces of legislation were passed, including the National Historic Preservation Act (NHPA) of 1966, Executive Order 11593 in 1971, the Archeological and Historic Preservation Act (AHPA) in 1974, which replaced the earlier Reservoir Salvage Act of 1960, and the Archaeological Resources Protection Act (ARPA) in 1979. Together, the three aforementioned acts and executive order codified and systematized federal agencies' responsibilities of identifying and managing archaeological and historic sites under their control.[385] At its broadest scale, RBS investigations conducted in advance of Pick-Sloan Missouri River Basin Program construction brought about a new consciousness of the implications of urban development on archaeological resources.

Post-War Expansion of Private Agricultural Irrigation, 1940-1980

Use of agricultural irrigation systems declined sharply in South Dakota during the economic and environmental hardships of the 1920s and onset of drought conditions. Agricultural irrigation began to rebound and expand after World War II. Between 1944 to 1980, South Dakota's irrigated acreage rose steadily as the drought subsided, returning to pre-1919 levels by 1954.[386] The 1970s were a particularly important decade in the state's history of agricultural irrigation, during which time the total irrigated acreage of the state more than doubled.[387] Most of the expansion of irrigation occurred in the private sector which, by the end of the decade, irrigated 377,192 acres compared to the 133,700 acres irrigated by the state.[388] The acreage of private irrigation projects supplied by surface water tripled, and use of groundwater sources expanded 5.3 times over. [389] Much of the rapid rise in irrigated agriculture can be attributed to the expanded use of center pivot irrigation in the state. In 1970, center pivot machines accounted for 7 percent of irrigation in South Dakota. By 1979, about 60 percent of irrigated agriculture used center pivot machines. Center pivot machines were most popular in eastern South Dakota but were not fully embraced in western regions.[390]

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[383] Banks, Snortland, and Czaplicki, "The Price We've Paid," 375.
[384] Banks, Snortland, and Czaplicki, "The Price We've Paid," 371.
[385] Banks, Snortland, and Czaplicki, "The Price We've Paid," 375.
[386] Taylor, "The 1970s: A Decade of Growth in South Dakota Irrigation."
[387] Taylor, "South Dakota Irrigation Regional Shifts During the 1970's," 3.
[388] Taylor, "South Dakota Irrigation: What's Special About It?"
[389] Taylor, "The 1970s: A Decade of Growth in South Dakota Irrigation," 10.
[390] Taylor, "South Dakota Irrigation: What's Special About It?"

Center Pivot Irrigation Machines

Center pivot irrigation was invented by Frank Zybach in eastern Colorado in 1948[391] and patented in 1952 as the "self-propelled sprinkling irrigation apparatus." [392] Although there is considerable variation in design from one manufacturer to the next, most center pivot irrigation machines consist of a series of water sprinklers mounted to a six-inch pipe supported by motorized tower structures mounted to steel or rubber wheels. Water is drawn from a source in the center of a field around which the pipe pivots, delivering water via sprinklers to the entire area of the circle. The tower most distant from the central pivot point controls the movement of the machine, and water is delivered at an increasing rate as distance from the central pivot point increases to ensure consistent application. Center pivot irrigation machines are typically 1,300 feet in length but can be as large as 4,900 feet.[393]

Soon after its invention, center pivot irrigation gained traction across the United States, particularly in states of the arid and semi-arid west. By 1976, *Scientific American* called it "perhaps the most significant mechanical innovation in agriculture since the replacement of draft animals by the tractor." [394] Center pivot irrigation systems offer numerous advantages that improve agricultural efficiency and productivity. One of the key benefits is the reduction in labor inputs required for irrigation, allowing farmers to automate the watering of extensive areas with minimal manual effort compared to traditional gravity irrigation systems that require the construction and maintenance of dams, canals, and ditches. Additionally, center pivot machines are versatile and effective across a range of soil types, crops, and topographies. Center pivot irrigation improves the productivity of soils with low water retention by lightly and frequently applying water to fields, allowing for intensive cropping of sandy soils. In contexts with poor soil quality, fertilizers can be added to the water supply to deliver nutrients and water simultaneously. Center pivot systems can be used on a wider variety of topographies compared to traditional gravity irrigation. Flexible couplings between support towers allow for pipes to adjust and move, making center pivot systems suitable for irrigation on rolling terrains.[395]

Despite their many advantages, center pivot irrigation systems have several notable drawbacks. Most significantly, their utility is limited by access to a suitable water source. In some regions, water can be pumped from nearby rivers or streams, but in others, water is derived from deep wells, raising concerns about the depletion of subterranean aquifers. Additionally, early diesel-powered center pivot machines were fuel intensive, though more recent machines have been developed that use electricity and hydraulic motors, making them more energy efficient.[396]

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[391] Evans, "Center Pivot Irrigation."
[392] Evans, "Center Pivot Irrigation," 1.
[393] Evans, "Center Pivot Irrigation," 1-2; Splinter, "Center-Pivot Irrigation."
[394] Splinter, "Center-Pivot Irrigation."
[395] Splinter, "Center-Pivot Irrigation."
[396] Splinter, "Center-Pivot Irrigation."

New Flood Control Strategies, 1950-1980

Flood Control Structures Built by the U. S. Army Corps of Engineers in South Dakota

In addition to flood control benefits conferred by projects built as part of the Pick-Sloan Plan, the U. S. Army Corps of Engineers was also involved in water infrastructure developments elsewhere in the state built almost exclusively for the purposes of flood control. These endeavors included improving existing channels, building earthen levees, and erecting concrete flood walls.

Prior to the 1950s, some minor earthen embankments for flood protection were built under the sponsorship of municipal governments and were comparatively small in scale when considered alongside later interventions made by the Army Corps of Engineers. Even though most such projects were built during the second half of the twentieth century, the first was completed in 1939 and known as the Belle Fourche Local Protection Project. Other levees described below were built to protect the cities of Hot Springs, Herreid, Sioux Falls, and Rapid City, among others.

Belle Fourche River Basin Levee System, Butte County

The Belle Fourche River Basin Levee System was the earliest USACE project in South Dakota, authorized under the 1936 Flood Control Act and completed in 1939 to protect the city of Belle Fourche from frequent floods. The project involved building a 2,800-foot earthen levee and a 340-foot concrete retaining wall along the Belle Fourche River. About 400 feet of the riverbank was also secured by building a rock riprap bank. The interior drainage is made possible by eight pipes that run through the levee, of which five work via automatic flap gates located at outlet points on the river.[397] The project was initiated to protect businesses, industries, and residential areas and, according to a report published by the USACE in 1991, has prevented an estimated $380,000 in flood damages through fiscal year 1990.[398]

Fall River Flood Control Project, Fall River County

The Fall River Flood Control Project was initiated to protect the city of Hot Springs and surrounding farmlands in the Black Hills. The project involved channel improvements to Cold Brook Creek and Cottonwood Springs Creek and construction of both the Cold Brook Dam and Reservoir and the Cotton Springs Creek Dam and Reservoir. Channel improvements were completed in 1950 and consisted of clearing 6,290 feet of channel, building a 4,776-foot concrete floodwall, and construction 3,468 feet of earthen levees that "were constructed of compacted random fill materials obtained from selected channel excavations."[399] That year, the creation of Cold Brook Lake also began with construction of an earthen dam, completed in 1953. The new

[397] U.S. Army Corps of Engineers, "National Levee Database."
[398] U.S. Army Corps of Engineers, "1991 South Dakota Water Resources Development," 20.
[399] U.S. Army Corps of Engineers, "National Levee Database;" U.S. Army Corps of Engineers, "Water Resources Development," 12-13.

dam created Cold Brook Lake as a reservoir to increase floodwater storage capacity. In 1969, USACE also built a dam on Cottonwood Spring Creek, creating additional lake storage capacity for floodwaters. The project provided not only flood control, but also created new recreational facilities, including conservation and recreational fishing developments on Cold Brook Lake supported by the installation of facilities like boat ramps.[400]

Herreid-Spring Creek River Basin Levee System, Campbell County

The Herreid-Spring Creek River Basin Levee System was built near the city of Herreid, located about 12 miles upstream from the confluence of Spring Creek and the Missouri River. Over the course of thirty years, the city of Herreid experienced eight major floods, including a flood in 1950 that left the city under three feet of water. In 1953, construction of the Herreid Flood Protection project began. The project involved construction of a 1.28-mile earthen levee along Spring Creek, installing interior drainage structures at two locations, adding rock riprap to 600 feet of Spring Creek's banks, and realigning 1,500 feet of its channel so that it would flow parallel to the levee, filling in the original creek channel in the process.[401] The USACE considered this a small project, and all work was completed in 1954, within a year of its initiation.

Sioux Falls Local Protection Project and Improvements to the Big Sioux River at Sioux City, Iowa and North Sioux City, South Dakota

After decades of intermittent and damaging floods, Sioux Falls experienced back-to-back floods in 1951 and 1952 that caused over one million dollars in damages each year. Under the Flood Control Act of 1954, the USACE was authorized to build local flood control projects to protect urban developments in and around Sioux Falls. Between 1956 and 1965, the USACE made 10 miles of river channel improvements throughout the city, dug 2.7 miles of new diversion channels, and constructed 27.1 miles of levees as part of the Sioux Falls Local Protection Project. The levees are located along Skunk Creek and have an average height of 12 feet.[402] They are outfitted with interior drainage via eleven gravity drainage structures. The levees were put to the test during floods in 1969 and 1970 and were credited with preventing an estimated 14,980,000 dollars in damages.[403] Later, under authorization of the Flood Control Act of 1968, further improvements were made to the Big Sioux River. Between 1976 and 1981, the USACE completed channel enlargements, bank stabilization, and the construction of additional levees. [404]

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[400] U.S. Army Corps of Engineers, "Water Resources Development," 13.
[401] U.S. Army Corps of Engineers, "National Levee Database."
[402] U.S. Army Corps of Engineers, "National Levee Database."
[403] U.S. Army Corps of Engineers, "Water Resources Development," 6.
[404] U.S. Army Corps of Engineers, "Water Resources Development," 8.

Black Hills-Rapid City Flood of 1972 and its Infrastructural Aftermath

The Black Hills-Rapid City Flood of 1972 was the worst flood ever recorded in South Dakota. The flood was caused by "unusual physical events" that culminated in a disaster that claimed the lives of 237 people, injured over 3,000, and left 5,000 more without homes. [405] Total damages were estimated at over $160 million.[406] The devastation began on June 9, 1972 when "an almost stationary group of thunderstorms formed over the eastern Black Hills of South Dakota near Rapid City and produced record amounts of rainfall and flood discharges."[407] The storm brought a deluge of record amounts of rainfall. In Nemo, South Dakota, 15 inches of rain fell in about 6 hours, and across a 60 square mile area, 10 inches of rain had fallen,[408] causing peak flow that gaging stations reported at a rate four times greater than any previously recorded flood events.[409]

Like other towns and cities in South Dakota built near waterways, floods were known to occur somewhat regularly in Rapid City and the Black Hills more generally. Accounts from as early as 1876 recall some of the earliest Euro-American settlers "being cautious about camping overnight in a floodplain,"[410] and the early townsite of Rapid City initially was built south of the floodplain. Although major flood events occurred in 1878, 1883, 1907, 1920, 1952, and 1962, construction of new housing had expanded quickly with a local population boom after World War II. By 1972, almost 50,000 people lived in Rapid City, and nearly all of its floodplain was urbanized, primarily with residential housing.[411]

Water Infrastructure Failures

The failure of the Canyon Lake Dam caused numerous deaths and significant destruction. During the flood, the spillway of Canyon Lake Dam clogged with large floating debris, weakening the dam until it ultimately failed, unleashing a violent flood through Rapid City. [412] In the aftermath of the Canyon Lake Dam collapse, Sturgis remained on the brink as floodwaters stressed the then 69-year-old Fort Meade Dam. Pumping was quickly implemented to remove water and pressure from the dam, the spillway was widened, and, rather than risk dam failure, the structure was intentionally destroyed to allow for a more controlled release of water.

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[405] Schwarz et al., "The Black Hills-Rapid City Flood of June 9-10, 1972," 1; U.S. Army Corps of Engineers, "Historical Vignette."
[406] Schwarz et al., "The Black Hills-Rapid City Flood of June 9-10, 1972," 1.
[407] Schwarz et al., "The Black Hills-Rapid City Flood of June 9-10, 1972."
[408] Schwarz et al., "The Black Hills-Rapid City Flood of June 9-10, 1972."
[409] Carter, Williamson, and Teller, "The 1972 Black Hills-Rapid City Flood Revisited," 3.
[410] Rahn, "Flood-Plain Management Program in Rapid City, South Dakota," 838.
[411] Rahn, "Flood-Plain Management Program in Rapid City, South Dakota," 838.
[412] Carter, Williamson, and Teller, "The 1972 Black Hills-Rapid City Flood Revisited," 3.

Flood Control Infrastructure Modifications

As Rapid City and other affected areas of the Black Hills were rebuilt in the wake of the 1972 flood, a number of modifications were made to infrastructure to mitigate harm in the event of future floods. The Canyon Lake Dam and numerous bridges throughout the region were redesigned to prevent debris clogs that could result in their catastrophic failure. [413] In addition to structural improvements of dams and bridges, Rapid City made channel improvements to Rapid Creek and levees were constructed by the USACE. Between 1977 and 1978, a single-segment system was installed that spans approximately 4,050 feet along Rapid Creek, varying in height from six to thirteen feet.[414] Likewise, in Sturgis, channel improvements were made to Deadman Gulch, which was channelized through a concrete canal and directed with training levees that would allow for water to travel down the steep slopes without runoff being so fast that it became destructive. Sturgis also constructed a debris basin and stilling basin to protect from future catastrophes.[415]

Greenways (Floodways) for Flood Control

In addition to building "hard engineering" structures like dams and levees, Rapid City and flood-prone areas elsewhere in South Dakota began to implement floodplain management practices that involved greenways, also known as floodways.[416] In Rapid City, a new floodplain management system designated floodplains as greenways, issuing new zoning policies, and converting many areas along Rapid Creek into large parks.[417] The city purchased land and the remains of destroyed buildings and set a moratorium on residential developments based on an "underlying concept that no one should sleep within the floodplain." [418]The city ultimately purchased 3,100 acres of land along a six-mile stretch of the floodplain, transforming it into a series of public parks, nature areas, trails, and recreation sites. [419] Nearly a decade after the 1972 disaster, Rapid City's flood control measures, particularly the creation of the greenway, were lauded as "a model for other cities located close to a river."[420] Other cities frequently impacted by flooding had followed suit, including Sioux Falls, for example, where a river greenway system was established in 1977 along the Big Sioux River. The greenway confers the benefits of flood control and provides recreational opportunities with a riverside trail system for pedestrian access and bicycling.[421] More broadly, a major national outcome of the disaster was the implementation of the U.S. Army Corps of Engineers Dam Safety Program, which monitors

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[413] U.S. Army Corps of Engineers, "Historical Vignette: The Rapid City Flood, June 1972," 5.
[414] U.S. Army Corps of Engineers, "National Levee Database."
[415] U.S. Army Corps of Engineers, "Historical Vignette: The Rapid City Flood, June 1972."
[416] Rahn, "Flood-Plain Management Program in Rapid City, South Dakota," 842.
[417] Carter, Williamson, and Teller, "The 1972 Black Hills-Rapid City Flood Revisited," 5.
[418] Carter, Williamson, and Teller, "The 1972 Black Hills-Rapid City Flood Revisited," 5.
[419] U.S. Army Corps of Engineers, "Historical Vignette: The Rapid City Flood, June 1972."
[420] Rahn, "Flood-Plain Management Program in Rapid City, South Dakota," 842.
[421] "Natural Floodplain Functions," 74.

dams with high downstream risk and significant potential for loss of life and property in the event of failure.[422]

Post-War Conservation, Management, and Recreation, 1950-1980

Wetland Drainage

Most of eastern South Dakota lies in what is known as the Prairie Pothole Region, an expansive area of small, shallow wetlands created as glaciers retreated from the region about 10,000 years ago (though portions of the Prairie Coteau region are older). Historically, wetlands of this sort in South Dakota have been referred to as potholes, swamps, bogs, or marshes. Prior to Euro-American colonization, as much as 80 percent of South Dakota's landscape drained into wetlands, ninety percent of which are located east of the Missouri River. West of the Missouri River, natural wetlands were virtually nonexistent, rendering intensive agricultural drainage unnecessary.[423]

Settlement patterns have played a major role in the drainage of wetlands in South Dakota. Beginning in the late 1900s, large ditches were built to provide drainage to agricultural lands in the river valleys of southeastern South Dakota, and thousands of short, open ditches were dug to drain lakes, potholes, and other depressions saturated with water.[424] Farm drain tiles, made of porous fired clay the consistency of a brick, were commonly used on smaller projects. The size of the tile installed varied based on the area to be drained.[425] Shallow farm tile drainage was installed two to two and a half feet below the surface, medium depth farm tile was positioned at least 3 feet below the surface, and deep drains were installed four to four and a half feet below ground. In the *Fifth Biennial Report of the State Engineer to the Governor of South Dakota*, a section called "Notes on Farm Drainage" provided relevant instructions for farmers on how to install small individual or local community-based drain tile projects.[426] Although large and extensive drainage projects were relatively uncommon in South Dakota, those that were built focused on bottomlands and floodplains and were documented to some extent by the State Engineer. Smaller drainage projects, like those that drained small areas or took place on individual farms were not as extensively documented, although wetlands were diminished over time and through the cumulative impacts of numerous small projects.

Drainage of South Dakota's wetlands accelerated between 1941 and 1950 as part of the Agricultural Conservation Program of the United States Department of Agriculture, during which time a total of 665,110 acres of wetlands in South Dakota underwent agricultural drainage. Nearly all of the total drainage was accomplished by use of open ditch (99.7 percent; 663,090 acres), along with a small fraction carried out by installation of enclosed drains (0.3 percent;

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422 U.S. Army Corps of Engineers, "Historical Vignette: The Rapid City Flood, June 1972."
423 Lea, *First Biennial Report of the State Engineer to the Governor of South Dakota*.
424 Visher, *The Geography of South Dakota*.
425 Lea, *Fourth Biennial Report of the State Engineer to the Governor of South Dakota*.
426 Derr, *Fifth Biennial Report of the State Engineer to the Governor of South Dakota,"* 187-92.

2,020 acres).[427] Agriculture remained the driving factor for wetland loss in the prairie pothole region,[428] where about 77 percent of wetlands are located in prime croplands, where the ease of drainage and financial incentives make them vulnerable to loss.[429] Most agricultural drainage was carried out in areas with level or undulating topographies that were easy to drain that became more valuable after drainage. [430] Reservoirs constructed along the mainstem of Missouri River in 1950s and 1960s within the state resulted in "the loss of nearly all the riparian wetlands and oxbow lakes in North and South Dakota (approximately 388,000 acres)."[431]

Artificial Wetlands as Waterfowl Habitats

The prairie pothole region is recognized as one of the most important habitats for waterfowl nesting and reproduction in North America[432] and is considered one of the most diverse and biologically productive habitats on the continent.[433] Prior to Euro-American colonization, as much as 80 percent of South Dakota's landscape drained into wetlands,[434] but by the early 1980s, an estimated 35 percent of natural wetlands had been lost,[435] primarily to agricultural drainage. In western parts of the state, natural wetlands were virtually nonexistent, rendering intensive agricultural drainage unnecessary, [436] but the proliferation of stock watering ponds created artificial wetland habitats of considerable value not only to ranchers and livestock, but also to aquatic species, especially waterfowl.[437]

Aerial images of South Dakota from 1951 documented 107,812 acres of stock-water dams across the state. About 72 percent (77,619 acres) of stock dams and dugouts were located west of the Missouri River, compared to about 28 percent (30,193 acres) east of the Missouri River. [438] In recent decades, artificial impoundments or excavated wetlands have come to account for about half of all wetlands in South Dakota,[439] covering about 9.8 percent of the state's total area. [440] These artificial wetlands provide important habitats for migratory and breeding waterfowl[441] and serve as water retention areas that buffer against flooding. Importantly, artificial bodies of water, including thousands of stock dams built as part of federal relief efforts during the 1930s now pepper the landscape of South Dakota. Large reservoirs built by the Bureau of Reclamation (Shadehill, Angostura, and Belle Fourche) have contributed an

[427] US Fish and Wildlife Service, *Wetlands Inventory of South Dakota*, 39.
[428] Johnston, "Wetland Losses Due to Row Crop Expansion in the Dakota Prairie Pothole Region."
[429] Johnson et al., *Eastern South Dakota Wetlands*.
[430] US Fish and Wildlife Service, *Wetlands Inventory of South Dakota*, 25.
[431] Goldstein, "The Impact of Federal Programs on Wetlands-Volume I," 93.
[432] Niemuth, Fleming, and Reynolds, "Waterfowl Conservation in the US Prairie Pothole Region."
[433] Johnsgard, *Wetland Birds of the Central Plains: South Dakota, Nebraska and Kansas*, 7.
[434] Johnson et al., *Eastern South Dakota Wetlands*, 22.
[435] Tiner, "Wetlands of the United States."
[436] US Fish and Wildlife Service, *Wetlands Inventory of South Dakota*, 32.
[437] Mack and Flake, "Habitat Relationships of Waterfowl Broods on South Dakota Stock Ponds."
[438] US Fish and Wildlife Service, *Wetlands Inventory of South Dakota*, 14.
[439] Austin and Buhl, "Factors Associated with Duck Use," 2.
[440] Johnson et al., *Eastern South Dakota Wetlands*.
[441] Austin and Buhl, "Factors Associated with Duck Use," 2.

additional 17,335 acres of wetland habitats to the state.[442] The newly established reservoirs from dams and water infrastructure of all scales created wetland habitats important for migratory waterfowl, fish, invertebrates, and other species. Locations identified as important habitats for wetland birds in South Dakota include Big Bend Dam and Lake Sharpe, Ft. Randall Dam and Lake Francis Case, Huron Wetland Management District, Lacreek National Wildlife Refuge, Lake Andes and Karl Mundt National Wildlife Refuges, Madison Wetland Management District, Oahe Dam and Lake Oahe, Pocasse National Wildlife Refuge, Samuel H. Ordway Jr. Memorial Prairie Preserve, Sand Lake National Wildlife Refuge, and Waubay National Wildlife Refuge.[443]

Recreational Fishing, 1950-1980

After World War II, public participation in recreational fishing expanded, and South Dakota began to build a lake-based recreation industry with fishing becoming a primary draw. Automobiles became increasingly commonplace, and new and improved roads facilitated access to recreational destinations. Numerous lakes, reservoirs, and their recreational facilities had been built or expanded during federal relief construction efforts in the 1930s, and the mainstem dams on the Missouri River had created large recreational reservoirs in the 1940s-1960s. One of the Pick-Sloan reservoirs, Lake Oahe, became nationally recognized for sport fishing for species including walleye and Chinook salmon. [444] In the 1960s and 1970s, comprehensive federal environmental legislation was passed (i.e., Endangered Species Act 2000; Federal Water Pollution Control Act 2000; National Environmental Policy Act 2000; Wild and Scenic Rivers Act 2000), that changed management practices to balance the original project purposes, changes to contemporary use trends, and protection of threatened and endangered species.[445]

Post-War Expansion of Fish Hatcheries, c. 1945-1980

As recreational fishing became more popular, conservation and management strategies increasingly relied on scientific evidence and investigation to inform management practices. After World War II, state and federal fish hatcheries operating in South Dakota expanded from providing supplemental food sources for residents to supplying fish for recreational and touristic purposes.[446] By 1949, six state fish hatcheries were in operation at Lakeside, Cleghorn Springs, Pickerel Lake, Twin Lakes, Lake Byron, and Lake Andes.

During the 1950s, South Dakota entered an era of scientific fisheries conservation and management. During this time, Games, Fish and Parks was reorganized into research and management sections of equal status, and the first fisheries biologists were hired, ushering in

[442] US Fish and Wildlife Service, *Wetlands Inventory of South Dakota*, 14.
[443] Johnsgard, *Wetland Birds of the Central Plains: South Dakota, Nebraska and Kansas*, 22-27.
[444] Erickson, Rath, and Best, “Operation of the Missouri River Reservoir System," 125.
[445] Erickson, Rath, and Best, “Operation of the Missouri River Reservoir System," 129.
[446] Barnes, “Fish Hatcheries and Stocking Practices.”

new science-backed approaches to conservation.[447] Hatchery managers began to focus on efficiency, moving from fry fish stocking that predominated throughout the first half of the twentieth century. Passage of the Federal Aid in Sport Fishing and Restoration Act in 1950 supported state agencies efforts at new and established fisheries programs. Additional rearing ponds were constructed in eastern parts of the state during the late 1950s and early 1960s, including bass ponds at Drake Springs in Minnehaha County and near Big Stone Lake in Roberts and Grant Counties, which remains in operation today. The Cleghorn Springs State Fish Hatchery was almost entirely destroyed during the 1972 Black Hills-Rapid City Flood, after which time only one building was left standing. The hatchery was rebuilt with concrete raceways and flood-proof buildings. [448]

Major changes occurred to hatcheries established in the Black Hills during the late 1800s. After the Spearfish National Fish Hatchery faced water supply issues during the late 1940s, the U.S. Fish and Wildlife Service made plans for the construction of McNenny National Fish Hatchery in Spearfish. Work on the hatchery was begun in 1949 and, following the sinking of artesian wells to supply the ponds and raceways with water in 1952, it was completed. The hatchery was fully operational by the following year. By 1954, record numbers of all-time high catchable-size trout were stocked. This trend in high catchable-trout stocking continued from the 1950s through the 1970s in the Black Hills. In 1972, however, fisheries were among the many structures damaged and destroyed by the Black Hills-Rapid City Flood. When the Cleghorn Springs State Fish Hatchery was completely destroyed, stocking numbers dipped between 1972 and 1974. The hatchery was later rebuilt with new and improved technology that ultimately enabled Cleghorn to increase and stabilize the number of catchable trout produced. In 1983, the state of South Dakota assumed control of the McNenny National Fish Hatchery, and numerous renovations were made to improve the location's water supply, incubation facilities, and outdoor rearing tanks.

In 1958, the Gavins Point National Fish Hatchery was established, four years after completion of the Gavins Point Dam and formation of Lewis and Clark Lake in Yankton County. The hatchery began to produce fish in 1961 and remains in operation as the largest hatchery in the state of South Dakota, with eight raceways and twenty-six original rearing ponds, and an additional ten rearing ponds that were added in 1983.

In addition to the Gavins Point National Fish Hatchery, fish stocking operations have taken place on small impoundments located adjacent to reservoirs designated as sub-impoundments. When sub-impoundments were constructed at Snake Creek next to Lake Francis Case in 1968, they were the first of their kind. Similar sites were built at other locations throughout the 1980s and 1990s.

[447] Scarnecchia and Barnes, "The Evolution of Trout Stream Management in the Black Hills."
[448] Barnes, "Fish Hatcheries and Stocking Practices" 276.

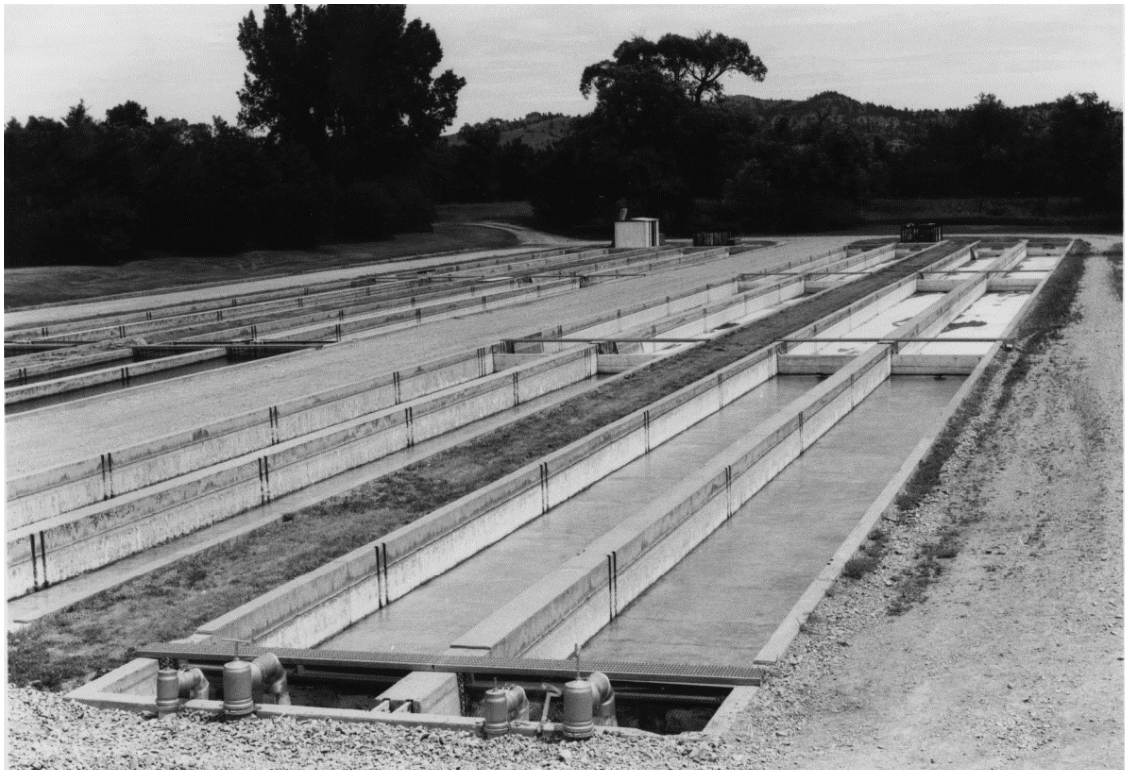

Figure 68. McNenny Fish Hatchery in Butte County in 1980. Watson Parker Ghost Town Notebooks, Leland D. Case Library for Western Historical Studies, BHSU (wp20171317).

In 1978, the Spearfish National Fish Hatchery was placed on the National Register of Historic Places. The U.S. Fish and Wildlife Service later established an on-site museum in 1982, shortly before federal budget cuts brought hatchery operations to a halt in 1983. Thereafter, the City of Spearfish has operated the hatchery for both fish stocking and tourism purposes. Fish rearing occurs on a season basis at the hatchery, now known as the D. C. Booth Historic National Fish Hatchery, and the U.S. Fish and Wildlife Service's National Fish and Aquatic Conservation Archive houses the largest collections of fisheries artifacts in the country.

Figure 69. Aerial Image of outdoor fish ponds at Gavin's Point National Fish Hatchery in Yankton County. Courtesy of the SDSHS, South Dakota Digital Archives (2011-01-25-023).

Figure 70. This photograph from 1961 shows fish stocking in action at Roubaix Lake from a truck labeled, "U.S. Department of the Interior Fish and Wildlife Service Spearfish, South Dakota." Courtesy of the Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20070089).

Survey Documentation Standards

The purpose of this chapter is to outline and clarify procedures for documenting water conveyance systems in South Dakota's architectural and archaeological survey data systems, since these type of properties often have linear or complex aspects that are less common in survey work.

Although the following guidance may not cover every unique circumstance that may arise, it is intended to help improve consistency and set some expectations. The guidance is subject to updates as technology tools change, other SDSHS survey manuals and guidelines are updated, and experience with these property types is expanded and aggregated.

> Survey work is often done to identify historic properties under Section 106 of the National Historic Preservation Act. Identification is one step in the Section 106 process for reviewing a federal undertaking and its potential impacts to historic properties.
>
> Information specific to the Section 106 process can be found on the State Historical Society's website: https://history.sd.gov/preservation/laws and especially *South Dakota Guidelines for Complying with Federal and State Preservation Laws* (2023) (referred to hereafter as "*SHPO Guidelines*").

Depending on their physical qualities, water conveyance resources may be recorded as either an archaeological site, an architectural property, or a multi-component resource with cross-referenced records entered in both systems. Water conveyance systems that are primarily above-ground may also have below-ground resources to record also, such as water pipes, foundations, tunnels, and other features. It is essential to keep these features in mind when planning and/or conducting survey work or subsurface excavations.

Survey Data Systems in South Dakota

The South Dakota State Historical Society currently hosts survey databases for structures, bridges, and cemeteries separately than records for archaeological sites.

The *Archaeological Resources Management System (ARMS)* is managed by the Archaeological Research Center (ARC) in Rapid City.

> Find links to ARMS at: https://history.sd.gov/archaeology/resources and https://archaeology.sd.gov/.
>
> Find information on completing site records in: *Guide for Completing a South Dakota Field Site Form* (2020) or as updated (referred to hereafter as the "*Site Form Manual*").

The *Cultural Resource Geographic Research Information Display (CRGRID)* system is managed by the State Historic Preservation Office (SHPO) in Pierre and includes datasets for structures, bridges, and cemeteries. SHPO maintains one online system that anyone can access to search and view unrestricted records, and one access-controlled online system that surveyors and SHPO staff can use to enter new records or edit existing records. Records are given a single coordinate point for their geographic location, typically the center of the resource. Data entered in CRGRID is also accessible through ARMS.

> Find links to both at: https://history.sd.gov/preservation/historicsitessurvey.
>
> Find information on using CRGRID and completing architectural record forms in: *South Dakota Architectural Survey Manual* (2021) or as updated (referred to hereafter as the "*Architectural Survey Manual*").

What Not to Record

A surveyor and/or principal investigator should give careful consideration in their professional judgment to determine what cultural remains merit recordation and which do not.

There are certain historic features related to water conveyance that are ubiquitous with little likelihood of significance that SDSHS acknowledges they typically would NOT require recordation. These include:

- non-historic pipelines
- isolated stock dams, wells, and/or windmills with no significant historic associations. Significant associations might include connections to larger historic farmstead landscapes or having a notable community use. For instance, occasionally wells or windmills were used by an entire group of farms in the area.
- rip-rap (stone, concrete, or other material used to slow erosion, particularly on lake or river shores)

In addition:

- Roadside drainage channels should typically not be recorded separately from their associated roads unless exhibiting uncommon design or engineering significance.
- Municipal water and sewer systems should typically not be recorded unless dating to a particularly early period of settlement (such as wood water pipes in an archaeological context) or components that feature higher levels of design or engineering significance (such as water treatment plant buildings).
- Movable or impermanent structures or objects such as siphon tubes, field pipes, or center-pivot irrigation equipment should typically not be recorded.

Larger bodies of water, especially natural bodies of water, should generally not themselves be recorded in a survey record, though portions might fall within a selected boundary of a cultural resource. Bodies of water that are more comprehensively human-modified—such as a canal/ditch, a raceway in a fish hatchery, or a farm's garden pond—may be considered and recorded as cultural resources.

> For instance, when recording a diversion channel from a natural creek, the adjacent creek bank might fall within the resource boundary for a headgate where the system connects to the creek, but the record should be primarily for the headgate or diversion channel—the creek itself should not be recorded in whole or as a separate resource. Similarly, a record created for a dam might include the shore along the earthworks of the dam but will typically not include the entire reservoir that the dam creates. (See more information in Determining Boundaries below.)

Archaeological Properties

Under the *SHPO Guidelines*, an archaeological property is "at least fifty years old and contains archaeological evidence, whether artifacts or features or a combination thereof, of past human activity."[449]

Archaeological site forms need to be completed by qualified cultural resource management professionals and submitted to ARC for inclusion in the ARMS system.

Shapefiles submitted with site forms should include a polygon for a site boundary that will be incorporated into ARC's Geodatabase and displays in the ARMS system. Within a site boundary, points, lines, and polygons can be used in combination to best capture the physical remnants that comprise the archaeological site.

Above-ground resources like structures and bridges should be recorded as archaeological properties only if in ruined, unrecognizable condition. Since ARMS can include polygon site boundaries, it is also best to record long or complex linear systems using archaeological Site Forms.

Properties related to this context that should be recorded in ARMS include:

- cultural remains and debris, including habitation or work sites like construction camps, mills, or ditchrider houses
- below-ground resources that are part of multi-component sites
- wells/cisterns
- long canals, ditches, levees, weirs/jetties, and other earthworks (see Linear Resources below)
- collapsed and/or abandoned dams, bridges/culverts, flumes, etc.

[449] State Historic Preservation Office, "South Dakota Guidelines," 13.

Architectural Properties

In CRGRID, resources can be recorded using either Structure, Bridge, or Cemetery forms. Per *SHPO Guidelines*, structures that are deteriorated but still standing and recognizable should be recorded as an architectural property.[450]

Properties related to this context that should be recorded in CRGRID include:

- dams
- standing bridges or culverts
- short canals, ditches, levees, weirs/jetties, and other earthworks
- buildings used for habitation, work, or recreation
- other structures like gaging stations, picnic shelters, etc.
- objects like fountains
- cultural landscape sites like earthen terraces, parks, gardens and plantings, etc.

Within CRGRID, the forms for Structures can be used for a wider variety of resources, including cultural landscapes. Not all fields in the Structure form will apply to most water conveyance resources. For instance, most will not have any Architectural Style (or Roof Material, etc.) to enter. In CRGRID, only select general fields are marked as required to be able to save/submit the form. Fields that do not apply can be left blank and more pertinent descriptive details written into the text fields for Physical Notes or Other Notes. Additional information, along with maps or sketches of the resource, can also be uploaded as attachments to the record (as JPG, TIF, or PDF).

For recordation in CRGRID, individual records should be created for single resources, whether buildings, structures, objects, or sites (typically landscape features) – those that would be counted separately as a resource category in a National Register nomination form (See Chapter 4 of *How to Apply the National Register Criteria for Evaluation*).

Groups of distinct but historically associated resources that will be evaluated for the National Register together can be recorded in a few ways:

- Associated resources can be recorded on individual forms and connections made by using a common basic name in the Property Name or Other Name fields, and/or SHPO can assign a district type SHPO ID number (See the *Architectural Survey Manual* for more on SHPO ID numbers). An example of common naming: "South Canal District, Smith House"; "South Canal District, Red Creek Dam"; and "South Canal District, main office."
- Or, if the associated resources are also close geographically, and most commonly if they are surveyed at the same time, they can be added as sub-forms to the same Site ID in

[450] State Historic Preservation Office, "South Dakota Guidelines," 13.

CRGRID so that they share basic Site Information fields. Sub-forms can also share a district SHPO ID and common name. (See the Architectural Survey Manual for more on entering Inventory Forms).

The types of forms or SHPO IDs used in CRGRID do not limit how a group of resources could be evaluated for the National Register of Historic Places as either individual resources or as a district.

Examples:

- For a hydroelectric plant on a creek, a surveyor on the same visit may use the sub-forms to document the building, a large retaining wall at a short distance, and an inlet channel leading into the turbines. However, a tunnel located a further distance along the creek but built for the power plant operations might have its own individual record in CRGRID. It can be assigned a district type SHPO ID number with the power plant set of resources and have part of the name in common (such as "Green Company Hydro Plant" and "Green Company, North Creek tunnel") to indicate its connection to the power plant resource.
- A small/moderate-sized dam that created a reservoir in the 1930s may have a single form that describes all connected features like the spillway and a concrete retaining wall along the creek at the base of the spillway. Separate records would be created for a substantial designed park entrance sign from the 1960s a half-mile away at the main road turn-off and for a walking trail loop below the dam. A public use recreational area built in the 1950s at another point on the reservoir may have its own set of records with sub-forms for the bathhouse, picnic shelter, swimming beach, parking area, etc. The dam might be evaluated individually for its construction history or architecture/design, and/or the dam and park might be evaluated together as a district for their shared recreational history.
- A small park landscape site with a pond and fountain may be recorded on a single form. Whereas a larger park with stone canals running through it would use sub-forms created under the same Site ID number for each canal, bridge, picnic shelter, and restroom building, as well as a form for the overall landscape to describe the layout, circulation patterns, general vegetative landscaping, and small repetitive features like lighting or benches.

For records of resources that have complex layouts or connections, it is strongly recommended to create a site map with components identified and labeled and upload it as an attachment to each records. (Access to attachments is public. Take care not to include any resources on attachments that must have their location restricted because they are archaeological or for any another reason.)

Linear Resources

Linear properties are resources that are typically long enough to not be able to observe in a single view. This may include roads, trails, railroads, and irrigation systems (such as canals and ditches). Many will be part of a network or system rather than a single line. Their length and potential complexity means that there are special recommendations for recording these resources.

In South Dakota, it typically will make the most sense to record linear resources with archaeological Site Forms for ARC so that a polygon can be created for the full extent of the surveyed resource. If a linear resource is smaller—for instance, if a person on the ground can see the full resource end-to-end from a central position—documentation as a Structure in CRGRID may be sufficient.

> For instance, a 50-foot levee built at the edge of a slough to keep ground dry for a park's picnic area might be recorded along with other park resources in CRGRID. However, a system of levees that are several hundred feet long and were built to create ponds at a wildlife management area might be better recorded using one or more archaeological Site Forms.

Linear resources often have multiple components that may have been built at different times or substantially remodeled. Some may, like an addition or remodeled porch on a building, be part of the surveyed resource but may warrant specific descriptions in the record as well as demarcation on a map or sketch plan of the resource.

Though not ideal, SDSHS recognizes that the logistics of a survey scope might constrain how much of a large linear resource is documented at a given time. In these cases, it is strongly recommended that the surveyor also include a brief general description of the resource that might include known information about the size, setting/environment, age, and purpose of the system overall. Additional survey work on different sections of the system might warrant separate site forms or might be better done as an update and expansion of an existing record. Surveyors can consult with ARC (or SHPO for CRGRID) staff about the best approach for the circumstance.

Elaborate networks may include multiple linear resources that relate to each other more as a historic district than a single resource. Site forms should indicate their connection to a larger network/district through the description text and/or property names.

> For instance, the ditches in the Lower Rapid Valley irrigation system are connected by geography and history, but they are recorded on separate archaeological Site Forms. Different irrigation canal systems in the valley might be evaluated for the National Register individually and/or as a larger historic district with different Contributing or Non-Contributing statuses.

Substantial buildings or structures that are associated with linear systems should be recorded in CRGRID. These might include resources like power plants, ditchrider houses, offices, dams, or bridges. Cross-references and/or common names can be used to indicate their connection to the larger system. Smaller, embedded, or repeating built resources like headgates, weirs, tow paths, fencing, etc. should typically be included in the Site Form recordation.

Determining Boundaries for Recordation

In an archaeological Site Form, the site boundary should include all historically associated resources. Site boundaries can be expanded, revised, or refined in re-survey efforts.

In CRGRID, in most cases, records should be created for each resource on the surveyed property. Generally, the bounds of a resource will not overlap with another resource, however there may be exceptions. For instance, a bridge built separately over a small dam structure or canal might be recorded separately; circulation roads or paths may cross over other resources; and there may be above-ground resources located over archaeological sites. As stated previously, a record can also be used to describe simple repetitive or across-landscape features, such as one created to describe a park's overall landscape including circulation patterns and repetitive lighting fixtures and benches. Since CRGRID records are assigned a single coordinate point, attaching a map that depicts the extent or bounds of the resource may be advisable (see Mapping and Photography Guidance section).

To determine what extent of a property to record on a form, especially of multi-component resources, consider:

- What has a direct historical association in terms of construction and/or use?

  In CRGRID, additions to a primary or earlier resource should not be considered a separate resource, and they should be described on the form with the primary resource. However, adjacent structures might need to be recorded as separate resources if built to operate separately (like commercial buildings on a Main Street that might have a shared wall but were separate businesses [often separate property lots]).

- How closely are the components of the system dependent on each other for their operation and/or function?

  In CRGRID, closely dependent components might be best recorded as a single resource on a single form, such as an artesian well and its adjacent stilling basin. Dependent components that are at a greater distance may be recorded separately but use district connections in name or ID (as described in the preceding Architectural Properties section) to tie them together. This might include a swimming beach dependent on the reservoir's dam, an observation deck built next to a dam, or a retaining wall upstream of the intake for a power plant.

- Are there below-ground or water-covered components to the resource? For instance, drops built just below a dam spillway would be part of that resource even if typically of low visibility below the water line.

- What is needed to understand and evaluate the property's character and significance under the eligibility criteria for the National Register of Historic Places? For instance:

  A spillway would typically not be able to be effectively evaluated for significance without its associated dam, so they should be recorded together.

  An irrigation ditch segment might not be able to be evaluated without documenting the full ditch extent with associated gates, etc. Full ditches could, however, be surveyed and/or evaluated with or without smaller privately-owned laterals, or with or without the larger irrigation network in the same valley.

Boundaries may be selected based on factors such as:

- The extent or concentration of extant cultural features
- Landscape features or landforms
- Legal property or lot boundaries (historic or current)

Generally, boundaries should focus on the cultural resource and not include extensive surroundings. For archaeological sites, it is conventional to include a buffer area both because it is difficult to determine the full extent of the site through usual survey methods and to account for variation in recording spatial data. Additionally, a resource's surroundings beyond the surveyed boundary may still be a factor in evaluating its integrity of setting and feeling under National Register criteria (see Evaluation Guidance).

Larger or more natural bodies of water such as rivers, lakes, and reservoirs may fall, in part, within the boundaries of the water conveyance systems where they are connected to the surveyed built resources but should generally not be recorded in whole or separately as cultural resources themselves.

Examples:

- The boundary of a canal recorded in ARMS would include features of the canal such as its banks and/or an adjacent walking path that was used for maintaining the canal. Both are clearly associated with the construction, use, and/or maintenance of the canal. Adjacent fields, however, would not be included in the boundary, as they are not a component of the canal as a resource. Bridges over the canal that are structurally independent, even if historically associated, would be recorded separately in CRGRID and can include a cross-reference in the notes.

- For a dam, a boundary in ARMS or CRGRID would include the earthworks or embankments and adjacent shore above the dam that were modified to support the dam structure (either in original construction or subsequent repair/improvement work) but would not extend along the continuing shoreline or far into the body of the reservoir. Below the dam, a boundary would terminate where the built components end and natural banks begin. If a road crosses the dam, the recorded boundary should only include the portion of road that overlaps with the dam structure and its embankments.

- For a small series of stone check dams built along a creek in a ranch pasture that are recorded and evaluated as a single resource, the boundary might be linear and include all check dams, the section of creek connected by the dams, and the shore of that creek section. But will likely not include upstream or downstream sections of the creek or the wider pasture fields for the purposes of recordation in ARMS (or CRGRID). [If such a resource were evaluated in context of a historic district for a ranch, an overall National Register boundary might be selected that would include fields, ranchyards, etc.]

> When surveying to identify historic properties for a Section 106 review, an area of potential effect or the scope of a survey project may be defined in a narrow way. Although it is not recommended to record only part of a historic property, if unavoidable because of such limits, it may be the case that an evaluation of the property's eligibility for the National Register will not be possible without full recordation.

Mapping and Photography Guidance

As with any survey record, maps and photographs of water conveyance resources in South Dakota should serve to accurately convey information about the physical character of the resource and its geographic context. The following guidance is related to the somewhat unique nature of water conveyance resources and intended to improve maps and photographs of them.

> In ARMS, maps (sketch map, site map, and location map) and photographs should be included in the site form in the designated sections or on attached sheets. The shapefile of the site boundary and the boundary depicted on all maps should match.
>
> In CRGRID, maps and photographs can be uploaded to records as attachments in JPG, TIF, or PDF formats.

Mapping Guidance

Maps created for the survey record should clearly depict relevant boundaries, identified resources or features within the boundaries, as well as standard mapping features like a title, author, date, compass direction, map scale, location (including as relevant/required: address, city, county, township, USGS quadrangle), and key/legend (as needed). Surveyed sites/resources shown on the map should be clearly identified with text labels and/or keyed points or polygons.

Maps for water conveyance resources are likely to include landscape elements like water, vegetation, surface materials, or landforms that can be depicted with symbology or shading (with key or legend) where doing so will aid in understanding the surveyed resource.

For large systems, adequate documentation may be best served by including multiple maps at varying scales, on different bases (such as aerial imagery v. topographic), or with alternate data sources like LiDAR. Including sketch plans or site plans without any base can convey clearer information about complex structures or groupings and their layout. When there are multiple maps, it is recommended to orient them to the same compass direction if feasible.

For example, documenting a flume on a map with a topographic base can convey the landforms and slopes that it carries water across. The same map with an aerial imagery base can, in turn, convey the current condition and surroundings of the flume to help inform assessments of integrity of design and setting.

A map using LiDAR data can help depict landforms, such as berms or drainage ditches built across abandoned agricultural fields.

However, not all types and extents of maps are necessary for every record. SDSHS acknowledges that the quantity or types of maps will vary depending on the intent and scope of the survey, as well as the cartographic expertise and resources available to a surveyor.

- The standard map to include with a survey record should include the entire documented property -- the site boundary for records in ARMS, and all associated resources for CRGRID.

- For long linear systems, it may be best to have an overview of the boundary and then create more detailed maps of sections of the historic property when that would improve the viewer's comprehension. Keying any maps done at smaller extents to the overview map can help viewers understand the context of the detail views.

  For example, for a large irrigation system, in addition to an overview map, there may be 1) map of the whole surveyed lateral to depict its course; components like gates; and its surroundings, as well as 2) a closer view of the headgate to show more structural details.

- We recommend including an overview map (or inset) that displays a wider extent of the system as a whole, even if only a portion was within the scope of the current survey work.

For resources such as dams or canals that have a more vertical presence, profile sketches of the resource at key points and/or representative points can convey information about their depth, design, and materials. This is particularly recommended when there are components that will not be visible in photographs because of cover by water and/or vegetation.

Identifying on a map those segments or components of the resource (especially linear resources) that are modern or significantly altered may help communicate visually a case made in the narrative about historic integrity.

Photography Guidance

** Find additional guidance in "Photograph Guidelines" in the Architectural Survey Manual and "Photography Guidelines for the Purposes of Section 106 Mitigation" in Appendix F of the *SHPO Guidelines*.

It is recommended to take photographs from vantage points that will convey the desired information clearly. Consider angles, vegetation coverage, and other such factors when choosing vantage points. However, SDSHS acknowledges that many water conveyance resources may offer challenges to finding vantage points that photographers can access physically, legally, and safely. It is recommended to add brief notes to the survey record if obstacles in the field prohibited the surveyor from getting views that would otherwise be expected.

Water conveyance resources can be larger, more complex, or best understood in a wider spatial context than typical architectural or archaeological resources. It is recommended to include several wider views of the resource to convey information about the relationship between components of a resource and its surroundings. The photographer should shoot these at a further distance or higher point or should use equipment such as wide-view lenses. (With wide lenses, monitor the camera angle and zoom extent so images aren't skewed or warped.)

Water conveyance resources can also have numerous small and technical components that may need sets of close photographs from various angles. If there are visible manufacturer's marks, names, and/or plaques on equipment associated with the system, we recommend photographing these. This information can help with dating a component, place it in historic context, and evaluating the resource.

It is recommended to include angles nearer the ground that may better display the topography when photographing earthworks or landforms. If feasible, certain times of day and lighting conditions can create longer shadows that are helpful for showing earthworks in the images. It can also help to do survey work at times of the year when there are minimal leaves, grass, and/or other vegetation growth that would obscure the resource. (For some cultural landscapes, vegetation may be part of the historic character and should be included in photographic documentation.)

If certain components are highly repetitive, it may only be necessary to submit representative views of those features. Similarly, long extents of linear resources like canals or ditches may need only representative views rather than complete coverage.

With larger or complex water conveyance resources, photographs of any modern or altered segments or components can help support information in the narrative description about historic integrity.

A map with a photo key overlaid is recommended to convey how thoroughly the submitted survey photographs cover the resource, especially for large resources or when landforms are indistinct in photographs.

Historical Photographs or Maps

Copies of historic photographs or maps are not required for survey documentation but may assist in conveying information about the resource's significance or integrity. For instance, a historic map or older aerial photographs of a drainage ditch can be useful in comparison to current aerial imagery to convey whether the ditch alignment has been altered or not. A historic photo of a dam compared to current photos may provide useful information on whether or not past repairs had changed the historic design or materials.

Historic photographs or maps should be cited with their source (and/or repository) and all available information on their title, date, author, etc. Those that are not in the public domain should not be replicated in a public survey record without permission.

In archaeological Site Forms, historical photos or maps can be included in attached pages.

In CRGRID, do not upload historic photos or maps as single image files, but they might be part of additional description/assessment that could be uploaded as a PDF attachment.

Resource Types

In this section, we will provide definitions and examples of resource types that may be encountered during a survey. Where possible, detail will be provided on the resource type's appearance and possible variations along with what characteristics can be used to identify the resource. This list is not exhaustive. If a surveyor comes across a water conveyance resource that is not included, it may still need to be recorded and/or evaluated, and SHPO and/or ARC can be consulted about specific questions.

Recommendations for additions or changes to this list can be sent to the SD SHPO at shpo@state.sd.us.

Canals and **Laterals.** Within the state of South Dakota, canal are manmade waterways constructed to allow for the passage of water, often in connection with agriculture and irrigation functions. Unlike in other parts of the country, few to none were built for boat traffic. Canals are in-ground, stream-like structures that are lined (though some may occur unlined) to channel water through the canal and prevent water loss. Materials associated with lining this resource can vary but may include stone, poured concrete, or pre-cast concrete.

A lateral refers to a canal that is built parallel to an existing stream or canal to ease navigation in that area. In South Dakota, the term lateral is often associated with branch channels leading from a primary canal(s) to agricultural fields.

Examples of canals and laterals in South Dakota:

- The Belle Fourche Irrigation District (BFID) is a multicomponent resource that features a dam, canals, laterals, and other associated features located in Butte County and Meade County. The district was constructed in the early 1900s through funds from the Bureau of Reclamation. From the reservoir created by Orman Dam, canals and laterals disperse water through the district for agricultural use.
- A stone-walled canal runs through Madison City Park (LK02900031) in Madison that was built in the 1930s to channel water from a natural drainage channel through the settled town landscape (Figure 71).

Ditches. Ditches are defined as linear, artificial waterways that allow for the drainage of water from agricultural and/or residential areas. In terms of appearance, ditches share similar characteristics with canals and laterals as they are in-ground structures that can be either lined or unlined. These resources are found throughout South Dakota and vary greatly in length, width, and depth. Large drainage ditch systems were constructed by several counties. Some towns constructed ditch systems rather than below-ground stormwater systems. Farmers might dig out ditches for their own fields. Many ditches are still in use today, but smaller or neglected ditches with overgrown vegetation may be very shallow and difficult to recognize.

Examples of ditches in South Dakota:

- The Vermillion Valley Ditch (CL00000523) in Clay County was constructed c.1910-1913. The development of this ditch system is associated with agricultural efforts to increase the amount of cropland available.
- Several blocks in Mount Vernon (Figure 72) in Davison County have small fieldstone-lined ditches running through the center of the block, with small bridges on the cross-roads over them. Though expected to date from the early 20th century, little is yet known about their origin.

Flumes. Like with dams and ditches, flumes are artificially constructed and designed to convey water as a means of transportation. There are several variations of flumes, including:

- *Log flumes* that transported logs and timber from cutting sites to processing mills.
- *Flow measurement flumes* that help to record the water flow rate.
- *Diversionary flumes* that transport water from one water source to another. In South Dakota mining history, flumes were historically used to transport gold-rich waters for processing (Figure 73).

The construction materials associated with flumes can vary. Wood was used most often, though there are instances where a flume may, in full or partial, have been constructed using concrete or stone. The appearance of a flume may also vary based on if it is location is on the ground surface or on support trusses. When flumes were no longer in use, the materials may have been removed for other uses or have been left to the elements. When flumes are extant, the levels of integrity can vary greatly.

Examples of flumes in South Dakota:

- The Sturgis Experimental Watershed, a project built by the USDA Forest Service in the 1960s, utilized San Dimas flumes to carry water through recordation equipment to measure water runoff and study watershed management.
- The Chicago, Milwaukee, St. Paul Railroad flume in Grant County was constructed in 1913 of concrete in order to channel rainwater over a lower railroad cut and keep it off the tracks.

Figure 71. Madison City Canal at Memorial Park in Madison, SD. Courtesy of SD SHPO.

Figure 72. Drainage ditch located between Cotton and Main in Mt. Vernon, SD. Courtesy of SD SHPO.

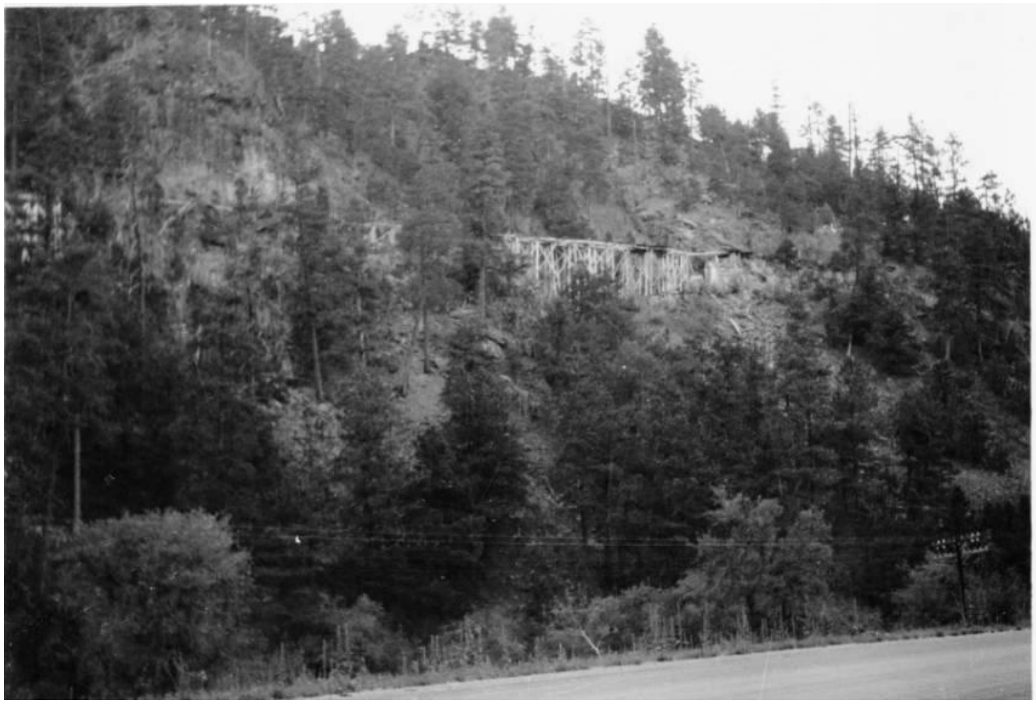

Figure 73. Big Bend Flume in Pennington County, SD in 1961. Courtesy of Watson Parker Ghost Town Notebooks, Leland D. Case Library for Western Historical Studies, BHSU.

Wells/Cisterns. Wells and cisterns are very similar in their function with one key difference. Wells are below-ground systems that provide access to available groundwater, while cisterns collect and store rainwater and can be above- or below-ground.

Wells and cisterns typically have both underground and aboveground components that can vary based on their age, design, and desired function. Some common components of wells include a head/cap, casing, and pump. There are three broad categories of well types, based on their construction. These include *dug wells*, *driven wells*, and *drilled wells*.

Components of a cistern may include the water collection system, storage container, suction pipe, spigot, and storage container access. Cisterns were used for residential and municipal water supply, as well as for industrial, irrigation, and mining uses.

Depending on their age, the subsurface portions were primarily constructed of bricks, stone, and/or concrete, while the surface components were often made with wood (though many modern cisterns use concrete) (Figures 76 and 77). Once abandoned, the wooden surface components often decay, making these features difficult to identify if vegetation is high.

Examples of wells and cisterns in South Dakota:

- The Stagebarn Stage Station in Meade County is associated with the Sidney-to-Deadwood Stage Route. The well at the station was constructed pre-1900 and is constructed of stone.

- At the Kudrna Ranch in Pennington County, there is a c.1910 concrete cistern.
- The Larson Artesian Well was original hand dug in c.1896-1897 near the town of Reliance in Lyman County. At the time of the original construction, the well was lined with stone and water collected by pail on a rope, but later was lined with a culvert and an electric pump was added.

Jetties. Jetties are built along shorelines and serve three primary purposes: erosion control by protecting the shoreline from damage by waves and/or currents, sediment control, and navigation. Jetties can also be built with boat access ramps. The construction material of jetties can vary from wood, soil, rocks, or concrete.

Example of jetties in South Dakota:

- The rock jetty at Farm Island (Figure 77), east of Pierre, served primarily as erosion control and was constructed by the CCC.[451]

Pipes. The materials associated with pipes used for irrigation can greatly vary based on construction date, pipe type, and primary usage. Pipes were also incorporated into some culvert construction to carry water under roadways or railroads. Some of the general, broad construction materials that have been utilized include stone, clay, concrete, metal, and in modern construction, PVC pipes have been used in some piping projects.

- *Gated pipes* and *inlet pipes* are very similar and are often used to channel water from rivers or creeks into irrigated fields using evenly spaced holes placed along one or more sides of the pipe.
- *Spray pipes/sprinkler systems* use large sprinklers to spray water across large portions of a field in a manner that imitates rainfall.
- *Underground pipes* are also sometimes applied to irrigation fields and function similarly to above-ground sprinkler systems but can significantly decrease the amount of water required.

Siphons in irrigation systems consist of airtight tubes or pipes in an airtight system that use different pressure levels to push water over a barrier (such as a raised irrigation channel). These are most often used to move water up into irrigated fields.

Example of pipes in South Dakota:

- Since 1981, Angostura Irrigation District has replaced several above-ground laterals with underground pipes. This has also decreased sedimentation rates.

[451] "Rock Jetty Erosion Control, Farm Island," Digital Library of South Dakota.

- Across the state, there are a number of culverts that are constructed of concrete and share a standard design. Culverts are also sometimes utilized as bridges.

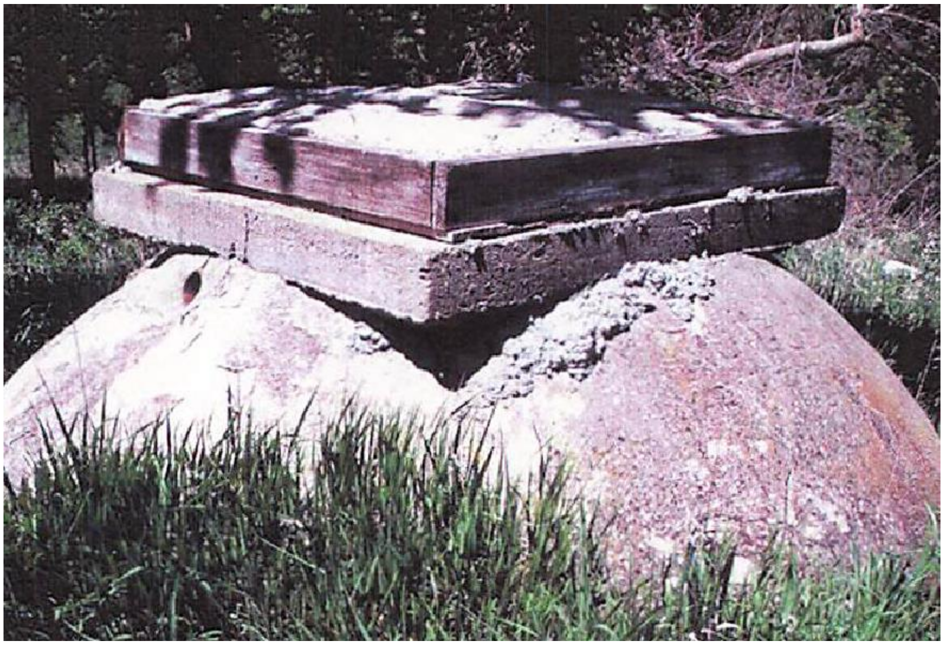

Figure 74. Concrete cistern recorded at Site 39LN78, Lincoln County, SD.[452]

Figure 75. Concrete cistern recorded at Site 39MH332, Minnehaha County, SD.[453]

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452 Lueck, "Cultural Resources Survey of the Proposed GFP Quigley Clean-Up Project."
453 Kruse and Lueck, "Cultural Resources Survey of Sweetman Partners, LLP Development Project."

Figure 76. Well lined with brick, mortar, and stone at Site 39HT0147.[454]

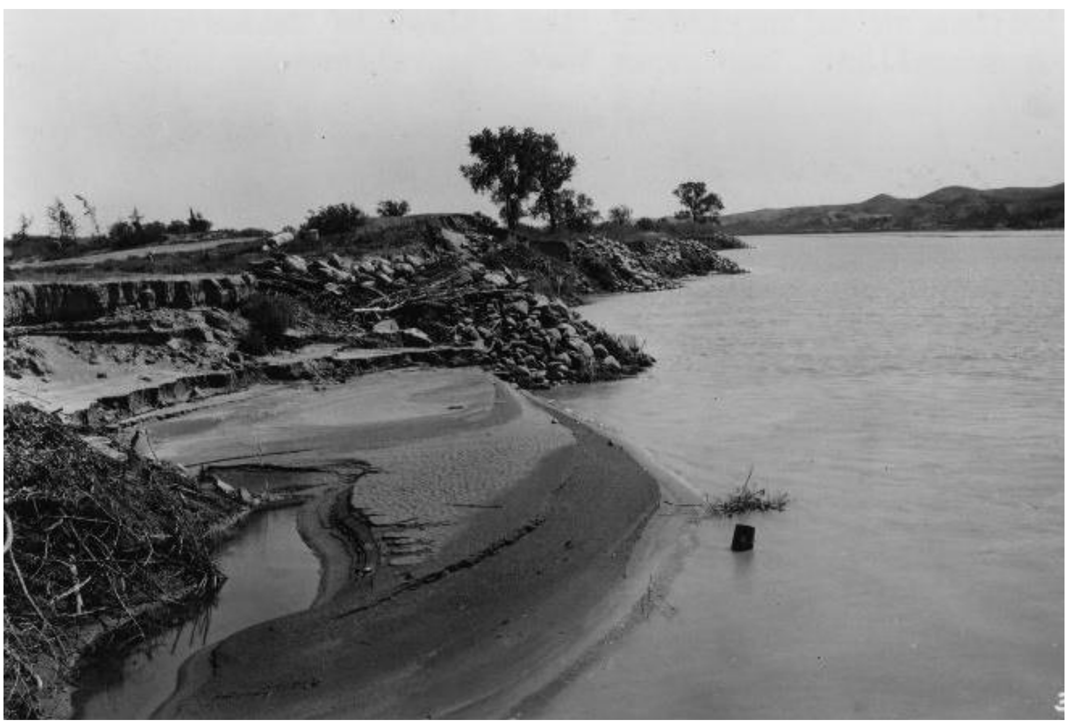

Figure 77. Rock jetties on south side of Farm Island to protect the south shoreline (work completed by CCC enrollees). Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20144654).

[454] Mayer, "Cultural Resources Survey of US Highway 18.

Figure 78. Inlet to 15" culvert constructed by CCC enrollees at Custer Camp F-12. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20141180).

Diversion Structures. Diversion stands are used to divert water from portions of a river from their original path. In irrigation systems, the purpose can vary to include erosion prevention, water supplementation for crops, collecting water for spreading, and diverting water away from farmsteads.

Gates along a water channel are used to control the flow of water, especially at points where different channels meet, or to keep debris or sediment from moving through the channel.

- *Turnouts* (or *turnout gates*) function in a similar manner to division stands in that these resources divert water, typically from a larger part of a water source (such as a canal) to a smaller portion.
- Both *Box and gate systems* and *division boxes* are used to direct water from one canal or ditch and another, and both operate similarly.
- *Head gates* are used to control the flow of water into an irrigation channel (such as a ditch or a canal). (Figure 80). Head gates are also a component of a hydroelectric dams. These gates, also known as intake gates, help to reduce or stop the flow of water through the dam.

- *Check gates* maintain a constant water level or flow by automating the amount of water that moves into the irrigation channel.
- A *debris/trash gate*, much like the name implies, is used to limit the movement of garbage into an irrigation channel or body of water.
- A *sand gate* collects sand and sediment to flush it out of the canal.

Drops, also known as a fall, are used to slow the flow of water and reinforce the water channel where the natural slope is steeper than the channel, particularly in canals. Typically built of masonry, drops help preserve the canal structure and the flow of water by reducing erosion. There are a wide variety of drop designs.

Retaining Walls are used to line the banks of canals and other irrigation channels to reduce erosion and maintain useable land space along the channel.

Different types of retaining walls include:

- *Gravity Retaining Walls* rely on their own weight to remain in place. Due to this, gravity retaining walls tend to be large, but can be built with a variety of different materials including concrete, stone, or masonry units.
- A *Crib Retaining Wall* is a sub-type of a gravity retaining wall. The main body of a crib wall is constructed of interlocking boxes that are then filled with crushed stone (or similar material) to provide drainage. The typical construction materials for the boxed include concrete or timber.
- *Gabion Retaining Wall* is composed of wire mesh boxes that are filled with rocks or other similar materials. This type of wall is typically good for helping to stabilize steep slopes.
- *Cantilever Retaining Wall* is composed of two elements, a stem and a base slab, and is typically made from concrete. With the stem as a divider, the base slab is divided into two sections – the toe and heel. The heel portion is the portion of the base slab that is covered with fill material.
- *Counter-fort Retaining Wall*, also known as Buttressed Retaining Wall, is similar to the cantilever retaining wall, but contains counter-forts on the heel slab to provide extra support.
- *Anchored Retaining Wall* is characterized as being a thin retaining wall that is further supported with anchors (made of metal rod and concrete) inserted into the earth.
- *Piled Retaining Wall* are concrete piles that are driven into the earth to create either a temporary or permanent structure.

- *Mechanically Stabilized Earth (MSE) Retaining Wall* is a composed of fill material contained by a reinforcement material. This types of walls can be composed of materials like panels, concrete block, or earth.

Figure 79. Homestake diversion stand near Hanna in 1961. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20144646).

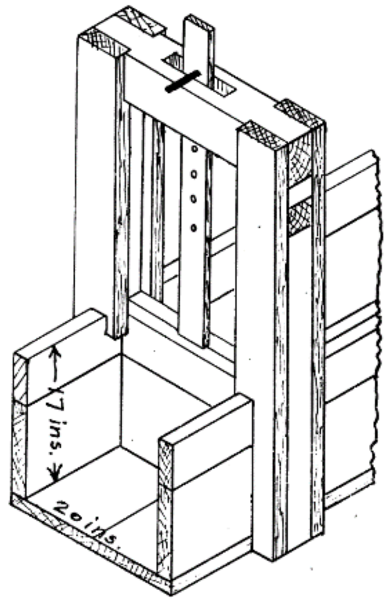

Figure 80. An example of a lateral headgate. The original caption explains, "the gate may be raised or lowered by means of the gate stem and held in place by a wooden peg as shown."[455]

Figure 81. A stone retaining wall along Fall River in the Hot Springs Historic District. Photo from SD SHPO.

[455] Lea, *Second Biennial Report of the State Engineer to the Governor of South Dakota for the Years 1907-1908*, 79.

Dams are built across streams or rivers to hold water on the upstream side of the dam. The reservoirs this creates can collect and hold water for a variety of uses including irrigation, water supply, hydroelectric power, or recreation. Although dam components can vary based on specialization or construction needs, common features are spillways, abutments, embankment, drains, filters, and riprap. Spillways are designed to release excess water safely so that the dam does not fail and spill over.

- *Earthen dams*, also referred to as embankment dams, are constructed from compacted soil, clay, or rock and sometimes reinforced by concrete. This type of dam can be identified by the visible slope on the non-water retention side.
- *Stock dams* are designed to hold water primarily for storage and pasture grazing (Figure 83). These dams have a general appearance with a body of water located between two earthen berms (typically from the constructed from material excavated for construction of the water storage area). These are often associated with ranching activities in South Dakota.
- *Concrete dams,* just as they are described, are manufactured almost entirely out of concrete (Figure 84). Because concrete is so durable, these dams are often larger than other dams, as they are strong enough to hold back significant quantities of water.
- *Hydroelectric dams* hold back water for the purpose of later releasing that water to create energy that is converted into power (such as electricity).
- *Weirs* are a type of low dam built over a river or stream to either regulate or increase the flow of the water.

Examples of dams in South Dakota:

- The Bismarck Lake Dam located in the Black Hills National Forest was constructed in 1936 and is an example of an earthen dam.
- The four mainstem Missouri River dams in South Dakota are Oahe Dam, Big Bend Dam, Fort Randall Dam, and the Gavins Point Dam. All are earthen dams that led to major innovations within earthen dam construction and popularized these types of dams.[456] All also have hydroelectric functions.
- LaBolt Dam Recreation Area in Grant County has dam, spillway, and walls that were constructed in 1936-1937. The WPA constructed dam is composed of a steep stone spillway with rubblestone and concrete walls.

[456] Ferrell, "Developing the Missouri: South Dakota and the Pick-Sloan Plan,"; Lawson, "Federal Water Projects and Indian Lands: The Pick-Sloan Plan, A Case Study"; Lawson, Dammed Indians; Lawson, Dammed Indians Revisited.

Figure 82. Bismarck Lake Dam, taken in 2024.

Figure 83. Stock dam on private land in McCook County, taken in 2024.

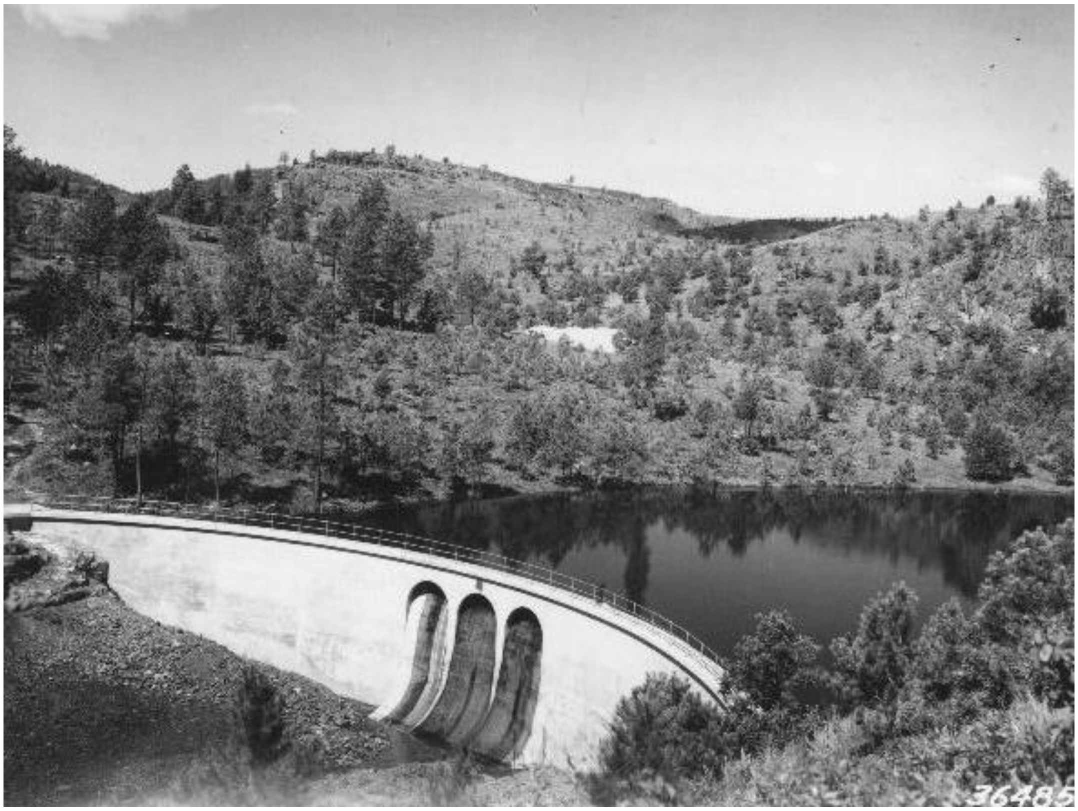

Figure 84. Victoria Dam in Pennington County in 1938. Damaged in the 1972 flood, the dam was later removed entirely. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20070095).

Dikes and **levees** are embankments constructed along waterways (such as rivers) to prevent water from flooding into the adjacent field.

Example of dikes and levees in South Dakota:

- The WPA-Bear Butte Lake property (which contains both architectural and archaeological resources) contains a levee (39MD347) that is Eligible based on Criterion A for its association with the Great Depression.
- Owen’s Bay Levee (CH01200004) at the Lake Andes National Wildlife Refuge was constructed in 1935 out of earthen materials. The function of the levee was to serve as a water control feature and as a light road.

Raceways, also known as **flow-through systems**, are manmade tanks of water used to culture fish and other riverine animals. These raceways are often part of larger hatcheries associated with natural waterbodies. Raceways are usually constructed with a step design that helps to reintroduce oxygen into the water. Raceways are typically constructed of concrete.

Example of a raceway in South Dakota:

- The D.C. Booth Historic National Fish Hatchery in Spearfish features several raceways. The original earthen raceway used when the hatchery first opened was replaced with concrete trough types in c.1939 by WPA crews. Since that time, the raceways have been replaced again, though with an in-kind material. The purpose of these raceways was to inventory fish and disease control.
- The Whitlock Bay Salmon Spawning Station at the West Whitlock Recreation Area near Gettysburg features a concrete fish ladder, concrete raceway, and work building.

Figure 85. Lower end of stilling basin of Sheridan Dam and Dakota Lake, where run-off water enters Spring Creek channel. Fish ladder and fish ladder well on right side. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20151576).

Figure 86. Construction of a weir from logs and rocks on a creek, Youth Conservation Corps, Camp Judson, 1970-79. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20160501).

Figure 87. Levee on western bank of the Big Sioux River in North Sioux City, South Dakota.

Associated Resources

Water conveyance systems can include a variety of different associated buildings, structures, and sites that may be encountered during the survey of water conveyance systems in South Dakota.

Recording structures and **gaging stations/sheds** are used to monitor bodies of water, such as streams, lakes, canals, and rivers, for collecting data on stream discharge and water levels.

Measuring devices, including measuring gates (also known as meter gates), are a submerged system that monitors and controls the flow of irrigation systems.

Example of these resources in South Dakota:

- As mentioned earlier in the flume section, the Sturgis Experimental Watershed project also contained gaging stations along the flume to collect data regarding the watershed. The gaging stations at this experiment resemble a small shed that contain measuring equipment in the floor of the structure.

Power stations (also called power plants or power houses) contain the turbines and generators that collect the energy created by moving water along a river or at a hydroelectric dam.

Examples of power stations in South Dakota:

- The Homestake Mining Company constructed Hydro Plant 1 in 1910 and Hydro Plant 2 in 1917 along Spearfish Creek to generate power for their mining operations.[457]

Pump houses (also known as pump stations or plants) are buildings that contain pumps and other equipment used for distributing water for the purposes of water supply, irrigation, fire prevention, wastewater, and/or flood control. The appearance of a pump house can vary based on the function, location, and date of construction.

Examples of pump house in South Dakota:

- Figures 91 and 92 show an example of what a dilapidated, abandoned pump house can look like during a survey. This pump house, part of site 39CD197, was recorded in an agricultural field near Watertown in 2024.[458]
- Pumphouse #1 and Pumphouse #2 located at the Placerville Church Camp in the Black Hills National Forest were constructed c.1971 with a log structure. These pumphouses are part of site 39PN0158.

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[457] Higbee, Powering Homestake.
[458] Denekamp and Buhta, "176th Street Enhancement Project."

Figure 88. Sturgis Watershed Gaging Station #2, Unknown date. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU.

Figure 89. The Homestake Mining Company Hydro Plant #2. Photo by SD SHPO, 2020.

Figure 90. Pumphouse at Dalton Campground, Date unknown. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU.

Figure 91. Overview of dilapidated pumphouse, filled with historic and modern trash, Recorded at Site 39CD197, a historic farmstead.[459]

[459] Denekamp and Buhta, "Cultural Resource Evaluation of 176th Street Enhancement Project."

Figure 92 Close-up of dilapidated pumphouse, filled with historic and modern trash, recorded at Site 39CD197, a historic farmstead. From Denekamp and Buhta, "Cultural Resource Evaluation of 176th Street Enhancement Project."

Farmsteads and Ranches connected to irrigation systems can contain a wide variety of buildings and sites, including but not limited to houses, barns, granaries, silos, ice houses, corrals, gardens, and others. For more on agricultural resources, please view the *Homesteading and Agricultural Development Context* by Allyson Brooks and Steph Jacon available at https://history.sd.gov/preservation/SHPOdocs.

Bridges and culverts are structures that allow circulation networks like roads and railroads to cross waterways. For additional information regarding these structure types, please view *Historic Bridges of South Dakota*, a SHPO context study, and *Prairie Crossings: South Dakota's Historic Roadway Bridges* by South Dakota Department of Transportation, both available at https://history.sd.gov/preservation/SHPOdocs.

Examples of bridges in South Dakota:

- Bridge 10-109-360 is located northeast of Belle Fourche. It was constructed by the Canton Bridge Company in 1906—one of five that the company built under contract with the Reclamation Service to carry local roads over the Diversion Dam Inlet Canal, part of the Belle Fourche Irrigation District. The bridge was listed in the National Register of Historic Places in 1993.

Figure 93. Bridge 10-109-360, Butte County, South Dakota. Photograph from National Register nomination.

Figure 94. This 1999 bridge crosses the top of the stone-lined Richmond Lake Dam, northeast of Aberdeen. Photo by SD SHPO.

Fountains are defined as being an ornamental structure with at least one stream of water ejected into the air**.** Additionally, there are drinking fountains that may be encountered in a variety of contexts. The primary function of a drinking fountain is to provide a stream of water that is drinkable. In general, fountains can be composed of a variety of materials, such as stone or concrete, and can vary in appearance based on function.

Examples of foundations in South Dakota:

- A historic fountain (Figure 95) was gifted to downtown Sioux Falls in 1907 by the National Humane Alliance, which gifted a total of 125 fountains to cities throughout the United States for the purpose of providing refreshments to horses, dogs, and other service animals. Though it once stood at the corner of 9th and Philips streets it is now located at the southeast corner of 8th and Philips.[460]
- The Flaming Fountain Memorial is located along the shore of Capitol Lake in Pierre. The memorial serves as a memorial to the veterans who served during wartime. Components of this memorial include a foundation, stone memorials, statues of servicemen of the different military branches, a waterfall, and an eagle statue.
- The Lake Preston Tourist Park Historic District, located in Lake Preston, includes both a fountain and a drinking fountain. The fountain itself is a circular, three tier fountain comprised of cobblestones. The drinking fountain is located to the west of the fountain and is comprised of concrete.

Figure 95. Historic fountain gifted to Sioux Falls by the National Humane Alliance, downtown Sioux Falls.

[460] "National Humane Alliance Fountain."

Construction Camps were often temporary establishments used by those working on the construction of larger water conveyance systems, such as dams and canals. CCC camps could include thousands of men and buildings (or tents) used for housing, administration offices, mess halls, kitchens, and bath houses (Figures 96 and 97). Because these camps were intended to be temporary, most structures would have been made of wood to minimum standards and those that were not removed for reuse elsewhere have largely deteriorated. Archaeological resources at such camps could include debris, structural remains, and equipment/machinery that were left behind.

Example of construction camps in South Dakota:

- CCC Camp Custer was located eight miles from the city of Custer and housed Company 1791. When operational, the camp had thirteen wood frame and log buildings that included barracks, mess hall and kitchen, root cellar, recreation facility, laundry, infirmary, garage, light plant, shops, and officer's quarters. The buildings were typically built in the Rustic Style. After the camp closed, the camp fell into disrepair and only the stone pillars and a few foundations remain.

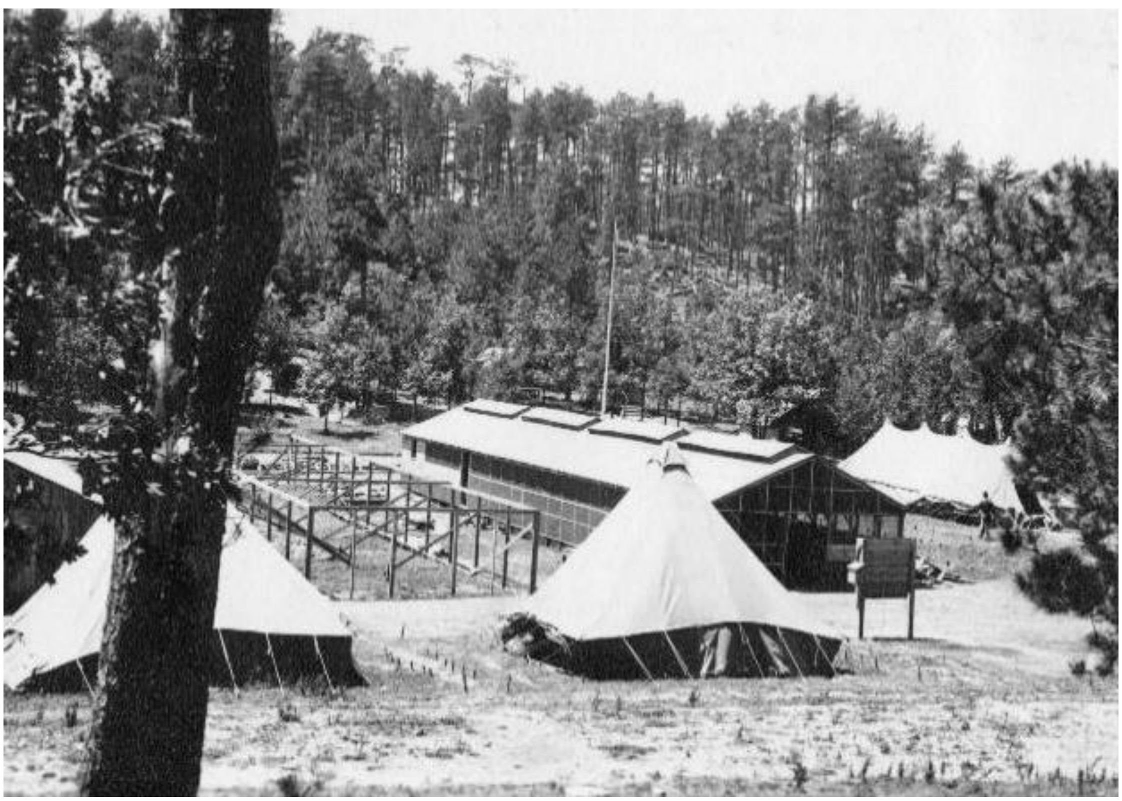

Figure 96. Row of barracks buildings (20' x 80') being constructed at the Rockerville CCC Camp F-10, Company 1794. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20221642).

Figure 97. Buildings in the process of construction at Rochford Camp F-5, showing Company Street with mess hall in right foreground. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20210251).

Borrow pits are areas where earth is removed to be used to build up another location. For water conveyance systems in South Dakota, borrow pits were often created during the removal of soil to construct earthen dams, canals, and access roads. Quarries differ from borrow pits in that a specific resource, such as stone, gold, marble, or other minerals, are being removed from a location. Both borrow pits and quarries leave a distinctive void on the landscape when abandoned, however.

Example of borrow pits in South Dakota:

- In the case of the Sheridan Dam, for example, several borrow pits were created to excavate hundreds of thousands of cubic yards of soil.[461] One of those borrow pits was located at Mallory Gulch (Figure 98) and was dug in 1939.

[461] "Sheridan: South Dakota Civilian Conservation Corps (CCC) Camp."

Figure 98. Mallory Gulch borrow pit at Sheridan Dam, taken in 1939. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU (Identifier BHNF20151512).

Access roads and **parking areas** are often used temporarily during the construction of larger water conveyance systems, such as dams, levees, and canals, but they may also be permanent components of certain resources for management and/or recreation purposes.

In that same vein, surveyors may come across **camp/picnic areas** that are also used for recreation in association with these resources. **Access ramps/piers** allowing people and watercraft (canoes, tubes, boats, etc.) into the water may also be present.

Example of these resources in South Dakota:

- Split Rock Creek Park, located near Garretson along the Big Sioux River, public park with access to the river at a point where a dam was built in 1933, one of the first five projects sponsored by the Reconstruction Finance Corporation in Minnehaha County. Other historic features of the park include a bathhouse, retaining walls, bridges, and culverts, which included WPA through the 1930s.
- Oahe Downstream Recreational Area, located southwest of the Oahe Dam near the Pierre/Ft. Pierre area, features a recreational area that contains picnic shelters, camping spots, parking lots, access roads, boat ramps, fishing docks, hiking trails, and other features.

Landscaping and the modification of vegetation were also often employed in water conveyance systems, especially when applied to irrigation systems. **Fields** were sometimes leveled to create a more successful surface for planting crops. As part of these modifications, **terracing** was also implemented by the CCC during the 1930s and 1940s primarily for soil conservation efforts to prevent erosion and moisture run-off (Figure 99). One such CCC Camp (SC-5) near Alcester began operations in 1935 and employed several men on this task.[462]

Figure 99. Earthen terraces near Deadwood, South Dakota, taken between 1959 and 1960. Courtesy of Black Hills National Forest Historical Collection, Leland D. Case Library for Western Historical Studies, BHSU.

Tunnels and **rock cuts** were often constructed to facilitate the construction of railroads and other modes of transportation over waterways. Others could be used to channel water through or provide personnel access within dam and hydropower plant systems.

Examples of tunnels and rock cuts in South Dakota:

- Both the Hydro 1 and Hydro 2 Plants have significant subsurface tunnels.

Salvage archaeology became a common undertaking starting in the 1930s in the United States. As a result of the Great Depression, the federal government partnered with several institutions,

[462] Hendrickson, "The Civilian Conservation Corps in South Dakota," 4.

including the Works Progress Administration and the Smithsonian Institute, to fund archaeological excavations that employed local residents in a time when paid work was difficult to attain.

In South Dakota, the Missouri River Basin Surveys were conducted to excavate a portion of archaeological sites that were expected to be impacted by the mainstem dams of the Pick-Sloan plan. The survey and excavations were funded through the National Park Service's Interagency Archaeological and Paleontological Salvage Program (IAPSP) and were operated from 1946-1969 through a collaboration with many museums, historical societies, and universities.[463]

In cases where an archaeological site connected to a water development project had an impact on the project plans or impacted archaeology as a profession, a site may have significance to consider under Criterion A as well as for the Criterion D significance of the cultural remains and features within the site itself.

[463] Banks, Snortland, and Czaplicki, "The Price We've Paid"; Sundstrom, "South Dakota State Plan for Archaeological Resources: 2018 Update."

Evaluation Guidance

The following guidance relates to how to apply the National Register criteria for significance and integrity to water conveyance systems in South Dakota. This guidance will not cover all circumstances.

Surveyors in completing survey records and/or site forms will typically make recommendations regarding the current eligibility of the resource for listing in the National Register—whether it meets the criteria for significance and integrity. When the forms are reviewed by State Historical Society staff, they will review this recommendation also. The Keeper of the National Register (an office of the National Park Service) makes formal determinations of eligibility when requested and makes final decisions about listing a property in the National Register.

South Dakota also has a State Register of Historic Places. Its criteria are similar to that of the National Register. The State Historic Preservation Officer makes the final determination regarding listing in the State Register. All properties listed in the National Register are also considered to be listed in the State Register.

National Register Criteria for Evaluation

To be eligible for listing on the National Register of Historic Places (NRHP), a water conveyance system must meet one or more of the following National Register criteria for **significance**:

A. That are associated with events that have made a significant contribution to the broad patterns of our history;

B. That are associated with the lives of persons significant in our past;

C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction;

D. That have yielded, or may be likely to yield, information important in prehistory or history.

And it must possess sufficient **integrity** of location, design, setting, materials, workmanship, feeling, and association to convey that significance for its period(s) of significance. Significance can be evaluated at a local, state, or national levels of historic context.

Properties that are historic districts will have an evaluation as a district overall, while resources within the district boundary are assigned “contributing” or “non-contributing” statuses. Contributing resources are associated with the district’s period(s) and area(s) of significance and retain sufficient historical integrity. Non-contributing resources do not fit the period(s) or area(s) of significance, or they no longer retain integrity because of the level of non-historic alterations or severe deterioration or (archaeologically) disturbance.

These criteria are discussed in more detail in guidance from the National Park Service, particularly: *How to Apply the National Register Criteria for Evaluation* (NR Bulletin 15). Related Bulletins that may also be relevant in various circumstances:

- *How to Evaluate and Nominate Designed Historic Landscapes* (NRB 18)
- *Guidelines for Evaluating and Documenting Rural Historic Landscapes* (NRB 30)
- *Guidelines for Evaluating and Registering Archeological Properties* (NRB 36)
- *Guidelines for Identifying, Evaluating and Registering Historic Mining Properties* (NRB 42)
- *Defining Boundaries for National Register Properties* (with Appendix, Definition of National Register Boundaries for Archeological Properties (NRB 21 & 12)

The full list of National Register guidance bulletins is currently online at: https://www.nps.gov/subjects/nationalregister/publications.htm.

For Archaeological Site Forms

See the *Site Form Manual.*

Site forms include a field for "National Register Status" that is completed by ARC staff. Options are Register (for properties after listing in the National Register), Eligible, Not Eligible (both based on determination by the SHPO, Agency, or by consensus), or Unevaluated.

Site forms can also list the criteria by which a property was listed or evaluated as eligible for listing in the National Register.

For Architectural Survey Records (CRGRID)

See the *Architectural Survey Manual*.

In CRGRID records, there are fields for a Determination of Eligibility (DOE) and for Historic District Rating. Eligible or Not Eligible should be selected for DOEs if there is solid justification for the determination. Where there is not enough available information on which to evaluate eligibility, there is an option for Unevaluated.

For large resources that are surveyed in segments, the DOE field should relate to the resource overall. Written notes can add information about alterations or deterioration that should be known for that segment. *Remember, large linear resources are best recorded as site forms submitted to the S.D. Archaeological Research Center*.

For historic districts with multiple resources:

- If the overall district is considered not to be eligible, the DOE field in each resource's record should be selected "Not Eligible" unless the resource has a different evaluation as an individual resource.
- If the overall district is considered eligible, the DOE field should correlate to the recommended Contributing or Non-Contributing status.
- If the overall district has not yet been evaluated, it is advised to leave DOE as unevaluated and include notes on a) the district's potential significance, if any, and b) the resource's potential to contribute to a district.

Determining Boundaries for Evaluation

Boundaries for Evaluation would be the area that could/would be nominated to the National Register of Historic Places. These boundaries would not necessarily be the same as the bounds of the resources from the descriptions or coordinates entered into survey records or site forms.

For archaeological sites, the evaluation boundary may correspond exactly with the site boundary, might include an adjacent area with significant landscape features related to the occupation of the site, or might include associated above-ground historic resources. In cases, multiple sites might be considered for eligibility as an archaeological district.

For resources that are entered in CRGRID, the evaluation boundary may be just a line drawn around the resource described in the record. For instance, a ditchrider house might be recorded on its own and evaluated on its own. An evaluation boundary might also include associated built resources or archaeological sites. For instance, the ditchrider house might be evaluated as part of a group that includes a garage, barn, other outbuildings, the adjacent canal segment, a bridge over the canal for a road leading to the house, and a refuse dump site in a nearby foundation ruin that was used by the occupants in the period of significance. Lastly, evaluation boundaries might be for districts of associated resources. For instance, it might include the ditchrider house & its close resources as well as the canal overall and other gates, bridges, etc. along the canal system.

There might be multiple viable options for an evaluation boundary. Ideally, they should all be considered.

For instance, in recording a series of low, stone check dams along a small creek in a pasture that were used to water livestock, the recordation boundary might be narrow along the creek just for the length where the dams are located. The series of dams should be evaluated both individually and also as a component of the ranch overall, with associated pastures and the barns and outbuildings located at the edge of the pasture. If the dams do not have sufficient significance on their own, they might still contribute to a ranch historic district.

The National Register program also allows for discontiguous boundaries that are physically distinct and separate but also are associated historically and evaluated or nominated jointly.

> For instance, in a situation where a dam at the south end of a reservoir created the lake and enabled the community to build recreational facilities, including a swimming beach and picnic grounds at the northwest corner of the reservoir – the dam and the recreation area might be evaluated and/or nominated individually if each have sufficient significance and integrity for individual listing. They might also be nominated jointly with a discontiguous boundary that does not include the unmodified shoreline between those areas of the lake. If the dam alone were a simple construction that might not have significance enough under Criterion A or C for individual listing, it is possible that that it could contribute to a nomination for significance in the area of Recreation that included the dam and recreation area jointly.
>
> In another example, a linear resource like a hydroelectric operation along a creek could include a long continuous boundary. However, it might use a discontinguous boundary if there is a large area along the creek without any cultural resources or with substantial non-historic development. For instance, two power plants along the same creek that were operated at the same time by the same company, but ten miles apart, might be evaluated both individually and/or together with a discontiguous boundary.

Similar questions for consideration can be asked while selecting a boundary for evaluation, even if the answers might be different than they would be for recordation:

- What components of a property or water conveyance system have a historical association in terms of their construction and/or use?
- What components are dependent on each other for their operation and/or function?
- Are there below-ground or water-covered components to the resource?
- What is needed to understand and evaluate the property's character and significance under the eligibility criteria for the National Register of Historic Places?

Boundaries may be selected based on factors such as:

- The extent or concentration of extant cultural features
- Landscape features or landforms
- Legal property or lot boundaries (historic or current)

When determining boundaries for evaluation, the boundary may include landscape features or surroundings beyond the surveyed boundary in situations where a) they support the integrity of setting and feeling for the property, and b) the logistical context makes sense.

> For instance, a property under consideration is a construction camp that had been used by an irrigation company that built an important canal system. The boundary of the recorded archaeological site of the camp might be focused on the concentration of remains identified in survey work. The boundary considered when evaluating the camp site's eligibility might also extend to the canal itself on one side and be set on the other sides at the historical boundary of the camp's grounds as depicted on a map from the period of significance.

Larger or more natural bodies of water such as rivers, lakes, and reservoirs may fall, in part, within the boundaries of the water conveyance systems where they are connected to the built resources being evaluated but should generally not be considered separately as cultural resources themselves and a boundary drawn to include the whole body of water.

On Historic Significance

For resources related to water conveyance, significance should be evaluated using relevant historic contexts for the geographic area, time period, and related areas of significance (alt. historical subjects, patterns, and/or themes). Determining which contexts are relevant relies on conducting sufficient research on the history of the particular property itself, its origins and use over time. Searches in existing survey data (through CRGRID or ARMS) may also provide comparisons for the relevant type or age of property.

Contexts included in document are intended to compile histories that will relate to many water conveyance resources in South Dakota, but they are not exhaustive. Surveyors and those evaluating eligibility may need to find and use additional histories particular to local geographic regions or counties, and to the historical events and trends in that area.

> South Dakota has previous historic contexts and Multiple Property Documentation that may have additional relevant context. Find most at: https://history.sd.gov/preservation/SHPOdocs.
>
> Note the following titles:
>
> CONTEXTS: Federal Relief Construction in South Dakota, 1929-1941; Historic Bridges of South Dakota; Historic Mining Resources in the Black Hills and South Dakota (DRAFT); Homesteading and Agricultural Development; and The History of Agriculture in South Dakota: Components for a Fully Developed Historic Context
>
> MULTIPLE PROPERTY: Historic Resources of Rural Butte and Meade Counties; Federal Relief Construction in South Dakota, 1929-1941; Historic Bridges in South Dakota, 1893-1942; and Historic Stone Arch Culverts in Turner County
>
> ALSO: South Dakota State Plan for Archaeological Resources (2018 Update)

We know that research materials to learn the histories and historical contexts of these types of resources can be hard to find. Sometimes, records were not kept from the outset because of the vernacular and utilitarian nature of these resources. Sometimes, records were not kept over time because they were stored in spaces or using methods that resulted in poor preservation of the documents, maps, photographs, etc. Sometimes, surviving research materials are in collections, institutions, or offices that those doing general historical research are less likely to be aware of, or may not have access to. The Research Guide, Annotated Bibliography, and Bibliography later in this document can be a resource for this information. *If you find other research sources or collections that are useful that you would recommend to others, send ideas to shpo@state.sd.us, and we'll add them to any future updates to this context.*

Among the four National Register criteria for significance, Criteria A and C are most likely to apply to water conveyance resources, followed by Criterion D for research potential. Like in general use, Criterion B is applicable and would apply most to residences or workplaces of significant individuals. If the individual's contribution was to the design or engineering of a resource at its origin or during significant modifications, the applicable criterion would likely be Criterion C.

For these criteria, the following Areas of Significance[464] from National Register guidance are likely to be most relevant to evaluating water conveyance systems:

- *Agriculture*, such as irrigation and drainage systems, wells/cisterns on farms or ranches.
- *Archeology*, where cultural remains at the property can be studied to learn about past human occupations there and/or how human-built water systems functioned in the past. Or where the site is important to the history of archaeology as a study/profession.
- *Architecture*, including architectural styles and design, but also building types/forms and the craftsmanship of construction (including carpentry, masonry, etc.)
- *Community Planning and Development*, such as municipal water systems, or dams or canals used for flood control.
- *Conservation*, such as dams, levees, artesian wells etc. that created significant fish or wildlife habitat
- *Engineering*, such as dams, gate systems, hydroelectric systems, mills, retaining walls, etc. that convey historically significant aspects related to design, innovation, or experimentation in their construction or operation.
- *Entertainment/Recreation*, such as dams, canals, fountains, etc. typically as components of a larger historic park or recreation area property.

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[464] The full list of Areas of Significance is in: *How to Apply the National Register Criteria for Evaluation* (NR Bulletin 15).

- *Exploration/Settlement*, such as canals, flumes, wells, etc. that supported the initial phases of a historically significant occupied settlement.
- *Industry*, such as hydroelectric systems and mills.
- *Landscape Architecture*, such as parks or grounds with substantial water features.
- *Invention*, similar to engineering, but especially if the innovation developed or tested at the subject property was then adopted for use elsewhere.

Numerous types of water conveyance system components are likely to be common, simple, or vernacular structures or landforms. Many of those may be unlikely to be significant in isolation, so it is important to evaluate them in association with their system as a whole. For instance, a single concrete-lined lateral may not have individual significance but may be part of an irrigation company's network that was important to a chain of farms through a particular valley.

For the relevant contexts, consider how a water conveyance resource might:

- Represent effort and expertise used in its design or engineering, including construction methods, craftmanship, and/or use of materials.
- Represent the effort of labor that went into its construction and/or operation.
- Represent a traditional ethnic or folk vernacular approach to aspects of life like settlement patterns or agricultural methods.
- Represent the achievements of a significant builder, company, or public program, such as New Deal work relief projects or a city initiative for parks beautification.
- Represent a significant event or response effort, such as building new greenways or channels after a flood event or building artesian wells to respond to a period of drought.
- Have served a critical function in making something possible, such as operating farms and ranches, providing clean water to a settlement area, keeping floods from damaging settled areas, conserving wildlife, etc.
- Have initiated or changed trends in historical patterns, such as for new technologies or methods; physical development of housing, businesses, or agricultural resources; opportunities for recreation; etc.
- Have filled an aesthetic/design or functional role in a larger built environment or cultural landscape.

Other factors that might help inform an evaluation of significance:

- Is the resource unique, was it adapted to fill a unique function, or was it adapted to fit a unique physical situation?

Or, for more common types, is it rare to have survived? How many others are recorded or extant in the local area, county, or across South Dakota? (Remember, significance can be evaluated at a local level as well as state or national level). Does it have unusually high integrity to represent that type/era of resource?

- Does the resource have a name? A name may indicate a cohesive construction effort or role in the community that may have significance.
- Is the resource depicted on historical or current maps of the location?
- Did the resource operate in relation to one property/occupant only? Did it impact multiple farms/ranches, a whole community, a larger industry, or the general public (especially for public property that is in open, regular use)?
- Did it have sustained impact over time? While length of operation is not itself justification for significance, it may indicate success of the original design or the resource being vital to a larger community.

  Or, if the development of the resource was never completed or was soon abandoned, did that failure have historical impacts of its own? For instance, did litigation over taking land by eminent domain for an ultimately abandoned canal change government policy or procedures? Did any of initial construction ultimately serve a different function (like recreation or conservation) that might be significant?
- Did it have substantial physical impact on the built environment? While a large size is not itself justification for significance, it may indicate the scale of effort that went into its construction, the extent of its impacts on a region, or it may have become a landmark to the community even if not operating for its original function.
- Have there been new uses or levels of community awareness of the resource that may not have been part of its intended original role?

If, after covering available research sources and making an adequate research effort, you cannot determine basic aspects of the resource's history such as function, age, or association, care should be taken in evaluation. Additional future research may uncover this information, especially since, over time, different research sources are added to collections or made more widely available. It may be advisable to not finalize an evaluation without that information. However, there may also be cases where the lack of resource sources may indeed indicate a lack of significance, but that should be considered carefully and not assumed. A note might be added to a survey record to clarify that a Not Eligible evaluation was made with available information but that future research might inform a revision of the evaluation. SDSHS staff may contribute insights while reviewing entered architectural survey records and site forms.

On Historic Integrity

Under National Register criteria, a property must also have sufficient historic integrity, which is assessed by weighing aspects of location, setting, materials, design, workmanship, feeling, and association. In addition to general guidance on integrity in *How to Apply the National Register Criteria for Evaluation* (NR Bulletin 15), the following may aid in assessing integrity for water conveyance resources.

Integrity is needed for all criteria for significance but the evaluation of how much integrity is sufficient may vary in relation to the property's significance.

> For instance, a dam significant for innovative use of a new material in its construction may no longer be eligible if later repairs have meant the loss of that material, which would affect integrity of material, design, workmanship, and association. On the other hand, material repairs over time to a dam significant for its role in creating a recreational or conservation landscape may be less likely to affect its eligibility.

Integrity should also be evaluated in relation to the period of significance.

> For instance, a mill built by a private individual in the 1890s but remodeled significantly by a municipality in 1920 to produce electrical power may not have integrity to the 1890s in the area of Industry but retain integrity for the 1920 period of its significance in the area of Government.
>
> The addition of several new buildings to a lakeside park landscape in the 1960s may have impacted integrity of the park for a period from 1934-1941, but they might add to the significance and integrity for a period from 1934-1968.

In many cases, the location of a water conveyance system would be difficult to change because of their nature. However, changes to the alignment of linear resources like canals, ditches, or flumes may impact integrity of location and design.

When components are moved within a larger resource, moves during the period of significance are less likely to negatively impact integrity. Moves within the same resource or system—such as, if a steel truss bridge over a canal is moved to a new location on the same canal—can receive careful consideration, but the bridge may remain eligible/contributing to the irrigation system overall. Moves that are more likely to lessen integrity include components moved out of or into the system, many components having moved, or moves that substantially change the design or feeling of the system.

Integrity of setting can be impacted by both the addition of adjacent development or the demolition and loss of historically associated resources. Both would also impact integrity of feeling, and the latter would impact integrity of association. The impact of new or lost vegetation will depend on the resource, what makes it significant, and best practices for landscape preservation. Examples:

A farm's well and garden pond might contribute to a historic farmyard, but if most of the farm buildings were gone and the current house post-dating the period of significance, the farm would likely have lost integrity (materials, design, and association) and although the well and pond were from the historic period, those types of resources are not likely to have significance for individual eligibility.

A riverside park with swimming beach and fishing pier may have historically had large elms to provide shade over its picnic grounds. Disease in the elm trees might necessitate their removal and change the historic setting, as well as material, design, and feeling, but there may remain sufficient historic integrity overall or other deciduous trees might be planted to help maintain integrity of setting and feeling.

Changes in conservation policy meant that a permanent breach was opened through a historic levee at a wildlife refuge. Though the change had some impact to the integrity of material and design, the majority of the obsolete levee remained. However, the breach also meant that the water was not held back, and a grass field grew where there had before been a lake used for recreational fishing as well as conservation. That would additionally impact setting and association and may result in a Not Eligible (or Non-Contributing) evaluation for that levee.

However, substantial resources might remain eligible even if setting and feeling were somewhat impacted, especially if the surroundings were less critical to the resource's historic character. A stone canal through a city might remain eligible even if new buildings or a recreational trail were constructed alongside the channel, because the canal structure itself was more critical to eligibility than its specific surroundings, and an urban character to the setting/feeling remained even if the actual material of the surroundings had changed.

Condition is not the same as integrity. Damage or deterioration is experienced by all kinds of historic properties, though it may be more regular or obvious with water conveyance resources where moving water, flooding, etc. can cause damage and some materials, like earthen banks, can be vulnerable to deterioration. Repair and rehabilitation work is an expected part of preservation practice. Repairing a breach in a levee after a flood or adding riprap to address erosion on a weir can be equivalent to resetting stones in a masonry wall or foundation. If repairs substantially change historic materials, design, setting, or feeling, that might lead to the property not being eligible for the National Register.

Deterioration can reach levels of severity that *would* have a big impact on integrity, especially of materials, design, workmanship, and feeling. In cases, repairs to return the property to functionality would require substantial reconstruction, which is the subject of Criteria Consideration E. Rebuilt small portions or components of a property does not need to meet the consideration. However, where most of a property's physical character is not from the historic period, or a district where a central resource or significant number of resources are substantial reconstructions, may not be eligible for the National Register. Some highly deteriorated properties in a ruin condition, may no longer have significance for Criterion C, but significance for Criterion D should still be evaluated. Reconstruction of a ruin that is eligible for Criterion D might lessen its eligibility.

> For instance, on a wildlife refuge, rodent activity in a levee might be repaired without impact to its eligibility. If a flood damages a segment of a historic earthen levee, rebuilding that section of the levee to the same dimensions and material would likely not impact its eligibility. If the rebuilding included small changes to improve performance, such as making one slope shallower and adding riprap up to an average water level, the balance of integrity may be retained and the levee would remain eligible, especially if it were part of a larger system of levees across the refuge. If repair included changing the alignment of the levee, making it much larger, or making one slope entirely out of concrete that was highly visible, those substantial changes to material, design, and feeling might mean the levee would no longer be eligible (or contributing to the system). If the flood had damaged most of the levee, so that the entire levee was removed and reconstructed, that levee might no longer be eligible/contributing. If multiple levees in the system had lost integrity through substantial changes or reconstructions, the system overall might not be eligible for the National Register.

On Periods of Significance

For water conveyance systems, the start of a period of significance will typically correspond to the year when the first earth was moved to begin construction on the property or prepare the site for construction. It should not include earlier years that a project was in planning.

For Criterion A significance for historical events or patterns of history, periods of significance would include the year(s) of the significant event, or the year range when the property was in operation related to its significance. For instance, if a canal important for its association with the County Irrigation Company was begun in 1891 and the company folded in 1911, that would be the terminus of the period of significance. A canal might also have a second, discontiguous period of significance if a public agency later re-opened the canal network for a time. A riverside mill may have a period associated with early flour-milling and a later or extended period of significance if it were converted for electrical generation functions.

For Criterion B, periods of significance would include the year(s) of occupation or association with the person(s) who had made significant contributions to history at that property.

For Criterion C related to architecture, workmanship, and engineering, periods of significance typically conclude with the completion of the property’s initial construction. For water systems that were constructed over a number of years, that may be a longer period than typical for single buildings. There might also be a second, discontiguous period of significance if the system had a historically significant and substantial addition or redesign/reconstruction. For instance, a park with substantial water features might have been initially opened in 1910, but components of the park were added or rebuilt during New Deal work relief projects in the 1930s, so its periods of significance might be both 1909-1910 and 1938-1940.

For Criterion D related to the property possessing the potential for research information, periods of significance would be similar to factors in Criteria A and C, depending on whether the information potential is related to the occupation and/or operation of the property over a longer period, or related to narrower periods of engineering design or construction (like for mines, mills, etc.)

On Linear Resources

Linear resources can be single resources but are often characterized as historic districts for larger systems with branches or associated buildings and structures.

> If considered a single resource (such as a structure or site), there should be one evaluation for it as a whole. In records, written description and maps can identify components of the resource that are newer, modified outside the period of significance, deteriorated, or (archaeologically) disturbed. These can help inform assessments of the resource's integrity overall.
>
> If considered a historic district, the historic district should have an evaluation of significance and overall integrity, but each resource within the boundary should also be evaluated for whether they are associated with the area(s) and period(s) of significance and whether they have sufficient integrity to convey that association. Surveyors can recommend Contributing or Non-Contributing statuses for each resource in the district, which SDSHS will review when reviewing architectural survey records.

It is possible that defined segments or associated buildings, structures, etc. of a linear resource may have substantial significance and sufficient integrity for individual eligibility for the National Register. The relevant areas of significance, or period of significance, may be different than those for the resource overall. Such recommendations and evaluations should be included in survey records in addition to the evaluation notes for it as a part of the whole.

As with recordation, evaluating a linear resource as a complete system is ideal but not always possible because of constraints in resources or scope for survey work. The significance or non-significance of the full linear resource can sometimes be (or may have been) assumed, if there is a sufficient amount of known history, historic contexts, previously surveyed segments, and information like windshield survey or aerial imagery, and if there is consensus among those working on the records. If the full resource has not been evaluated, or an assumption cannot be made or agreed upon, the evaluation of the surveyed segment may not be possible until additional information is available.

Research Guide

If you find other research sources or collections that are useful that you would recommend to others, send ideas to shpo@state.sd.us, and we'll add them to any future updates to this context.

Databases

- Permits to Appropriate Water within the State of South Dakota
  The South Dakota Department of Agriculture & Natural Resources maintains a record of Application for a Permit to Appropriate Water within the State of South Dakota dating from 1876 to the present. Applications include information about the source of water supply, legal locations, and its intended use for irrigation, hydroelectric development, hatcheries management, and so forth, among other details. Importantly, records include maps of water sources, ditch locations, and cross section diagrams, along with details about infrastructural dimensions, diversion structures, headgates, wasteway locations, powerhouse site locations and equipment descriptions, depending on the intended use of appropriated water.

- Dry Draw Location Notices
  The South Dakota Department of Agriculture & Natural Resources maintains records of Dry Draw Location Notices dating from 1899 to the present. Location Notices include information about the location of dams built across dry draws and associated moving water infrastructure like the locations of diversion structures, ditches, flumes, and reservoirs. Records also report the acreage of water claimed annually and estimated surface area of storage basins.

- Water Well Completion Reports
  The South Dakota Department of Agriculture & Natural Resources maintains a record of Water Well Completion Reports dating from 1882 to the present day. Records are available through a map-based search, or can be located by county, legal location, ownership, driller, well type, completion date, or other search terms.

- Abandoned Wells in South Dakota
  The South Dakota Department of Agriculture & Natural Resources website provides information about the environmental and safety hazards of abandoned wells, explains property owners' legal responsibilities, and provides resources for sealing abandoned wells.

- National Levee Database
  The U.S. Army Corps of Engineers, in partnership with the Federal Emergency Management Agency, maintains the National Levee Database, which provides a record of all known levees in the United States. Records are available through a map-based search and provides a summary of the levee's authorization and construction history,

dimensions, and organizations responsible for maintenance and oversight, among other details.

- National Inventory of Dams
  The U.S. Army Corps of Engineers maintains the National Inventory of Dams, documenting all known dams in the United States that meet certain hazard potential criteria. Records are available through a map-based search, or can be retrieved by searching by name, location, or address of a specific dam. Records include information on ownership, dimensions, purpose, dam type, and year completed, among other relevant details.

Digitized Serial Collections

- Biennial Reports of the State Engineer of South Dakota (1906-1964)
  Biennial reports of the State Engineer for the years 1906 through 1964 are digitized and available to the public. Topics include irrigation, drainage, hydroelectric power, water law, and updates on work completed by the Office of the State Engineer during the years covered in a given report. Lists of each year's applications are included in tables with applicant names and the legal locations of structures.

- Annual Reports of the Department of Game and Fish of South Dakota (1909-1952)
  Annual reports written by the State Game Warden of South Dakota for the years 1909 through 1952 are digitized and available to the public. Topics include lake and waterway improvements, fish hatcheries, fishing, and legislation relevant to fishing and hunting in South Dakota.

- Research Bulletins of the South Dakota Agricultural Experiment Station (1887-2011)
  South Dakota State University's Open PRAIRIE (Public Research Access Institutional Repository and Information Exchange) provides access to research bulletins published by the Agricultural Experiment Station between 1887 and 2011. The content includes discussions of research on irrigation, crops, farming, ranching, wildlife, weather conditions, and other related topics.

- *Pahasapa Quarterly* (1912-1921) and *The Black Hills Engineer* (1923-1947)
  Pahasapa Quarterly, later renamed *The Black Hills Engineer*, was published by the South Dakota School of Mines and Technology during the early to mid-twentieth century. Articles span a wide variety of topics related to engineering and scientific advancement, including case studies on moving water sites and structures related to irrigation, fish and wildlife management, and hydroelectric developments in and around the Black Hills.

- Annual Reports of the Commissioner of Indian Affairs (1826-1932)
  Annual reports written by agents of the Office of Indian Affairs are digitized and available to the public for the years 1826 through 1932. Reports are organized by state or

territory and provide yearly updates about the general conditions on reservations, including details on farming, stock raising, and related water infrastructure.

- Water Supply and Irrigation Papers of the United States Geological Society (1896-2001)
  The U.S. Geological Survey Publication Warehouse maintains a digital record of Water Supply and Irrigation Papers from 1896 to 2001. This series of publications covers a variety of water-related topics, including hydrology, water quality, and water resources associated with moving water sites and structures.

Museum and Archival Collections

- South Dakota State Archives (SDSHS)
  The South Dakota State Archives, located in Pierre, houses numerous archival collections related to moving water sites and structures throughout the state. The Archives have some digital collections online including photographs, and numerous indexes give additional information about their full collection. There are records related to the Missouri River Dams projects and some county collections include drainage ditch records. Researchers are advised to check the Research Services page for the most up-to-date information regarding collections access.

- South Dakota Archaeological Research Center (SDSHS)
  The South Dakota Archaeological Research Center, located in Rapid City, houses numerous archaeological collections, reports, and studies for qualified professionals to access. Find information about requesting a record search from their site forms data or contact the office about setting up an appointment to visit for other research. Select publications are also available on their Resources page.

- Historic American Engineering Record (HAER)
  The Library of Congress maintains submitted HAER records (as well as those for the Historic American Building Survey (HABS) and Historic American Landscape Survey (HALS). Those for South Dakota include:
    - HAER SD-5, Lower Rapid Valley Irrigation Ditches, North & south sides of Rapid Creek, Rapid City, Pennington County, SD.
    - HAER SD-6, Hawthorne Ditch, North side of Rapid Creek
    - HAER SD-7, Cyclone Ditch, South side of Rapid Creek
    - HAER SD-8, Lower Rapid Ditch, South side of Rapid Creek
    - HAER SD-9, Rapid Valley Ditch, North side of Rapid Creek
    - HAER SD-10, St. Germain Ditch, North side of Rapid Creek
    - HAER SD-11, Lone Tree Ditch, North side of Rapid Creek
    - HAER SD-12, Iowa Ditch, North side of Rapid Creek
    - HAER SD-13, Little Grant Ditch, North side of Rapid Creek

- U.S. Fish & Wildlife Service National Fish & Aquatic Conservation Archive
  The U.S. Fish & Wildlife Service National Fish & Aquatic Conservation Archive is housed at the D.C. Booth Historic National Fish Hatchery in Spearfish. The archive is the largest collection of fisheries artifacts in the nation and include publications, periodicals, fish management equipment, and other cultural items. The archive is open by appointment only.

- Hilton M. Briggs Library, South Dakota State University
  The library maintains an open access digital collection for university publications called OpenPRAIRIE, which include the Research Bulletins mentioned above and several others.

- Beulah Williams Library, Northern State University, Aberdeen
  The library's special collections includes the Harriet Montgomery Water Resources Collection with material that includes the topics of Oahe Conservancy Subdistrict and United Family Farmers, among others.

- Local museums and libraries
  The Hot Springs Public Library's Helen Magee Collection of local history has material related to the Angostura Reservoir project.
  The Tri-State Museum in Belle Fourche has information related to the Belle Fourche Irrigation District.

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