North Loup Division

Pick-Sloan Missouri Basin Program

Kevin E. Rucker
Bureau of Reclamation

Table of Contents

North Loup Division-Pick-Sloan Missouri Basin Program

The North Loup Division controls the waters of the North Loup River and its tributaries, including the Calamus River, in central Nebraska. The name Nebraska comes from the Otoe Indian word *nebrathka* meaning "flat water," in reference to the broad shallow waters of the Platte River. The Pawnee called the Loup Rivers, *Its Kari Kitsu*, or "Plenty Potatoes Rivers," because of the abundance of wild edible tubers growing on the banks. The word *Loup* is French for "wolf." The Calamus River takes its name from the calamus plant (acorus calamus), known widely today as Sweet Flag, which was prized by Native Americans for its medicinal properties in relieving stomach disorders. The Sioux called the Calamus River *Sinke ta wote wakpa*, "food for the muskrat river." The North Loup River and its tributaries rise out of the Nebraska Sandhills' underlying Ogallala Aquifier. Since settlement in the 1 870s and 1 880s, the region's settlers contended with periodic droughts and occasional severe thunderstorms wreaking havoc with flash floods.[1]

Project Location

The North Loup Division of the Pick-Sloan Missouri Basin Program is located within the Loup River drainage basin in central Nebraska. Diversion facilities are on the Calamus and North Loup Rivers. Although situated almost wholly within the Loess Hills region, the Division borders on and receives its water supply from the Sand Hills region which thins out near Burwell at the mouth of the Calamus River. The outstanding characteristic of the Sand Hills region is the remarkably uniform flow of the Calamus River, and other streams, attributable to ground water

1. State of Nebraska, Nebraska Game and Parks Commission, "Calamus Reservoir State Recreation Area.," http://www.ngpc.state.ne.us/parks/calamus.html 2001, 1; State of Nebraska, Nebraska Game and Parks Commission, "Nebraska Canoe Trails - North Loup River," http://www.ngpc.state.ne.us/boating/canoe-nlp.html, 2001; State of Nebraska, Nebraska Game and Parks Commission, "Nebraska Canoe Trails - Calamus River," http://www.ngpc.state.ne.us/boating/canoe-cal.html , 2001.

percolation. The plan provides direct surface water service to 53,000 acres of land. Operation of the division provides a sustained ground-water supply for the development of an additional 17,000 acres by private investment. Of the 70,000 acres benefitting from project development, 43,500 are considered to be nonirrigated and 26,500 are considered to be irrigated. In 1992, the total irrigable land was 33,970 acres. The Twin Loups Reclamation District and the Twin Loups Irrigation District benefit from and pay for the irrigation facilities. In addition to irrigation, the division includes recreation and fish and wildlife benefits.[2]

Historic Setting

Geologic Setting and Physiography

The bulk of the lands of the North Loup Division are located in the Loess Hills region in Nebraska. It is characterized as gently rolling with relatively low relief, wide stream valleys, and intervening upland divide areas which are gradually dissected by erosional gullies.

This region is characterized geologically by a lack of solid surface rock. The Cretaceous Pierre shale lies at a depth of 200-600 feet below the surface and below it lie the other sedimentary rocks of the Mesozoic and Paleozoic eras and the pre-Cambrian granite. Resting uncomfortably on the Pierre shale is the continental Pliocene age Ogallala formation, the bedrock of the area. The Ogallala formation in this region varies from a compact, stratified, fine-grained sand and silt containing locally cemented beds, to layers of chalky or silicified limestone.

In an idealized geologic section, the Ogallala formation is overlain successively by the permeable Grand Island sands and gravels, Sappa silty sands possibly including the Pearlette ash bed, Crete sands, Loveland loess, Sangamon soil, Peorian loess and finally dune sand on a

2. United States Department of the Interior, Bureau of Reclamation, "Pick-Sloan Missouri Basin Program - North Loup Division, Nebraska," Bureau of Reclamation DataWeb: http://dataweb.usbr.gov/htm1/northloup.html 2001, 1.

portion of the area. These Pleistocene sediments vary in thickness from place to place and some strata are absent locally due to erosion between periods of sedimentation.

The river valleys have eroded and backfilled several times, the deepest entrenchment probably occurred during the long Sangamon interglacial period. As a result, the present North Loup River meanders through a wide valley which has been filled to a considerable depth with reworked stratified sands and silts, the products of several alluviations. Irrigable lands in the valley lie on terraces left by this sequence of geological events. Soils of the irrigable lands on the uplands are for the most part Peorian loess.

Calamus Dam and the upper reaches of Mirdan Canal are in the transitional zone between the Sand Hills region and the Loess Hills region. However, the Division is dependent upon the Sand Hills region for its water supply. Irrigable lands of the Division represent two general types of terrain. These are terraces of the major river valleys and the upland valley areas of the tributary streams. In most cases, the terraces of the major river valleys have a gentle slope. They are bordered on one side by the river and on the other by rough loess hills and are dissected at intervals by small intermittent streams. The upland valleys associated with the tributary streams, have flat to moderately rolling topography drained by many small intermittent streams.

River elevations vary from approximately 2,250 feet at the upper end of the Calamus Reservoir to 1,620 feet at Fullerton, Nebraska. Elevations of irrigable lads vary from 2,300 feet under the Geranium Canal to 1,630 feet at Fullerton.

The Sand Hills region, from which the water supply of the North Loup River originates is characterized by sandy soils and a dune type topography which usually lacks any kind of continuous drainage pattern. There is little soil cultivation with virtually the entire region being covered with a variety of native grasses.

Between the Sand Hills and Loess Hills regions is a narrow transitional zone where the loess deposits are thinly mantled by the sand, or, in places, they are exposed. Calamus Dam and Reservoir is located in this transitional zone. The irrigable lands of the division lie downstream within the Loess Hills region. Soils of the upland portion of the North Loup Division are generally deep silt barns. The valley's soils are composed of reworked valley fills making up terraces, and vary from silt barns to fine loamy sand. All soils are fertile and produce abundantly when provided with an adequate water supply.

The area's climate is subhumid with hot and dry summers with abundant sunshine. Humidity is variable with frequent sudden changes in weather. Annual precipitation averages twenty-four inches, eighty percent of which is likely during the April through September growing season. The North Loup River Valley's frost free period averages 150 days. Winters are cold, windy and relatively dry. Temperature extremes of record are -39 degrees and 114 degrees Fahrenheit.

Native vegetation consists of prairie grasses in the uncultivated areas and scattered trees along the watercourses and the ephemeral streambeds. Trees native to the area are willow, cottonwood, red cedar, and scrub oak.[3]

Prehistoric Setting

The available data suggests that North America could have been occupied by human groups anytime during the last 60,000 years, although evidence for possible occupations prior to 13,000 B.C. are not universally accepted. North American anthropologists and archaeologists divide prehistoric Native American cultural periods into four major categories: Paleo-Indian, Archaic Indian, Proto-Historic Indian, and Historic Indian.

3. Denver, Colorado, National Archives and Records Administration: Rocky Mountain Region, Records of Bureau of Reclamation, Record Group 115, "Annual Project History, North Loup Division, Pick-Sloan Missouri Basin Program, 1959," 2, 12.

The Paleo-Indian period is placed chronologically from 10,000 B.C. to 6,000 B.C. These people were big game hunters using spears to hunt the great game herds of the last ice age. With the end of ice age the vast game herds began to disappear. With the stabilization of the climate and the seasons some species, such as the mammoths, camels, and horses, became extinct, while others, such as the pronghorn antelope, bison, and mule deer expanded their range. Prehistoric peoples of the Great Plains entered into their Archaic Indian Period, 6,000 B.C. to A.D. I, supplementing their big game diet with small game, such as rabbits, squirrels, and water fowl, and gathering edible roots, berries, seeds, and nuts. Grinding stones became common and the Archaic hunting weapon of choice was the throwing stick. atl-atl, the precursor to the bow and arrow.[4]

The transition from the Archaic Indian Period to the Proto-Historic Indian Period, AD. 1 to A.D. 1500, was marked by the development of the bow and arrow, pottery, and agriculture. During the early Proto-Historic Period, A.D. 1 to A.D. 1000, people in the North Loup River Valley began clustering in small villages and lived in small, oval-shaped, pole frame structures made of mats twigs or grass plastered with mud. Besides hunting and gathering, they began tending small garden plots of maize, or corn.

The Native American culture in the later Proto-Historic Period, A.D. 1300 to 1500, in the future North Loup Division site was termed the Upper Republican Culture. These people constructed permanent, unfortified villages on terraces along the Loup River and its smaller tributary streams. These were larger settlements than before and composed of several large rectangular pit houses with some as large as thirty feet in diameter. Game hunting continued with small scale agriculture expanding to include cultivation of maize, beans, and squash - the

4. Wedel, Waldo. *Prehistoric Man on the Great Plains.* Norman, Oklahoma: University of Oklahoma Press, 1978. 80, 82, 94.

"three sisters of agriculture." Native American semi-horticultural societies harvesting the "three sisters" guaranteed themselves the basic balanced diet of nutrients to maintain good health.[5]

Historic Setting

Archaeologists believe the pre-l 500 semi-horticultural peoples in the North Loup River Valley were the ancestors of the Caddoan speaking Pawnee who settled into the future site of the North Loup Division. The name Pawnee was derived from the Caddoan word "pani" meaning "horn." This was in reference to the Pawnee custom of men shaving their heads except for a scalp lock that they stiffened with grease and shaped into what resembled a horn. The Pawnee dwelt in large, permanent, agricultural villages fortified by ditches and walls located on high terraces or bluff tops for protection. Their large, semi-subterranean, earthen, circular lodges could each shelter up to forty people.[6]

During the I7th century Europeans made inroads into the trans-Mississippi west. The French explorer Robert Cavelier de La Salle traveled from the Great Lakes down the Mississippi River to its mouth in 1682 and claimed all of the lands, including Nebraska, whose waters drained into it as French territory. La Salle named this new land Louisiana in recognition of his monarch, Louis XIV. French fur traders began making inroads up the tributaries of the Missouri River, including the Loup River basin. The first recorded European to explore central Nebraska was French officer Veniard de Bourgmont in 1724. His report noted seeing several large Pawnee villages in the region. After establishing amiable relations with the Pawnee, the French began trading muskets and other manufactured goods for furs. In 1796, American fur trader James McKay led an expedition through the North Loup River Valley, possibly as far as its confluence

5. United States Department of the Interior, National Park Service. Missouri River Basin Recreation Survey. "Outline of the Prehistoric and Historic Indian Cultures of Central Nebraska and Kansas," (U.S. Govermnent Printing Office: 1947), 11, 16.
6. "Outline of the Prehistoric and Historic Indian Cultures of Central Nebraska and Kansas," 18; Wedel, 100-2, 108.

near present day Burwell, Nebraska. In his journal, MacKay described "wild oxen," actually bison, in large numbers.[7]

In the aftermath of France's 1761 defeat by Great Britain in the Seven Years War, or French and Indian War, the French signed over in 1762 their land claims west of the Mississippi River to their Spanish allies rather than lose the territory to the British. In 1799, Napoleonic France coerced the Spanish to return the title to the Louisiana territory. Napoleon had grandiose ideas about resurrecting a North American French colony to supply agricultural goods to feed his burgeoning armies. But, the British Navy ruled the seas and it became apparent to Napoleon that Louisiana's contribution to France's war effort would be minimal.

It was time to dispose of the Louisiana territory at fire sale prices. In 1803, an American delegation sent by U.S. President Thomas Jefferson approached the French about purchasing New Orleans. Napoleon offered the incredulous delegation all of the Louisiana territory, from the Mississippi River west to the Rocky Mountains, for a paltry $15 million, three cents an acre, to double the geographical size of the young American republic. The delegation quickly consummated the deal and the North Loup River basin officially became American territory.

Also, at this time there was an ethnographic shift southward on the Great Plains to the west of the Pawnee. After acquiring horses in the 18th century, the Sioux and the linguistically related Cheyenne and Arapahoe left their traditional homeland west of the Great Lakes and migrated south into the Great Plains. The Pawnee retained possession of the North Loup River basin, but now they were perpetually at war with their new aggressive neighbors to the west.[8]

Nebraska was part of the Territory of Indiana from October 1, 1804, to July 4, 1805. From that time until December 7, 1812, it was part of the Louisiana Territory. It then became

7. "Calamus Reservoir State Recreation Area," 1.
8. Wedel, 123.

part of the Territory of Missouri until 1821, when Missouri became a state and Nebraska part of an unorganized region usually called "Indian country." American expeditions came through the area en route to the West. The 1819-1820 Stephen Long expedition used the erroneous term the "Great American Desert" in its report to describe the plains. Primarily because of this image, Nebraska was considered an unlikely environment for Euro-American agricultural settlement. To the south of the North Loup River the first settlers started arriving in the Platte River Valley by the way of the Oregon Trail in 1832. On June 30, 1834, the U. S. Congress defined the boundaries of this Indian country and passed the Indian Intercourse Act, which excluded white settlers outside of Nebraska's Platte River Valley and formalized relations between the United States and the Native Americans. The Indian superintendent at St. Louis was made governor of this area. Traffic along the Platte River's Oregon Trail surged with the start of the California Gold Rush of 1849.[9]

The Kansas-Nebraska Act of was passed by Congress in 1854 organizing the Nebraska Territory and the first session of the territorial legislature met January 16, 1856. More complete maps and descriptions were prepared of the North Loup River Valley in the mid-1850s by a young soldier, Lieutenant G. K. Warren. An officer in the elite Corps of Topographical Engineers, Warren was assigned to the Office of Pacific Railroad Surveys to map the Trans-Mississippi West and locate a railroad route to the Pacific coast.[10]

At this time eastern Nebraska was opened for white settlement with the removal of many of the regional Missouri River Native American tribes to Indian Territory in Oklahoma. They were fortunate to remain on a parcel of their traditional lands when they signed a 1857 treaty with the U.S. government. The Pawnee received a reservation along the Loup River in the

9. Vogel, Phillip E., "Nebraska," *Lexicon Universal Encyclopedia*, (New York: Lexicon Publications, Inc., 1985), 74.
10. Vogel, 74.

eastern portion of the future North Loup Division, present day Nance County, Nebraska. The treaty provided for the Pawnee to retain their traditional hunting privileges along the Loup and Republican Rivers.[11]

Beginning in 1858, gold seekers traversed Nebraska on their way to Colorado. For the most part the North Loup River Valley was bypassed with traffic concentrated on the Platte River to the south. As tens of thousands of prospectors rushed for riches in the Rockies, Native Americans on the Great Plains saw the bison herds scatter and the river valleys' grass consumed by the wagon teams of mules, horses, and oxen. The swarms of gold seekers en route to Colorado inevitably led to conflict with the Cheyenne and the Arapahoe, and their allies, the Sioux.

By 1860, settlers began moving into the lower reaches of the Loup River in Nebraska, but no settlers ventured northward into the future North Loup Division's lands until the late 1860s. The Pawnee continued to leave their Loup River Reservation on annual hunts in the Loup and Republican River valleys and generally were tolerant of the settlers. Events to the west in Colorado shattered this peaceful coexistence between Native Americans and the settlers. On November 29, 1864, Major John Chivington led the 3rd Colorado Volunteers into a massacre of peaceful Cheyenne and Arapahoe on their Sand Creek reservation in southeastern Colorado, igniting a major Indian war on the Great Plains for the next five years. Cheyenne, Arapahoe, and Sioux war parties attacked settlers and harassed emigrant trail traffic from the Platte River in Nebraska to the Arkansas River in Kansas.

The Pawnee readily agreed to the U.S. government's offer to help in the war against their traditional enemies. Pawnee under the command of William F. "Buffalo Bill" Cody slaughtered

11. "Calamus Reservoir State Recreation Area," 1; Utley, Robert M. *The Indian Frontier of the American West; 1846-1890.* (Albuquerque, New Mexico: University of New Mexico Press, 1984), 127.

fleeing Cheyenne and Sioux men, women , and children in the aftermath of the decisive 1869 Battle of Summit Springs in northeastern Colorado. After this crushing defeat, the Indian war generally moved north into Wyoming, Montana, and the Dakotas, away from central Nebraska.[12]

The first known permanent settler in the North Loup River Valley was fur trader Jack "Happy Jack" Swearengen who, in 1869, bui1t his dugout at the base of Happy Jack Peak in the chalk hills near present day Scotia, Nebraska. The amiable fur trader guided new settlers to the area and welcomed passerbys with the greeting, "Happy to see people," hence his nickname and the peak's name. The peak's base contained limestone that was later quarried for many of the area's building foundations. The first homestead claim in the future North Loup Division's lands was filed in 1871 by J. E. Cady in Howard County, adjoining the Pawnee's Loup River Reservation to the east. As settlers began to pour into the North Loup River Valley, the pioneers pooled their resources and built a bridge over the river in 1871. In 1872, a Canadian colony established itself in Howard County in the area to become known as Canadian Hill, a Seventh Day Baptist colony from Wisconsin established the town of North Loup, and a settlement of Danes from Wisconsin settled on the North Loup River near Ord.[13]

Alarmed settlers began complaining of Sioux war parties crossing their farms to attack the Pawnee on their Loup River Reservation. The U.S. Army ordered Company C, 9th Infantry, to duty along the North Loup River to prevent Sioux marauding. During the summer of 1873, the Pawnee, numbering five hundred men, women, and children, ventured out on their annual communal buffalo hunt along the Upper Republican River in southern Nebraska. On August 5, the Pawnee were attacked by a combined Brule and Ogallala Sioux war party of over 1,000

12. Utley, 131.
13. Cutler, William G., "Howard County," *Andrea 's History of the State of Nebraska* (Chicago, Illinois: The Western Historical Company, 1882); Cutler, "Loup County"; Happy Jack Chalk Mine Association, "Chalk Mines," http://www.esu 10.k12 .ne.us/~scotia/chalk.html ,2001.

warriors. The Pawnee were overwhelmed and suffered a crushing defeat at the Battle of Massacre Canyon. At least seventy Pawnee were killed and scores wounded.[14]

That same year skirmishes between the settlers and the Sioux, plus the attacks suffered by the Pawnee, led the U.S. Army in 1874 to establish Fort Hartsuff three miles north of present day Elyria in the North Loup River Valley. Named for Civil War Major General George L. Hartsuff, construction of the army post began in the fall and nine major concrete buildings were constructed fronting a 500 foot by 500 foot square parade ground. The construction of the post proved to be a godsend to the local settlers since their crops were destroyed that summer of 1874 by a plague of grasshoppers. Local men were glad to work for the government as carpenters, masons, and haulers. A man with a team of horses earned the premium wage of three dollars a day.[15]

Forced out of Nebraska by the Sioux, the Pawnee in 1875 agreed to accept a reservation to the south in Indian Territory (presently Oklahoma) along the Arkansas River. Squatters immediately moved in on the newly vacated Pawnee lands. In 1878, the lands were officially offered for sale at a government auction and the squatters secured their land titles.

Fort Hartsuff was generally manned by one infantry company of less than one hundred men. Their primary duty was scouting along the Loup Rivers for hostile Sioux. Also, the army helped civil authorities pursue horse thieves, murderers, and train robbers. In April of 1876, northwest of Burwell. the site of the future Calamus Dam, a party of Sioux warriors were harassing settlers. A detachment was sent out *from* the fort and engaged the Sioux in the Battle of the Blowout. Only one trooper, Sergeant William Dougherty, was killed in the skirmish, but

14. Utley, 137.
15. "Fort Hartsuff," *Historic Forts of the West*, http://www.ida.net/users/lamar/historicfort.html, 2001; Nebraska Game and Parks Commission, "Fort Hartsuff State Historical Park," http://ngp.ngpc.state.ne.us/parks/showpark.html, 2001.

three soldiers were awarded the Medal of Honor for gallantry: Lieutenant Charles Heath Heyl, Corporal Patrick Leonard, and Corporal Jeptha L. Lytton. In 1877, a detachment from the post pioneered a new trail from Grand Island, Nebraska, to Deadwood in the Black Hills escorting travelers to the Dakota gold fields. With the surrender of the Sioux and their subsequent confinement to reservations in the late 1870s, the fort outlived its usefulness. On April 13, 1881, orders for the abandonment of Fort Hartsuff were issued by U.S. Army's Department of the Platte. The site and buildings were sold to the Union Pacific Railroad for $5,000. The railroad decided not to build a rail line on the north side of the North Loup River and sold the fort to private individuals in 1897. In 1961, Dr. Glen Auble of Ord, Nebraska, presented the site to the state of Nebraska and it became a state historical park. Fort Hartsuff was placed on the National Register of Historic Places in l978.[16]

Previous strains of domestic wheat on the Great Plains fared poorly due to the lack of precipitation and the searing summer heat. German-Russian Mennonite immigrants introduced hard winter wheat from the Russian steppes that transformed Nebraskan agriculture. Planted in the fall, the wheat seeds lie dormant throughout the winter. The spring snows and rains nourish the hardy sprouts, which mature for harvest in June before the onset of the scorching summer heat.[17]

The blizzards of the winters of 1885-1886 and 1886-1887 devastated the Great Plains cattle industry, including Nebraska. The ensuing onset of a severe drought caught the settlers of the North Loup River Valley unprepared. Eight of the next ten years of the drought saw crop failures, plus the collapse of agricultural commodity prices during the Depression of 1893, caused some farmers to give up and move away.

16. *Ibid*.
17. Shortridge, James R. "Kansas," *Lexicon Universal Encyclopedia,* (New York: Lexicon Publications, Inc., *1985),* 21.

Gradually, branch railroads and roads extended up from the Platte into the Loup River valleys. Branch lines of Union Pacific and Burlington Railroad provided local service. By 1890, practically all of the land in these valleys was homesteaded, with most of the arable land in the future North Loup Division cultivated in dry land farms. The greatest deterrents to farming were insufficient rainfall and recurring disastrous drought. These factors and plentiful water supplies naturally led to irrigation. In *1895,* the Newton Irrigation District was organized and in the following year an earth and brush diversion structure and sixteen miles of canals built.

Times did get better for a while. After the turn of the century the rains came back and farmers' optimism soared. High agricultural commodity prices and readily available credit during World War I encouraged farmers to put more land into cultivation. Counties and towns within the North Loup Division gained in population until 1920 when nearly 40,000 people resided ii Valley, Greeley, Howard, and Nance Counties. The most intensively developed areas, towns, and transportation facilities were located in main valleys of North Loup and Loup Rivers with agriculture the leading industry. Subsequent drought, the Great Depression of the 1930s, and advanced technology in agriculture caused an outward migration. By 1950, the region's population dropped to 26,565.[18]

Elected president in 1932, Franklin Delano Roosevelt believed the government had an obligation to ease the economic stress the nation's citizenry experienced in the Depression. Previous administrations believed market forces should not be tampered with and relief efforts were best left to private charitable organizations. The severity of economic depression, however, overwhelmed the relief efforts of the private sector and Roosevelt implemented "New Deal" programs of relief, recovery, and reform. Within the U.S. Department of Agriculture, New Deal

18. "Annual Project History, North Loup Division, Pick-Sloan Missouri Basin Program, *1959,"* 3.

programs taught farmers dry land farming techniques, crop rotation, and planting of trees as wind breaks for erosion prevention. What the North Loup River basin really needed was more water for irrigation.

Since the 1930s, drought-intensive farming methods and irrigation were developed. Investigations in the area were conducted by private engineering firms beginning in 1933. In 1938, the North Loup River Public Power and Irrigation District completed a gravity project under the Public Works Administration (P.W.A.) program. The District operated three diversion structures and three main canals with attendant lateral systems between Taylor and North Loup. Organized in 1938, Almeria Public Power and Irrigation District replaced an older district. Portions of the older district's irrigation works dated back to the 1890s with 1934 the last time the system was rehabilitated. Other irrigation prior to the project was limited to pump irrigation out of river onto adjacent lands. Concern for flood control became a priority when the North Loup River Valley experienced a disastrous flood.[19]

Reconnaissance investigations initiated by Bureau of Reclamation began in 1943 and the resulting recommendations for irrigation development in the North Loup River Valley were included in Senate Document 191. In 1944 and 1946, lands as described in Senate Document No.191 within North Loup Division was authorized by Public Laws 534-78-2 and 526-79-2. A more intensive investigation was undertaken late in 1944 and a preliminary report was completed for the Lower Platte River Basin in 1951. Plans for a North Loup Division, similar to those in Senate Document 191, were included in this broad basin plan. Detailed studies in 1954 resulted in publication of a feasibility report that was included in House Document No. 491, 87th

19. "Annual Project History, North Loup Division, Pick-Sloan Missouri Basin Program, *1959,"* 4, 12.

Congress, 2nd session, dated 1962.[20]

In 1954, Twin Loups Reclamation District formed. Electors of the district approved a proposition authorizing the Twin Loups Reclamation District board to levy an ad valorem tax on tangible property. By 1958 within the North Loup Division, there were many irrigation wells and river pumps serving both valley lands and uplands. These wells and pumps served about 16,800 acres of land, but the water supplies range from poor to good. In organizing an irrigation district in 1958 for the Division about forty percent of the owners, representing 7,500 acres of irrigated land, petitioned for inclusion and for project service. During May of 1958, Geranium area and certain other tracts were annexed to the district and on November 4, 1958, Twin Loups Irrigation District was organized.[21]

In 1963, two bills H.R. 4950 and S 1242 were introduced for reauthorization of the Division. On July 17, 1970, Congressional field hearings on the North Loup Division was held at Ord, Nebraska, by the subcommittee on Irrigation and Reclamation of the committee on Interior and Insular Affairs, House of Representatives, 91st Congress, Second Session. On March 20 and 21, l972, Congress held public hearings held before thee Subcommittees of both the United States Senate and House of Representatives concerning authorization of North Loup Division. The Final Environmental Statement was filed on September 18, 1972, with the U.S. Council on Environmental Quality and made available to the public.[22]

Project Authorization

The North Loup Division was authorized by the Reclamation Project Authorization Act of 1972, Public Law 92-5 14, on October 20, 1972. The Public Works for Water and Power

20. United States Department of the Interior, Water and Power Resource Service, *Project Data*, (Denver: U.S. Government Printing Office, 1981), 948.
21. "Annual Project History, North Loup Division, Pick-Sloan Missouri Basin Program, 1976," Appendix, 1; *Project Data*, 948.
22. "Annual Project History, North Loup Division, Pick-Sloan Missouri Basin Program, 1976," Appendix, 1-2.

Development and Energy Research Appropriation Act of 1976 authorized and provided funds for start of construction.[23]

Construction History

The principal features of the North Loup Division include Calamus Dam and Reservoir (currently named Virginia Smith Dam and Reservoir), Kent Diversion Dam, Davis Creek Dam and Reservoir, five principal canals, one major and several small pumping plants, and laterals. The lengths and capacities of the canals and laterals, and the number of units, capacities, heads, and horsepower requirements for the pumping plants are as authorized and based on feasibility designs contained in House Document No. 491, the February 1971 re-evaluation statement, and the April 1978 special report.

Virginia Smith Dam - Formerly Calamus Dam

Virginia Smith Darn is located across the Calamus River five and a half miles northwest of Burwell, Nebraska. The darn is constructed of rolled earthfill with a maximum height above streambed of ninety-five feet and a crest length of *7,295* feet. The crest's elevation is 2,259 feet. The embankment volume is about six million cubic yards.

The dam's upstream slope is protected by a layer of soil cement. An impervious blanket ten feet thick extends upstream 500 feet from the upstream toe. This, together with an earthfill cutoff trench to a depth of thirty feet below the ground surface, reduces percolation under the dam. Water percolating to the darn's downstream toe is intercepted and drained by inspection and drainage wells, and a five foot thick sand and gravel drain located under the downstream toe. The dam's crest is thirty feet wide.

The river outlet works have a capacity to discharge 2,460 cubic feet per second. It

23. *Project Data,* 947.

consists of a trashrack, inlet transition, and a ten foot diameter steel lined conduit to a six and a half by ten foot outlet gate installed in a gate chamber thirty feet upstream from the dam axis. Downstream of the gate chamber is a concrete encased nine foot diameter steel pipe terminating in a wye branch, with each branch containing two five and a half foot high pressure gates in control houses.

One branch of the wye carries water to the canal outlet works. This branch can discharge 720 cubic feet per second into the Mirdan Canal when the reservoir water surface is at the bottom of conservation capacity, elevation 2213.3. After passing through high pressure gates, the water goes through a wave suppressor and then a twenty foot wide Parshall flume. Beyond the flume, the water enters the canal at water surface elevation 2206.5.

The other branch of the wye controls the water required for returns to the Calamus River. The branch to the river is used to discharge part of the inflow design flood. All natural flows of the Calamus River during July and August, and those of September when storage water is available to meet division needs, is returned to the river. Beyond the high pressure gates is a stilling basin. The releases are measured at a gaging station located two miles downstream from the damsite.

The spillway is a morning-glory type with a crest of thirty feet in diameter located in the upstream slope of the dam at elevation 2244. Spilled water drops forty-four feet into a ten foot diameter conduit extending through the dam. At the conduit's outlet end, a stilling basin dissipates the water's energy before it enters the Calamus River channel below the dam. With the use of 27,400 acre feet of surcharge, the maximum discharge through the spillway is 2,760 cubic feet per second under conditions of the inflow design flood.[24]

24. Bureau of Reclamation DataWeb, 2.

On April 13, 1976, Contract No. 14-06-700-346, not to exceed $57,170, was awarded to the University of Nebraska to conduct a survey and evaluate the architectural, paleontological and historical sites and objects located in Calamus and Davis Creek Dam areas. Contract No. 14-06-700-8467 for construction of Calamus Dam and Reservoir and access road improvement was awarded on June 30, 1976, to Paulsen Building and Supply, Inc. of Cozad, Nebraska, for the low bid of $371,583. On July 23, l976, Reclamation gave notice to proceed with a completion deadline set for July 19, 1977. The subcontractor began moving equipment onsite on August 16, 1976, and construction started the next day. Change order No.1, increased the contract by $43,672 when a peat bog area containing large amounts of decayed organic material was encountered during construction several feet below existing road surface. The contractor constructed an open drain right of existing road center line from Station 120+00 to 144+00 to the lines, grades and dimensions and disposed of the organic material. Then the open drain was refilled with selected gravel.[25]

The Calamus Laboratory, constructed in 1979, was located six miles northwest of Burwell, Nebraska, 1,700 feet downstream of Calamus Dam Station 62+00. The laboratory building was a prefabricated metal building twenty-four feet wide by sixty feet long. The laboratory portion consisted of 836 square feet and the office section contained *395* square feet. A ten foot by fifty foot mobile trailer was located next door for the inspection personnel. The Calamus laboratory building was organized for complete testing of both earth and concrete and was classified as a Class B laboratory. A maximum of twelve personnel, plus summer aides, worked out of the laboratory during the construction period.[26]

On February 7, 1980, Contract No. 0-07-DC-7405 for construction of Calamus Dam,

25. "Annual Project History, North Loup Division, Pick-Sloan Missouri Basin Program, 1976," 5-6.
26. "Annual Project History, North Loup Division, Pick-Sloan Missouri Basin Program, 1987," 108.

Stage 1, was awarded to Ames Construction Company, Inc. of Burnsville, Minnesota, for a low bid of $1,081,660. The prime contractor began on June 27, 1980, stripping topsoil along the centerline of the dam from Stations 26+00 to 28+00 and stockpiling it downstream of the dam. On August 18, 1980, the fencing crew began building 16,000 linear feet of fencing, completing it on April 9, 1980. Initial investigations incorporated into the plans showed excavation of foundation trench and river outlet works was above ground water table. But some excavations were below isolated areas of perched ground water. It became a problem using scrapers to excavate the last few feet because of extremely wet material. Finally, a large track mounted backhoe was used to remove last of material.

Excavation of spillway channel began on June 27, 1980, from Stations 20+00 to 29+00. By October, 1980, 257,000 cubic yards were excavated and stockpiled. During first week of November, the contractor moved two scrapers to the other side of river (right) and started foundation trench excavation. On November 11, the contractor encountered very spongy, unstable material and water between Stations 64+00 and 72+00. Throughout November and December and into January and February of the next year, the contractor kept encountering soft, wet material in several areas of the channel and foundation trench. It became impossible to excavate with scrapers or crawler tractors. On January 15, 1981, the contractor was directed to take necessary action to excavate the wet materials to specifications grades. But, the contractor continued excavating all of the material he could with scrapers and push Caterpillars. Finally, on March 25, 1981, contractor brought in a 235 Caterpillar backhoe to excavate remaining channel and trench. Nearly 69,000 cubic yards excavated by this method. Excavating on the north side of river on April 1, 1981, and by April 16, 1981, all excavation was completed. A total of

1,320,718 cubic yards of material was excavated during this project phase.[27]

On October 23, 1981, stripping began for the upstream blanket between Stations 43+50 and 59+00 with Caterpillar scrapers. Work progressed smoothly since very few trees existed in the damsite. Over-excavating was done to remove peat between Stations 42+50 and 44+00 of the upstream blanket area. Peat occurred in two layers separated by two to three feet of silty sand, with the peat layers itself varying in thickness from a few inches to more than a foot.

At this time structure foundation dewatering was accomplished at the spillway structure, river outlet works, and drop structure. Methods included a series of deep wells, well points, and sump pumps for removing excess water. Dewatering efforts were hampered because the contractor did very little to protect excavated areas from surface runoff. The outlet works stilling basin foundation floor was cleaned and accepted on March 17, 1983, as suitable for placement of the concrete protective coating.

Earthwork for the dam included the following: excavation for embankment foundation; spillway and river outlet works channels and structures; borrow and stockpile; construction of embankment; and soil-cement slope protection. Work was primarily accomplished using Caterpillar scrapers and bulldozers except when material was wet or the areas were confined, then draglines and backhoes were used. Monthly average production was 170,000 cubic yards of materials. 1,800,000 cubic yards of materials were excavated for the dam embankment and five million cubic yards were placed back as embankment. The contractor generally worked two ten hour shifts five to six days a week, but during closure of the dam the work crews worked a seven day a week schedule

The contractor completed excavation for the upstream blanket in April of 1982. From

27. "Annual Project History, North Loup Division, Pick-Sloan Missouri Basin Program, 1987," 61, 71-4.

Stations 46+00 to 50+00 and from 42+00 to 44+00 25,000 cubic yards of organic material were removed because it was deemed unsuitable. In May of 1982, excavation for the dam cutoff trench began. A motor grader trimmed the cut slopes as the trench was excavated. In July of 1983, the cutoff trench excavation was completed. 2,900 cubic yards of the excavated material was wet, sandy silt that did not meet requirements for zoned embankment and was hauled to waste, 1,000 feet upstream. The trench's depth ranged from zero to twenty feet and dewatering was required between stations 17+50 and 60+00. The foundation trench's sandy slopes were easily eroded by water after each rain causing an additional 7,000 cubic yards to be over excavated in areas of rainfall erosion. Work began in October of 1984 excavating the Calamus River bottom after was diverted through the dam river outlet works.[28]

Excavation began in early March of 1982 for the outlet works and Mirdan Canal branch. By the end of the month excavation for the Mirdan Canal outlet control structure was completed. Excavation for the inlet and outlet channels of the river outlet works was completed in September of 1983. Excavation for the outlet works stilling basin was in poorly graded, cross-bedded, fine to coarse sand with the structural subgrade being in the Ogallala Formation. Almost all of the excavation was accomplished with scrapers with the final grading at the structures done with hand shovels.

The contractor had difficulty scheduling meetings with the Denver design inspection team. Many times when a foundation inspection was requested, the foundation was not ready for inspection on the requested date due to inclement weather, equipment problems, and other difficulties. The contractor complained that he could not coordinate the inspections and carry on his construction work effectively because of lag time, weather, equipment problems, and other

28. "Annual Project History, North Loup Division, Pick-Sloan Missouri Basin Program, 1987," 76, 79, 82, 83.

difficulties. The problem was compounded by the fact that the contractor requested numerous small “postage stamp” inspections which greatly increased the number of foundation inspections required.

The armor layer was constructed in the spillway and river outlet works outlet channels. It extended from spillway Station 25+3 9 and the river outlet works Station 3 5+22 to the river channel. The armor layer and transition material were a pervious mixture of crushed rock obtained from Kerford Limestone Company, Weeping Water, Nebraska. Hauled to the jobsite in bottom-dump grain trucks, the placement of the armor layer started on October 22, 1983, in the spillway outlet channel.

Excavation began July 8, 1982, for slurry trench and completed on November 12, 1984. The slurry ponds were located upstream from the slurry trench and three inch pipe was used to transport the slurry to the trench excavation. The bentonite slurry consisted of water and powdered bentonite.

There were two soil-cement batch plant setups at the Calamus Dam construction site. The first setup was upstream of the blanket at Station 3 2+00. This setup was used to place soil-cement for the blanket, outlet works inlet channel, and a portion of the upstream dam face on the right side of the Calamus River during 1984. On July *5,* 1984, soil-cement placement was started on the upstream blanket 700 feet upstream on the dam centerline, Stations 23+00 to 27+60. Placement of soil-cement on the outlet works intake structure channel’s 3:1 slope was started in August of 1984. The contractor requested that he be allowed to dump soil-cement at the top of the slope and then spread and compact it with Caterpillar bulldozers. This proved to be the best method except that the finished product showed bulldozer tracks and consequently, the loose soil-cement on the surface was unacceptable. Loose soil-cement on the surface was unacceptable

for the following reasons: during normal reservoir operation, the water surface would fluctuate exposing loose unbonded soil-cement to wave action; any soil-cement particles entering the outlet works would act as an abrasive on metal work; and soil-cement material making it out of the stilling basin could plug the downstream filter system. The contractor was directed to remove loose material with a motor grader.

In September of 1984, soil-cement placement began on the upstream face of the dam between Stations 30+20 and 39+50. Throughout October soil-cement placement slowed considerably due to the specifications requirement that the soil-cement was not to be mixed or placed when the air temperature was below 45 degrees. Prior to the 1985 construction season, the soil-cement batch plant was moved to the left side of the river channel upstream of the blanket at Station 61+00. The remaining placement of soil-cement was batched at this location and placement began on May 31, 1985. By the first week of July soil-cement on the blanket was finished and all soil-cement placement was completed on August 10, 1985.[29]

On April of 1982, the concrete batch plant set up was completed, located 550 feet downstream from Calamus Dam Station 34+50. The four major structures constructed on the Calamus Dam project were the spillway, river outlet works, river channel drop structure, and the Mirdan Canal branch. Other concrete placements included the instrument houses. The first concrete protective coating placement was between Mirdan Canal branch stations 3 +04.5 and 3+55.5, placed April 14, 1982. The first structure concrete placement was between Mirdan Canal branch chute and stilling basin floor slab, Stations 2+75 and 3+50.5, on May 4, 1982. Concrete placement was completed in September of 1985. Approximately 5,961 cubic yards of concrete was placed in the river outlet works; 3,559 cubic yards in the spillway; 1,094 cubic yards in the

29. "Annual Project History, North Loup Division, Pick-Sloan Missouri Basin Program, 1987," 84, 87, 89, 94-6.

Mirdan Canal branch; 1,058 cubic yards in the drop structure; and 229 cubic yards in the outlet works gate chamber, second stage.

Major equipment at the river outlet works and Mirdan Canal branch included one six and a half by ten foot high pressure gate, four five by six foot high pressure gates, trash racks, stop logs, one ten by ten foot bulkhead gate, one six inch diameter slide gate, weather barriers, engine generator set, and heating, lighting, and ventilation systems. The river outlet works includes an intake structure with trash racks and slide gate blockout, one 120-inch interior diameter steel-lined concrete conduit under the embankment to the emergency gate chamber near mid-point of the dam, one hydraulically operated high pressure slide gate, and one 108-inch diameter steel outlet pipe. A bifurcation in the steel pipe immediately downstream of the dam toe branches the pipe to the river outlet works and to the Mirdan Canal outlet. The river outlet works branch contains a wye with two five by six foot high pressure gates. The Mirdan Canal branch continues downstream for 236 feet where the Mirdan Canal outlet control structure contains a wye with five by six foot high pressure gates. All gates are hydraulically operated. The five by six foot gates have weather barriers.

A manually operated six inch diameter slide gate is installed in the Mirdan Canal outlet stilling basin to dewater that structure when necessary. An engine generator set is housed adjacent to the outlet works control house. Other equipment includes reservoir level gage, heating, and ventilation systems. The spillway has a concrete encased 120-inch interior diameter steel pipe. Crawler mounted and truck mounted cranes were used for hoisting and installing equipment. Electrical service is provided by Loup Valley Rural Public Power. The service is supplied by overhead lines to a terminal pole near the river outlet works control house.

In July of 1983, during pipe installation in the outlet works downstream of the six and a

half foot by ten foot gate, two problems were encountered. The first consisted of a misalignment of the bolt holes of the downstream gate transition and the matching flange of the outlet pipe. The transition was drilled with a bolt hole on the centerline while the pipe flange was drilled to be installed with two top bolts straddling the centerline. Reclamation accepted the contractor's proposal to cut off the pipe flange between the flange and the manhole, rotate the flange to align with transition, and reweld the pipe flange to the pipe. The second problem consisted with the wye at the Mirdan Canal branch being two inches short, and the section of embedded pipe upstream of the wye being off line and grade. Reclamation accepted the contractor's proposal to cut the embedded pipe upstream of the wye, add a filler ring, and adjust the alignment and grade during the subsequent rewelding. Hydrostatic testing of all river outlet pipe downstream of the gate chamber was completed on January 6, 1984.[30]

Approximately 368,000 cubic yards of material were excavated from the relief well collector system, drainage trench, and river channel. Most of the material was excavated using Caterpillar 627B scrapers and bulldozers. The excavated material from the river channel consisted of debris, roots, stumps, and other organic material and most of this was hauled to waste. Excavated material from the relief well collector system and the drainage system was hauled and placed as miscellaneous fill in the old river channel downstream from the dam. Beginning in October of 1983, the contractor placed miscellaneous fill in the downstream old river channel. 155,000 cubic yards of material was placed in a berm 5,000 feet in length along the downstream portion of the dam. Drainage material was hauled to the fill area from 95,000 cubic yard stockpile left from Stage 2 contract. In order to alleviate a shortage of drainage material of 4,000 cubic yards, the contractor proposed substituting washed Zone 2 material for

30. "Annual Project History, North Loup Division, Pick-Sloan Missouri Basin Program, 1987," 112, 121, 123.

drainage material at the downstream end of the horizontal drainage blanket. Reclamation approved this substitution provided that the minimum six foot thickness of the drainage blanket was always maintained.

A fatal accident occurred on April 18, 1985, on the Stage 3 contract. A maintenance manager for Industrial Constructors Corporation was killed in an accident at the Zone 2 wash plant located along the northeast boundary of the borrow area east of Calamus Dam. The contractor had decided to move the stacking conveyors, and a P. & H. Model R-200 crane was being used to relocate them. While moving the conveyors with the crane, the boom came into contact with a three phase 12,470 volt phase-to-phase and 7,200 volt phase-to-ground line being used as power for the wash plant. The victim was holding onto the twenty-five foot conveyor section when the crane boom made contact with the power line causing him to be electrocuted. On September 29, 1984, Calamus River diverted through river outlet works. The final cost was $463,319,878 for the Calamus Dam and Reservoir.[31]

Kent Diversion Dam

Kent Diversion Dam is located in Loup County on the North Loup River eight miles upstream from its confluence with the Calamus River. It is a concrete ogee structure with a height of nine feet above streambed. Its length is 1,000 feet and the canal headworks capacity is 350 cubic feet per second. The structure is used to desilt and divert water from the North Loup River into the Kent Canal.[32]

Davis Creek Dam

Davis Creek Dam is located on a tributary to Davis Creek about five and a half miles south of

31. "Annual Project History, North Loup Division, Pick-Sloan Missouri Basin Program, 1987," 137, 138, *156;* "Volume II, Appendix C, Final Construction Report, North Loup Division, Pick- Sloan Missouri Basin Program, 1992," 1.
32. Bureau of Reclamation DataWeb, 2.

the city of North Loup, Nebraska. The dam and blankets near each end are protected by either a three foot layer of rock riprap or a layer of soil-cement. The downstream slope is covered with twelve inches of topsoil and seeded to grass. Drainage is accommodated by a sand and gravel blanket with a tile toe drain, located in the dam's downstream toe. The embankment has a volume of 3,350,000 cubic yards.

A single canal outlet has the capacity to discharge four hundred cubic feet per second with water in the reservoir at the bottom of the conservation capacity, elevation 2,003 feet. It consists of a trashrack, inlet transition, and a six foot diameter conduit to a five foot square high pressure control gate installed in a gate chamber fifty feet upstream from the dam's crest. Below the control gate is a seventy-two inch diameter steel pipe in a ten foot, four inch concrete conduit. The steel pipe terminates in a wye with each branch containing a three and a half foot square, high pressure regulating gate. Water from the outlet passes into a spilling basin to dissipate energy before entering the Fullerton Canal at water surface elevation 1980.

The spillway is a rectangular drop inlet covered by a trashrack with a crest elevation of 2,076 feet. A concrete conduit four and a half feet in diameter extends from the bottom of the drop inlet to a stilling basin beyond the downstream toe of the dam. The basin dissipates the energy in the water before it discharges into an excavated channel that joins the Fullerton Canal.[33]

Canals, Laterals, and Pumping Plants

Six canals serve the lands of the North Loup Division. They are the Mirdan, Kent, Geranium, Scotia, Fullerton, and Elba Canals, and range in capacity from twelve to 720 cubic feet per second and in length from four to forty-nine miles. Concrete lining or compacted earth

33. Bureau of Reclamation DataWeb, 3.

lining were required for some reaches of the canals. The lateral system consists of 146 miles of laterals with capacities ranging from four to eighty cubic feet per second.

One large and one small pumping plant were constructed. Geranium Pumping Plant is located less than a mile west of Mirdan Canal, southwest of Elyria, Nebraska. The pumping plant permits irrigation of 11,746 acres that are too high an elevation to be irrigated by gravity service. The plant is capable of lifting 200 cubic feet per second at a dynamic head of 130 feet. The average annual power requirements for this plant is four million kilowatt-hours, with a peak demand of 3,460 kilowatts. Power from the Pick-Sloan Missouri Basin Program serves the plant. The smaller pumping plant is located on Geranium Lateral, and has a capacity of thirteen cubic feet per second.

Mirdan Canal

Mirdan Canal conveys water from Calamus Dam for about fifty miles and terminates at Davis Creek Reservoir. Its water is delivered to project lands in Sections 2 and 3. Section 1 starts at the end of the outlet works at Calamus Dam is nineteen miles long and includes the following types of work and structures: canal sections; inline Parshall flume; pipe siphons; radial gate check structure; stoplog check structure; trapezoidal wash siphon; trapezoidal county road crossing; Kent Canal inlet; inlet from Taylor-Ord Canal; turnouts to Taylor-Ord laterals; Taylor Ord laterals relocations; outlet to Taylor-Ord Canal; Geranium Canal turnout; animal escapes; wasteway; overchute; pipe culverts; detention dike culverts; irrigation and waterline crossings; interceptor drains and divert drainage; drain inlets; bridges; floatwells; right-of-way; safety fencing; floats.

Twenty-four miles of eight inch through thirty-nine inch diameter pipe, with hydrostatic heads ranging from twenty-five to 250 feet, were required to construct sixteen laterals.

Appurtenant pipeline features include line and saddle meters, air, butterfly and gate valves, and blowoffs and drains.

On September 16, 1981, contract for construction of Mirdan Canal, Section 1, was awarded. Section 1 begins at Station 24+ 5.76 and ends at 104 1+56.47. Construction of the reach where most of the subsequent subsidence problems have occurred, between Station 600+00 and 717+00, began with clearing in May of 1982 and the earthwork was completed in October. On July of 1983, concrete lining began and was completed in August. Section I was completed on August 18, 1986.

Section II and III, awarded on February 22, 22, 1984, and was completed on June 9, 1987. Section II ends at Station 1657+25.80 and Section III ends at Station 2541+00. Nothing occurred during construction to indicate that foundation problems might exist anywhere in this reach of the canal.

In June of 1983, construction of siphon was completed and use began immediately. Canal flow was 150 cubic feet per second for delivery to Taylor-Ord system. Subsidence at bottom of structure required grouting and was fixed May and June 1986.[34]

Geranium Canal

On March 14, 1985, the Geranium Canal contract was awarded and the project completed on July 9, 1987. Located southwest of Ord, Nebraska, in Valley County, the canal originates at Station 990+00 on Mirdan Canal, Section 1, and ends at Station 1444+75 on Mirdan Canal, Section 2. The open canal part of the system includes fifteen miles of canals varying in capacity from 200 cubic feet per second to thirteen cubic feet per second, thirty-three cross-drainage

34. "Construction Considerations, Mirdan Canal - Section 1, North Loup Division, Pick-Sloan Missouri Basin Program, October 1981 ," 1; "Construction Considerations, Mirdan Pipe Laterals, Sections 1 and 2, North Loup Division, Pick-Sloan Missouri Basin Program, April 1983," 2; "Subsidence Report, Mirdan and Geranium Canals, North Loup Division, Pick-Sloan Missouri Basin Program, May 1989," 31.

culverts, ten in-line siphons, three check structures, twenty-nine turnouts, five farm bridges, five county road bridges, various fencing, operations and maintenance roads, berm drains, and divert and interceptor drains. The open lateral part of the system includes six miles of laterals varying in capacity from fifty cubic feet per second to eight cubic feet per second, seven in-line siphons, three pipe drops, three cross-drainage culverts, two ramp flumes, nine farm turnouts, and five sublateral turnouts, berm drainage, side channel emergency wasteway, county road relocations, and other minor structures. The pipe laterals include twenty-five miles of eight inch through thirty inch diameter pipe, air valves, blowoffs, pipe vents, meters, valves, drains, and fittings.

The Geranium Pumping Plant is a wet sump, outdoor type, reinforced concrete structure that has the pumping units arranged in double echelon form. Lateral G-7.0 Pumping Plant has a regulating reservoir.

Leakage was detected at siphon at Station 179+90 during testing due to uneven settlement. On July 1987, subsidence near Station 38+00.[35]

Scotia Canal

On November 14, 1986, the construction contract for the Scotia Canal was awarded. Scotia Canal originates at Station 1593+96.33 on Mirdan Canal, Section 2, and ends at Station 1844+26 on Scotia Pipe Canal. The open canal portion of the system includes thirty-one miles of canals has a design capacity of 190 cubic feet per second at its beginning and forty-two cubic feet per second capacity where the open canal ends and the canal's pipe portion begins. The canal carries irrigation water to 10,197 acres of project lands. Features include forty-four cross-drainage culverts, twenty-six inline siphons, five inline pipe drops, one inline pipe chute, fifty-seven turnouts, two farm bridges, one county road bridge, four county road crossings, three

35. "Construction Considerations, Geranium Canal, Laterals and Pumping Plants, North Loup Division, Pick-Sloan Missouri Basin Program, December 1984," 2.

farm road crossings, various types of fencing, operations and maintenance roads, berm drains, and divert and interceptor drains. The work associated with the pipe canal and laterals include thirty miles of eight and thirty inch diameter pipe, air valves, blowoffs, pipe vents, meters, valves, drains, and fittings. Twenty-four lateral turnout structures are located off the open canal and are equipped with trash racks and slide gates. Eleven of the twenty-four structures have adjacent meter wells with associated open-flow meters. One of the eleven meter wells is for operational wasteway pipeline located off the Lateral S-3 1.2 turnout structure. Laterals S-3 .7, S-18.5, and S-26.9 tee off canal inline siphons and have no turnout structures associated with them.

Construction problems were encountered between Stations 75 5+00 and 780+00 when sinkholes developed. Upon examination it was determined these were caused by old animal burrows dug hundreds of years ago.

Scotia Canal project was accepted as completed on January 10, 1989.[36]

Fullerton Canal

In November of 1989, designs and specifications were completed. Construction began in late February of 1990, with a September of 1992 planned finish. Section 1 of the Fullerton Canal is thirteen miles long and has a capacity varying from 400 cubic feet per second where it begins at Davis Creek Dam to 270 cubic feet per second at the outlet south of the North Loup Siphon. Fullerton Canal's Section 2 is fifteen miles long and capacity varies from 270 cubic feet per second at the upstream end to 200 cubic feet per second at the downstream end. Section 3 is nineteen miles long and its capacity varies from 200 cubic feet per second at the upstream end to thirty-six cubic feet per second at the downstream end. The canal's Section 3 has vertical cuts

36. "Construction Considerations, Scotia Canal and Laterals, North Loup Division, Pick-Sloan Missouri Basin Program, November 1986," 2; "Final Construction Report, Scotia Canal and Laterals, North Loup Division, Pick-Sloan Missouri Basin Program, 1989," 34.

above the operations and maintenance road as deep as sixty feet and fills as high as thirty feet.

Fullerton Canal features include: forty-one culverts; eight county road bridges; nine farm bridges; thirty-eight siphons; fifty-three farm and lateral turnouts from the canal; nine farm and lateral turnouts from siphons; four wasteways; one pipe canal inlet; two overchutes; two stream channelizations; and one wave suppressor.

Fullerton Pipe Canal is located at the downstream end of Canal Section 3 and is four and a half miles long and varies from twenty-seven inches down to eight inches in diameter. Flow rates in the pipe canal vary from twenty-four cubic feet per second down to two cubic feet per second. There are forty-five pipe laterals constructed under these specifications with a total length of twenty-six and a half miles. The pipe laterals vary in diameter from twenty-seven to eight inches with capacities of twenty-one to two cubic feet per second. The pipe canal and laterals serve a total of 163 deliveries ranging in size from eight to fourteen inches with capacities varying from two to seven and a half cubic feet per second.

Eight ten by six and a quarter foot radial gates are required for the check inlet structures to control water surface elevations and to regulate the flow of water through the Fullerton Canal. Cady Creek wasteway consists of an oveflow weir, a bypass pipe (with flowmeter) and a wasteway gate and pipe. The wasteway pipe's end is a combination baffled outlet and baffled apron drop. A trashrack is installed to prevent trash from entering the flowmeter pipe and affecting the flowmeter. Cady Creek flows intermittently during rainy periods. Water from the wasteway will drastically alter the current creek condition, changing the creek from being predominately dry to predominately wet.[37]

Elba Canal

37. "Design Summary, Fullerton Canal and Pipe Laterals and Fullerton Pipe Canal, North Loup Division, Pick-Sloan Missouri Basin Program, November 1992," 1, 2, 12, *35*, 38.

Elba Canal's designs and specifications were completed in November of 1989. Construction began in late February of 1990, with a targeted finish of September of 1992. The canal branches off from Fullerton Canal to serve lands south of North Loup River near Elba, Nebraska. It is four miles long with a capacity varying from eighty-five cubic feet per second where it begins to fifty cubic feet per second where the open canal ends and the pipe section begins.[38]

Kent Canal

Kent Canal extends from Kent Diversion Dam for 4.6 miles to Mirdan Canal on the northern side of the North Loup River. On March of 1992 work started and completed on October 1993 work completed. The canal is unlined from its beginning at Station 10+93.13 to Station 61+29.25. The unlined canal between Stations 25+50 and 48+50 was constructed with increased width and depth in order for this portion of the canal to serve as a desilting basin. The canal has a capacity of 350 cubic feet per second. From Station 61+29.25 to its end at Station 254+3 8.96 the canal is lined with a sand and gravel protected membrane. The membrane lined canal has a bottom width of sixteen feet with water depth of six feet at full capacity. To control water surface elevation at Kent Diversion Structure and to regulate flow into Kent Canal three twenty-five by eight and a half foot river radial gates, one fifteen by eight and a half foot sluiceway radial gate, and one twenty by five foot headworks radial gate are required.[39]

Post Construction History

Bureau of Reclamation has been working with the Twin Loups Irrigation District to improve operations of the Fullerton Canal system. The district and Reclamation entered into a

38. "Design Summary, Fullerton Canal and Pipe Laterals and Fullerton Pipe Canal, North Loup Division, Pick-Sloan Missouri Basin Program, November 1992," *35; Project Data*, 950.
39. "Design Summary, Kent Canal and Diversion Structure, North Loup Division, Pick-Sloan Missouri Basin Program, June 1992." 1, 20, 37.

cooperative agreement that would place three pneumatic bladder overflow check structures in Fullerton Canal, which will improve the operational flexibility of Fullerton Canal by reducing the need for operational spills and reducing the downstream seepage. One of these structures was installed in the spring of 1998, and the other two were installed in the fall of 1999.

Emergency Action Plans for Virginia Smith (formerly Calamus) and Davis Creek Dams were updated and exercised on May 26, 1999. An emergency radio has been installed at Virginia Smith Dam as a backup communication system to contact local 24-hour warning points.

Filling of Calamus Reservoir to the normal wintering level was delayed in the fall of 1999 so that the Nebraska Game and Parks Commission could make boat repairs to a boat ramp. The reservoir at the end of the year was at 2234.33 feet, the lowest year end level since initial filling.

Repairs to Mirdan Canal were made during the fall of 2000 and continued into the spring of 2001. These repairs restricted diversions into Davis Creek Reservoir.[40]

Settlement of the Project

The North Loup River Valley's arable land was virtually all settled by the 1890s. Due to existing settlement, no new lands were developed in conjunction with the project.

Project Benefits

Irrigation

In Twin Loups Irrigation District during 1990, there were 234 farms receiving project waters to irrigate 33,970 acres. During that year 14,093 bushels of corn, 1,846 bushels of soybeans, 1,305 tons of hay, and ninety-eight bushels of sorghums were harvested. Land irrigated in 1999 totaled 30,927 acres above Davis Creek Reservoir and 17,942 below the

40. United States Department of the Interior, Bureau of Reclamation, Niobrara-Kansas AOP, "Chapter II - Niobrara and Lower Platte River Basins," 2001, 4, 5. http ://www.gp.usbr.gov/aop/nk/9900/chapter2.htm

reservoir with the 1995 completion of the Fullerton Canal.[41]

Recreation

Virginia Smith Reservoir (formerly Calamus) is open twenty-four hours with good access roads. The reservoir peaks at 5,125 surface acres and experiences moderates fluctuations being in irrigation supply reservoir. Recreational opportunities include boating, camping, wildlife viewing, picnicking, and fishing. Year round fishing has anglers casting for walleye, northern pike, largemouth bass, rainbow trout, and crappie.

Davis Creek Reservoir is open twenty-four hours with fair access roads. Reservoir peaks at 1,140 surface acres, but since it functions as a irrigation supply reservoir it experiences extreme fluctuations. Recreational opportunities include boating, camping, hiking, picnicking, water sports, wildlife viewing, and fishing. Fishing season is year round with available species including largemouth bass, walleye, crappie, yellow perch, channel catfish, and bullhead. Hunting is available to the public for deer, waterfowl, and upland game.[42]

Conclusion

The North Loup Division of the Pick-Sloan Missouri Basin Program has changed the economic well-being of central Nebraska. Participating farmers in the division's irrigation district enjoy today the benefits of a guaranteed source of dependable water enabling them to more than double their crop yields. The threat of flash floods is but a memory with the construction of dams on the North Loup River. Recreational activities centered on the reservoirs has enhanced the quality of life for this rural region's residents. Even though the North Loup Division does not rate in the top tier of the Bureau of Reclamation's projects, it has had an

41. United States Department of the Interior, Bureau of Reclamation, *1990 Summary Statistics: Water, Land and Related Data*, 294; "Chapter II - Niobrara and Lower Platte River Basins," 4.
42. United States Department of the Interior, Bureau of Reclamation, "Calamus Reservoir," 2001. http://www.recreation.gov/detai1.cfm?ID=73 United States Department of the Interior, Bureau of Reclamation, "Davis Creek Reservoir," 2001. http://www.recreation.gov/detail.cfm?1D=74

immense positive impact on this region.

About the Author

Kevin E. Rucker was born in Clarinda, Iowa, but raised in Colorado. Rucker received his Bachelor of Science in Marketing from Metropolitan State College of Denver in 1993, Bachelor of Arts in History from University of Colorado at Denver in 1995, Master of Arts in History from the University of Colorado at Denver in 1997. Rucker is currently enrolled in the Ph.D. program of the Graduate School of Public Affairs at the University of Colorado at Denver. He teaches European, American, and Colorado history at Metropolitan State College of Denver, Red Rocks Community College, and Arapahoe Community College. A published author with four books, Rucker served on the Jefferson County Historical Commission from 1997 to 2001. Rucker is married to Darcey, an environmental science major at Metropolitan State College of Denver, and has three children and resides in Arvada, Colorado.

Bibliography

Archival Collections

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

"Annual Project History. North Loup Division. Pick-Sloan Missouri Basin Program. 1959-92.

Government Documents

State of Nebraska, Nebraska Game and Parks Commission. "Calamus Reservoir State Recreation Area.," 2001. http://www.ngpc.state.ne.us/parks/calamus.html.

State of Nebraska, Nebraska Game and Parks Commission. "Fort Hartsuff State Historical Park," 2001. http://ngp.ngpc.state.ne.us/parks/showpark.ihtml.

State of Nebraska, Nebraska Game and Parks Commission. "Nebraska Canoe Trails - Calamus River," 2001. http://www.ngpc.state.ne.us/boating/canoe-cal.html.

State of Nebraska, Nebraska Game and Parks Commission. "Nebraska Canoe Trails - North Loup River," 2001. http://www.ngpc.state.ne.us/boating/canoe-nlp.html.

United States Department of the Interior, Bureau of Reclamation. *1990 Summary Statistics: Water, Land and Related Data.* Denver [1991].

United States Department of the Interior, Bureau of Reclamation. "Davis Creek Reservoir," 2001. Http://www.recreation.gov/detail.cfm?ID=74

United States Department of the Interior, Bureau of Reclamation, Niobrara-Kansas AOP. "Chapter II - Niobrara and Lower Platte River Basins," 2001. http://www.gp.usbr.gov/aop/nk/990/chapter2.htm.

United States Department of the Interior, Bureau of Reclamation. "Pick-Sloan Missouri Basin Program - North Loup Division, Nebraska," 2001. http://wwwdataweb.usbr.gov/html/northloup.html.

United States Department of the Interior, Bureau of Reclamation. "Virginia Smith Reservoir," 2001. http://www.recreation.gov/detail.cfin?ID=73

United States Department of the Interior, National Park Service. "Outline of the Prehistoric and Historic Indian Cultures of Central Nebraska and Kansas," *Missouri River Basin Recreation Survey*. U.S. Government Printing Office, 1947.

United States Department of the Interior, Water and Power Resources Service. *Project Data.*

Denver: U.S. Government Printing Office, 1981.

Books

Cutler, William G. *Andreas ' History of the State of Nebraska.* Chicago, Illinois: The Western Historical Company, 1882.

Utley, Robert M. *The Indian Frontier of the American West: 1846-1890.* Albuquerque, New Mexico: University of New Mexico Press, 1984.

Shortridge, James R. "Kansas," *Lexicon Universal Encyclopedia.* New York: Lexicon Publications, Inc., 1985.

Vogel, Phillip B. "Nebraska," *Lexicon Universal Encyclopedia.* New York: Lexicon Publications, Inc., 1985.

Wedel, Waldo. *Prehistoric Man on the Great Plains.* Norman, Oklahoma: University of Oklahoma Press, 1978.

Articles

"Fort Hartsuff," *Historic Forts of the West,* 2001. http://www.ida.net/users/lamar/historicfort.html

Happy Jack Chalk Mine Association. "Chalk Mines," 2001. http://www.esu1O.k12.ne.uskscotialchalk.html.

Index