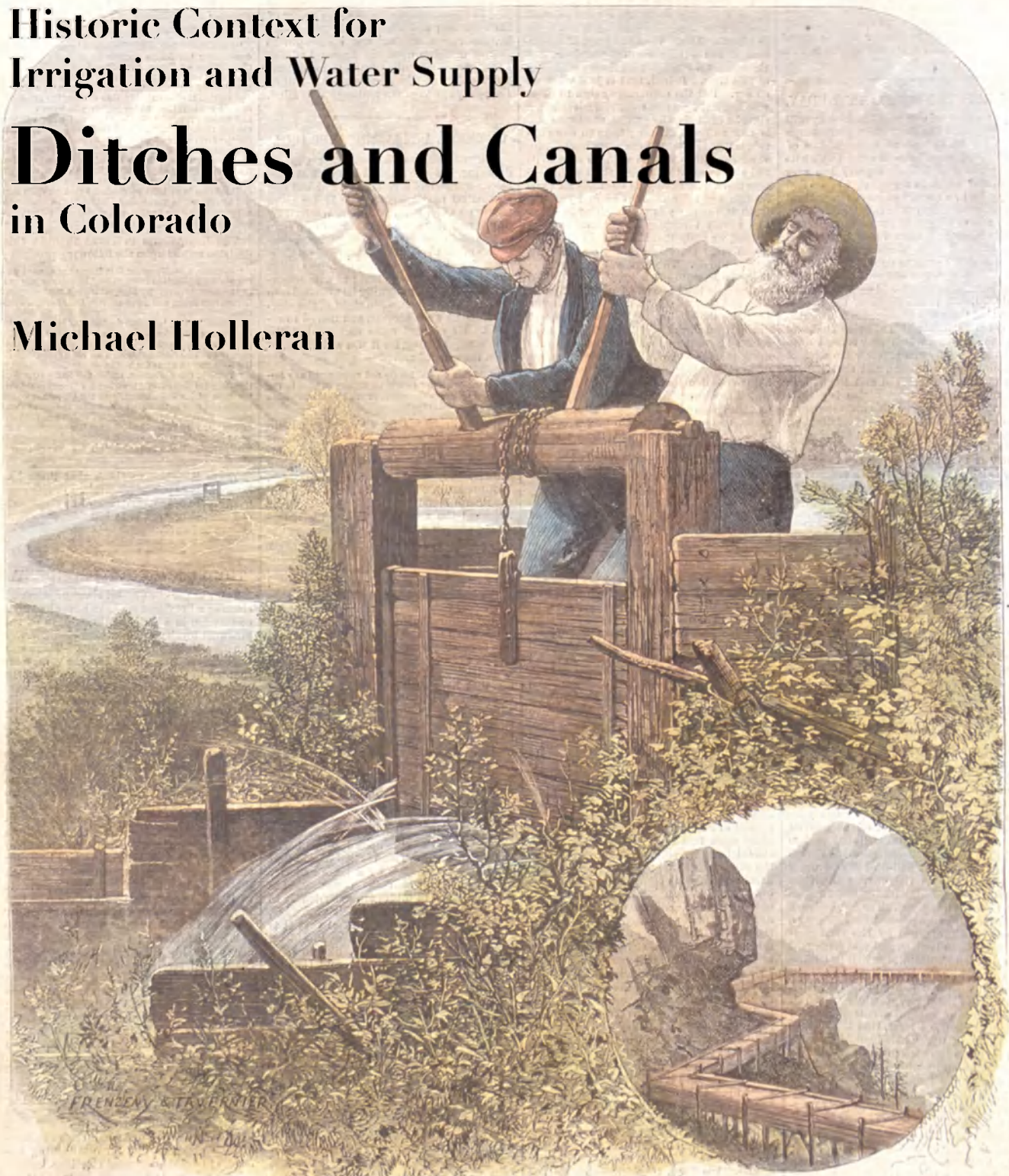


Historic Context for
Irrigation and Water Supply

Ditches and Canals in Colorado

Michael Holleran



IRRIGATION IN COLORADO—LETTING WATER INTO A SIDE SLICE-WAY.—[SEE PAGE 114.]

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in Colorado

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University of Colorado at Denver and Health Sciences Center

June 2005

with support from the State Historical Fund, Colorado Historical Society (2001-02-068)

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Acknowledgements

Manish Chalana and **Kris Christensen** contributed substantial portions of the research and writing for this report.

Big thanks to Neal Ackerly for all his help. At the University of Colorado, thanks also to Michael Hinke, Brian Mulle, Patty Limerick, Laurine Speights, Kate Kienast, and Chris Meschuk. At the Colorado Historical Society, thanks to Estella Cole, Dale Heckendorn, Modupe Labode, Thomas Carr, Susan Collins, Todd McMahon, and Mark Wolfe.

Thanks to Britt Storey, Toni Rae Linenberger, and Christine Pfaff at the Bureau of Reclamation; Christine Whitacre at the National Parks Service; Carl Barna at the Bureau of Land Management; Doug Stenzlow at the Colorado Department of Water Resources; Wendy Hall at the Boulder Carnegie Library; Dianna Litvak at CDOT, and to Michael Doseh and Michelle Clark at the Olmsted Archives. Thanks to James Wescoat, Dan Tyler, Alf Simon, Attilio Petruccioli, Andrew Gulliford, and Mark McCaffrey. Thanks to Karen Rademacher, John McKenzie, Catherine Long Gates, Bob Crifasi, Jerry Foster, Jim Snow, Carol Ellinghouse, Sarah Binford Avery, Delani Wheeler, Boyd Sheets, Walter Epley, John Wilkins-Wells, Tom Waymire, Greg Silkensen, Ned Williams, Karl Anuta, Everett Long, Kurt Gerstle, Pete Gleichman, Cindy Carlisle, Tom Cowing, Bill Arndt, Art Wainwright, Eric Pommer, Sarah Wise, Jerry Davis. Many of these are ditch folks who have taken an interest in this project, and I hope they will feel their efforts have been worthwhile.

Louis Charles McClure, an unknowing collaborator (who died the year after I was born), took the perfect photos for this context, a century ago. Finally, thanks to Judith Morrow Sanders for her help and for her patience.

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Introduction

Most of Colorado is semi-arid, with average precipitation of ten to twelve inches on the eastern plains, and as little as five inches in the San Luis Valley, but up to fifty inches in the mountains. Precipitation in the mountains falls mainly as snow in the spring, and melts throughout the summer, which is the growing season below on the plains and in the valleys. Colorado was settled by redistributing this water through irrigation, bringing mountain runoff to fields in the sunny lowlands by means of ditches and canals.¹ Some of Colorado's settlers came north from New Mexico and brought a centuries-old irrigation culture, with roots going back still further in the Old World. Others came from the humid East and Midwest of the United States and found an unfamiliar climate here, but learned from those among them who had experienced irrigation in California, Utah, New Mexico or Texas.

Many of these settlers came in the Gold Rush of 1859 and first built water works for mining rather than agriculture. Over the years other ditches and canals supplied water for towns, for water-powered mills, for industrial process water and for hydroelectric generation. Many systems were built for multiple purposes, or were adapted to new purposes as things changed around them. Agriculture was and remains the biggest use of diverted water in Colorado and the main purpose of most of the delivery systems.

This report is intended generally as an overview of the history of Colorado's water conveyance systems and the kinds of historical resources that remain as their legacy, and specifically as an historic context to aid in evaluating the eligibility of these resources for listing on the National Register of Historic Places.

In 1860, in the early stages of both Hispano and Anglo settlement in Colorado, about 35,000 acres were irrigated through a few dozen mutual ditches and probably a greater number of individual farm ditches that have gone unrecorded. By 1890 the total was over a million acres,² and more than 4,000 ditch owners had filed for adjudication of

¹ There is no clear definition distinguishing "canals" from "ditches," yet the two terms are not quite interchangeable. "Ditch" is the more inclusive term, and is sometimes used to refer to all water conveyance channels no matter what size. "Canal" generally refers to a larger channel, but that may mean anything from 10 to 150 feet in width.

² Royce J. Tipton, "More Efficient Use of Water Resulting from Consolidation of Ditches and Regulation of Water Supplies," in Colorado Water Conservation Board, and Colorado State University, *A hundred years of irrigation in Colorado; 100 years organized and continuous irrigation, 1852-1952* (Fort Collins: Colorado Water Conservation

water rights. Ten years later Colorado passed California as the state irrigating the greatest land area.

By 1950 the total irrigated acreage tripled to 3.2 million, served by 9,258 “irrigation enterprises” (this number includes some reservoir companies that were distinct from ditch companies) running about 17,000 miles of canal.³ In 2000, the Colorado Water Resources Department database listed 22,800 ditches and canals.⁴ Of these, 17,500 have appropriation dates before 1950. That total includes a handful of great canals that shaped the development of the state, such as the Rio Grande Canal in the San Luis Valley, the largest in the United States when it was completed in 1884, or the canal systems that run for more than a hundred miles along the Arkansas and South Platte Rivers, or the biggest systems of all, the Colorado-Big Thompson and other Bureau of Reclamation projects. The total also includes thousands of mutual ditches that bring water to their shareholders, beginning with the 1852 San Luis People’s Ditch. And it includes thousands of individual ranch ditches that may carry water a hundred yards to a stock pond. The physical legacy of water diversion systems in Colorado also includes the remains of probably thousands of little ditches that watered a homestead, townsite, or mining claim that did not survive long enough to enter the state’s water adjudication system.

This report is organized in four parts. The first is a history of Colorado’s water systems. It is generally chronological, but also considers thematic topics such as water rights and administration, that are only loosely tied to a particular period. The second part is an illustrated guide to the parts of ditch and canal systems and other property types that may be associated with them. The third section describes National Register of Historic Places registration requirements: how to evaluate ditch and canal systems for NRHP eligibility, including the criteria for significance, and how to evaluate whether ditch systems and their components retain the historical integrity required for NRHP eligibility. Finally, a research guide includes both a bibliography and an introduction to other sources on ditch history.

Board and Colorado Agricultural and Mechanical College, 1952), 42; Colorado State Engineer, *Fifth Biennial Report, 1889-90* (Denver, 1890), 533.

³ Tipton, in *A hundred years of irrigation in Colorado*, 4.

⁴ This number is inflated by perhaps a few hundred, because canals are listed more than once if they cross water district boundaries.

1. History

Before 1848

Prehistoric inhabitants of the American Southwest constructed water distribution systems, some of them extensive, but most of Colorado is outside the region of these cultures. One exception was the water system at Mesa Verde, which included check dams, small diversion ditches and reservoirs.⁵ Any pre-European water-related resources are treated in Colorado Historical Society archaeological context reports.⁶

The earliest Colorado irrigation ditches in historical times were short-lived features of aborted settlements in the Spanish and Mexican periods, or served Anglo-American trading posts during the same period. The first were at the San Carlo de Jupes settlement next to the Arkansas River about eight miles east of present-day Pueblo, begun in 1787 but abandoned just a few months later. In the Arkansas Valley at Bent's Old Fort, the Bent brothers irrigated 40 acres beginning in 1832.⁷ A ditch at the early settlement of Pueblo operated from 1841 until a massacre by the Utes in 1854. John Hatcher, a Bent brothers foreman, established a supply station in 1846 on the Purgatoire River twenty miles downstream from Trinidad and dug a ditch to irrigate about 60 acres. He abandoned it about a year later after conflict with the Indians. J. W. Lewelling revived the ditch in 1865. This may be the oldest operating (though not continuously operating) ditch in Colorado.⁸

⁵ Wright, Kenneth R. *Water for the Anasazi: How the Ancients of Mesa Verde Engineered Public Works* (Boise: Public Works Historical Society, Essays in Public Works History no. 22, 2003).

⁶ Frank W. Eddy, Allen S. Kane, and Paul R. Nickens, *Southwest Colorado Prehistoric Context: Archaeological Background and Research Directions* (Denver: Colorado Historical Society, 1984); Alan D. Reed, *West Central Colorado Prehistoric Context: Regional Research Design* (Denver: Colorado Historical Society, 1984); Mark R. Guthrie et al., *Colorado Mountains Prehistoric Context* (Denver: Colorado Historical Society, 1984); Jeffrey L. Eighmy, *Colorado Plains Prehistoric Context*; James Grady, *Northwest Colorado Prehistoric Context* (Denver: Colorado Historical Society, 1984).

⁷ A. W. McHendrie, "The Early History of Irrigation in Colorado and the Doctrine of Appropriation," in *A hundred years of irrigation in Colorado*, 14-15; Carroll Joe Carter and Steven F. Mehls, *Southern Frontier Historical Context* (Denver: Colorado Historical Society, 1984), II-2.

⁸ A. W. McHendrie, "The Hatcher Ditch (1846-1928): The Oldest Colorado Irrigation Ditch Now in Use." *Colorado Magazine* 5:3 (June, 1928): 81-91; Carter and Mehls, *Southern Frontier*, II-46.

The following sections of this report treat the history of Colorado's ditches and canals, both by types and by themes. The types are arranged chronologically in terms of their origins: Hispanic acequias, mining diversions, pioneer ditches, colony ditch systems, commercial canals, state, federal, and municipal water systems. These types did not supersede one another but formed layers in an increasingly complex structure. Themes such as water law and administration cut across the different categories of ditch types.

Hispanic acequias

Hispanic settlers moving north from New Mexico established the first permanent Euro-American settlements in present-day Colorado after the U.S. acquired southern Colorado from Mexico in 1848 and signed a treaty with the Utes in 1849. By the early 1850s, the towns of San Luis and San Pedro were established in the San Luis Valley. By the middle of the decade they were followed by Guadalupe (now Conejos), Servilleta, Mogote, San Pablo, San Acacio, and San Francisco.⁹ These settlements all relied upon small communal ditches. The **San Luis People's Ditch*** is the oldest continuously operating (that is, never abandoned) ditch in Colorado, and its water right, with a priority date of April 10, 1852, is priority number 1 in the state.¹⁰ The U.S. Army's Fort Garland, established 1858 in the San Luis Valley, also included irrigated agriculture in the town that grew up around it.¹¹

Hispano ditches are called *acequias* (ah·SAY·kee·uhs). In New Mexico and Texas, the history of acequia irrigation goes back to the seventeenth and eighteenth centuries, and shows continuity with both Puebloan irrigation systems predating European settlement in the area, and with European roots that in turn come from the Middle East via the Moorish period in Spain. New Mexico in particular has generated a rich acequia history and culture and an extensive literature describing them.¹²

The acequia is best understood as both a physical and a cultural system. The word acequia refers both to the ditch and to the ditch company, which in the acequia tradition is the smallest unit of civil government. This tradition is one of community

⁹ Carter and Mehls, *Southern Frontier*, II-17-18.

* Boldface ditch names may be found on the locator maps on pages 30 to 35.

¹⁰ Hinderlider (in *A hundred years of irrigation in Colorado*, 25) suggests that work may have begun as early as 1849. Cultural resource inventory form 5CT47.13 (San Luis Peoples Ditch), Office of Archaeology and Historic Preservation, Colorado Historical Society.

¹¹ Carter and Mehls, *Southern Frontier*, II-35.

¹² Neal W. Ackerly, *A Review of the Historic Significance and Management Recommendations for Preserving New Mexico's Acequia Systems* (Silver City, New Mexico: Dos Rios Consultants, for New Mexico Historic Preservation Division, 1996); Stanley Crawford, *Mayordomo: Chronicle of an Acequia in Northern New Mexico* (Albuquerque: University of New Mexico Press, 1988); José A. Rivera, *Acequia Culture: Water, Land and Community in the Southwest* (Albuquerque: University of New Mexico Press, 1998); Michael C. Meyer, *Water in the Hispanic Southwest: A Social and Legal History, 1550-1850* (Tucson: University of Arizona Press, 1984, 1996).

control of generally small-scale systems. Water resources and shortages are shared, as is the work of maintenance and decisions about the system. Irrigation historian Karl Wittfogel refers to this as the “local subsistence mode” of irrigation; American irrigation historian Donald Worster describes it as “characterized by a general dependence on local skills and means.”¹³ The Colorado Territorial Legislature recognized Hispanic practice in 1866 by providing for annual elections, in Costilla and Conejos counties (at that time all of the San Luis Valley and southwestern Colorado), of acequia superintendents (mayordomos).¹⁴

Agriculture in Hispanic areas of southern Colorado began shifting from a subsistence to a market economy with the opening of gold fields after 1859. Acequias maintained cultural continuity with their Hispano origins, even while becoming absorbed into Colorado’s system of water administration after statehood. More than a century of further irrigation development – of large investor canals and federal reclamation projects – have added new layers in the Arkansas and San Luis Valleys, but have not crased the initial layer of accquia heritage.¹⁵

Mining diversions

Prospectors and miners constructed the first wave of water diversions in the Anglo-American era. Early miners needed water to wash sand and gravel from heavier gold in placer mining, using rocker boxes, long toms, or sluices. A number of Colorado gold seekers in 1859 had been to California as Forty-niners. They brought familiarity with the technology and culture of mining, including water diversions. They dug small temporary ditches or built temporary flumes. Few if any of these survive or were recorded. As the summer progressed and stream flows diminished, operations halted and miners often turned to building ditches from more reliable water supplies that might be some distance away. Ditches permitted working “dry diggings,” alluvial deposits not along a watercourse.

In later years, the industry brought much greater water needs for hydraulic mining, for dredge mining, and as a power source for hard-rock mills. Hydraulic mining involved spraying water under pressure to excavate sand and gravel deposits. The pressure came from water supply ditches and flumes elevated above the diggings. Dredges worked deposits in the bed of a stream, whose flow might be controlled through dams and ponds and augmented by ditches.

¹³ Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York: Pantheon, 1985), 64.

¹⁴ McLendrie, *A hundred years of irrigation in Colorado*, 17.

¹⁵ Carter and Mehls, *Southern Frontier*, II-46-47.



Figure 1. “Extension of Ditch for Gold Queen Placers” c. 1886-1895. Photographer: Charles Goodman. Courtesy Denver Public Library, Western History Collection [Z-1383]

Some mining ditches also served agricultural users, or were later adapted as part of agricultural supply systems.¹⁶ The Davidson Ditch outside Golden, dug for placer mining in 1859, was bought in 1862 for agricultural use.¹⁷

Pioneer ditches

Pioneer ditches refer not to a specific period of Colorado’s history, but rather to the first generation of ditches in any particular locality. Pioneer ditches typically watered bottomlands, the floodplain and flat lands not much elevated above the stream itself. A ditch for such purposes could be brought off the stream close to its users, and required little elaborate engineering and little capital. The dates of the pioneer ditch period vary from valley to valley, depending when settlement began, from the 1850s and 1860s to the early twentieth century. Some places skipped the pioneer ditch period altogether

¹⁶ This transition was common in California. JRP Historical Consulting Services and the California Department of Transportation, *Water Conveyance Systems in California: Historical Context Development and Evaluation Procedures* (Sacramento: California Department of Transportation, 2000), 53.

¹⁷ Gregory M. Silkens, *The Farmers’ High Line Canal and Reservoir Company: A Century of Change on Clear Creek* (Denver: North Suburban Printing, 2000), 9.

when early settlement was controlled by a colony or commercial enterprise building a larger coordinated system.

If the ditch served a single user it was a *farm* or *ranch ditch*, if it served and was owned by multiple users it was a *mutual ditch*. Ditches that are not individually owned are generally operated by a *ditch company*; the term is used whether or not it is operated for profit. A *ditch rider* tends the ditch, making sure both the main headgate to the ditch and the lateral gates from it are opened and closed at the proper time, and watching for debris, leaks and other problems.

Pioneer ditches were usually small and simply constructed. The paramount goal in the first year was to get the water running. Most were reworked over time. Some were well-sited and later extended to serve additional land, a few becoming the stems of large canal systems. Others were absorbed as branches of these larger systems. Where topography or other factors prevented incorporation into a larger, re-engineered system, the pioneer ditch may remain in substantially its original form.

Mining technology, from California and Colorado, informed agricultural ditch development. So did mining economics. Some Forty-niners had observed in California that supplying food and fodder to prospectors could tap mineral wealth more reliably than prospecting itself. David K. Wall, after living in California from 1850 to 1854, came to Golden in 1859, skipped gold prospecting and went straight to digging a ditch and growing crops. He made the princely sum of \$2,000 that year.¹⁸ That same year two of Boulder's first residents, Marinus Smith and William Pell, sold a single load of hay to miners in Black Hawk for \$400. Smith and Pell dug Boulder's first ditch.¹⁹

Many early ditches sustained the local production of hay for animal feed. In an economy where animals were the power source for most transportation and industry, hay was the functional equivalent of petroleum fuels today. Irrigators also grew produce and grains for local consumption. As transportation improved, they grew more grain for distant markets, and as population increased they grew more produce for towns and cities. After the drought of the 1880s and the disastrous winter of 1885-86, when cattle by the thousands froze to death, irrigated hay again increased in importance as ranchers combined rangeland grazing with supplementary feeding.²⁰

¹⁸ Silkensen, *Farmers' High Line*, 7. Several of the Boulder Valley's early ditch builders came to Colorado after spending time in California. Michael Holleran, *Boulder Valley Ditches Historical Survey Report: Anderson Ditch (5BL3935), Farmers Ditch (5BL6632), Silver Lake Ditch (5BL3813)* (Denver: University of Colorado College of Architecture and Planning, 2000).

¹⁹ Amos Bixby, *History of Clear Creek and Boulder Valleys* (Chicago, 1880), 389; Phyllis Smith, *A Look at Boulder: From Settlement to City* (Boulder: Pruett, 1981), 20.

²⁰ R. Laurie Simmons and Thomas H. Simmons, "Historic Ranching Resources of South Park, Colorado" (National Register of Historic Places Multiple Property Documentation Form, 1999), 12-13, 15.

Smith's Ditch (later **City Ditch**) in Denver marked a transition from the pioneer ditch period. It was begun in 1860 by the Capital Hydraulic Company, but was laid out without sufficient drop, and work stopped in 1861. Denver businessman John W. Smith revived the project, working with surveyor Richard S. Little (for whom Littleton is named). They relocated its headgate and enlarged its channel. When they finished it in 1867, it was more than twenty miles long and irrigated thousands of acres of benchland, an early demonstration that Colorado agriculture could extend beyond the river bottoms.²¹

In order to water benchlands above a river valley, a canal needed to leave the stream above the land to be irrigated, often many miles upstream. Such canals were beyond the reach of a few farmers acting together; they required capital and a large workforce. One solution, which would soon become common, was outside investment. Another solution, communitarian or colony organization, was tried first with conspicuous success, and remained for years one strain of Colorado irrigation development.

Colony ditch systems

Agricultural colonies were established by settlers who organized themselves elsewhere and then came to Colorado as a group to build a community together. The first significant one, and the best known, was the Union Colony that built Greeley. It was led by Nathan Meeker, the agricultural editor for Horace Greeley's *New York Tribune*. Meeker had lived for a time in a Utopian settlement in the East, and had travelled to see Mormon irrigation in Utah. He launched the Union Colony with an organizational meeting at the Cooper Institute in New York City on December 23, 1869, explaining to his audience the great promise of irrigated agriculture in the West and the usefulness of cooperative action in achieving it. Prospective colonists paid \$155 for a Union Colony membership, which entitled them to an irrigated farm and a lot in town. By the following year Meeker had bought 12,000 acres on the Cache La Poudre River, and five hundred families arrived on the site that summer.²²

Among their first tasks was building ditches. Meeker, with General Robert A. Cameron, another Union Colony member, laid out a comprehensive system that was extraordinarily ambitious. Four main ditches of up to 35 miles in length would water both the valley floor and the bluffs above on both sides of the Cache La Poudre. Work

²¹ Cultural resource inventory forms 5DV181 and 5A11254 (City Ditch), Office of Archaeology and Historic Preservation, Colorado Historical Society; Earl A. Mosley, 'History of the Denver Water System: 1858 to 1919,' Unpublished MS, Denver Water Department (1966), 28, 53.

²² David Boyd, *Irrigation near Greeley, Colorado* (Washington: U.S. Government printing office, 1897), 28; Worster, *Rivers of Empire*, 83-88; Christine Whitacre and R. Laurie Simmons, *Historic Farms and Ranches of Weld County Multiple Property Listing* (Denver: Front Range Research Associates, 1990), 7; Jane E. Norris, *Written in Water : the life of Benjamin Harrison Eaton* (Athens, Ohio: Swallow Press/Ohio University Press, 1990)

started first on **Greeley No. 3 Ditch**, which watered the townsite. It was intended to irrigate 5,000 acres, but in its first year did not carry enough for 200 acres.



Figure 2. Greeley: Ditch No. 3, 1870. Photographer unknown.
Courtesy Denver Public Library, Western History Collection [X-9069]

At the Cooper Institute meeting Meeker had reassured his audience that “the cost of irrigation is perhaps equal to fencing.”²³ It proved a little more costly than that. The colonists budgeted \$20,000 for the whole system of four canals. Greeley No. 3 needed to be enlarged in each of the next three years, and ended up costing \$27,000. **Greeley No. 2** was the biggest ditch, watering the benchlands on the north side of the Poudre across from town. It too was begun in 1870, but not completed until 1877, in part by hiring Benjamin Eaton (who would go on to build even bigger canals and later to be elected governor).²⁴

By the time the system was complete, it cost by various reckonings from \$200,000 to more than \$400,000, soaking up the capital that colonists intended for other shared enterprises. The year after Greeley No. 2 was completed, the Union Colony sold it to

²³ Quoted in McKinnon, *A hundred years of irrigation in Colorado*, 33.

²⁴ Boyd, *Irrigation near Greeley*; McKinnon, *A hundred years of irrigation in Colorado*, 33-34; Norris, *Written in Water*, 93-94.

its users, who organized themselves as the Cache La Poudre Irrigation Co. Some of the cost overrun came from gross underestimation of the magnitude of the project. But much of it came from errors in design and construction. Grades were too shallow and the water would not flow, or too steep and the ditch washed out. Everything had to be done over.²⁵ “When they began digging,” writes Donald Worster, “what they knew about the rise and fall of a Rocky Mountain stream or how much water it took to irrigate a crop could have been put in a tin cup.”²⁶

The Union Colony’s irrigation experiment was not easy, but it succeeded. While the cost was daunting, the system irrigated tens of thousands of acres; by one calculation it came to a very reasonable \$350 per 80 acres irrigated. The colonists, and particularly their engineer, Edwin S. Nettleton, learned from their mistakes so that they would do it right the next time – for example, incorporating check structures where a channel needed to run down a slope.²⁷ The novelty of the effort and the coverage of the New York *Tribune* ensured that the eyes of the nation were upon Greeley. The colony movement was born, with imitators within the year.

The Chicago-Colorado Company founded Longmont in 1870-71. The St. Louis-Western Colony was established at Evans in 1871. Fort Collins Agricultural Colony, including some Union Colony members, began in 1872. Other colony towns included Montrose, Green City, and Platteville.²⁸ Colony settlement and irrigated agriculture were not inherently linked, but they were a good fit with one another. Irrigation required disciplined cooperative effort and rewarded it well, and the colony philosophy sought just such opportunities. Colonies varied in their level of communalism. Some were little more than attempts to market townsites by invoking the success of Greeley.²⁹

One notable set of colonies drew from a group of settlers with well-established traditions of communal enterprise and irrigation - the Mormons. The Latter-Day Saints established colonies, particularly in the San Luis Valley, where they settled Manassa in 1879 and Richfield in 1881. Other Mormon colonies in the valley included Sanford, Morgan, and Uracca. Ephraim was settled in 1881 but abandoned in 1888; Eastdale was settled in 1890 and lasted until 1909. All built ditches first. The Richfield site was

²⁵ Boyd, *Irrigation near Greeley*, 29; Norris, *Written in Water*, 198

²⁶ Worster, *Rivers of Empire*, 87.

²⁷ McKinnon, *A hundred years of irrigation in Colorado*, 34; Boyd, *Irrigation near Greeley*.

²⁸ Alvin T. Steinel, *History of Agriculture in Colorado* (Fort Collins: State Agricultural College, 1926), 390-95; Whitacre and Simmons, *Historic Farms and Ranches of Weld County*, E4-5; Norris, *Written in Water*, 113-15; Worster, *Rivers of Empire*, 85. Green City was also known as the “Tennessee Colony.”

²⁹ Kathleen A. Brosnan, *Uniting Mountain & Plain: Cities, Law, and Environmental Change along the Front Range* (Albuquerque: University of New Mexico, 2002), 76-77; Steven F. Mehls, *Colorado Plains Historic Context* (Denver: Colorado Historical Society, 1984), 55-62.

made possible by Mormon skills in surveying, which demonstrated that a new ditch could in fact reach the site.³⁰

The San Luis Valley attracted other colony settlements, encouraged by the Denver and Rio Grande Railroad. The Mosca Land and Farm Company established Mosca in 1891. The Costilla Estate Development Company built a reservoir in 1909 and set up the towns of San Acacio, Mesita, and Jarosa, where Seventh-day Adventists set up a colony and cooperative farm. Farther west, the Colorado Cooperative Company, incorporated in 1894, established Piñon and Nucla. At Piñon the colonists in 1903 built the Cottonwood Trestle, the longest and highest irrigation flume in the world (see figure 16). In the Arkansas Valley, east of Lamar, the Salvation Army in April 1898 established the town of Amity. Intensive irrigation rendered the soil there alkaline, and the colonists abandoned Amity in 1908.³¹

Greeley's influence extended beyond the example that it set for large-scale irrigation and cooperative effort. Greeley produced many of the irrigation advocates and innovators who would advance the field for the rest of the century. E. S. Nettleton (who became the first State Engineer), Benjamin Eaton (who became governor), William E. Pabor, J. Max Clark, Abner S. Baker, and David Boyd were Greeley men who designed and developed many of the major canal systems throughout Colorado, in particular the rest of the South Platte Valley east of Greeley. Some were active in new colony settlements, but they also brought their experience to a new generation of canals built by private enterprise for profit.

Water law and administration

Greeley's experience also shaped water law in Colorado, and much of the rest of the West. Water development requires some system of assuring who will have the right to use the water. This is important even in an ordinary year, but critically important in a drought. Colorado developed its own distinctive system of water law, which became a prototype for most of the other western states. The "Colorado Doctrine" refers, in short, to prior appropriation rights together with a system of government administration.³²

³⁰ Steinel, *History of Agriculture in Colorado*, 401-05; Carter and Mehls, *Southern Frontier*, II-109; Andrew Jenson, "The Founding of Mormon Settlements in the San Luis Valley, Colorado," *Colorado Magazine* 17 (1940), 179.

³¹ Duane D. Mercer, "The Colorado Co-operative Company, 1894-1904," *Colorado Magazine* 44:4 (1967) 293-306; Modupe Labode, "A Western Slope Utopia," *Colorado History NOW* (December 2004), 3; Michael B. Husband, *Colorado Plateau Country Historic Context*. (Denver: Colorado Historical Society, [1984]), 100; Carter and Mehls, *Southern Frontier*, II-110.

³² Donald J. Pisani, *Water, Land, and Law in the West: the Limits of Public Policy, 1850-1920* (Lawrence: University Press of Kansas, 1992); Pisani, *To Reclaim a Divided West: Water, Law, and Public Policy, 1848-1902* (Albuquerque: University of New Mexico Press, 1996); Donald Worster, *Rivers of Empire: Water, Aridity, and the*

Prior appropriation is the basis of water rights in Colorado and most of the West, and is often called “First in time, first in right.” The person who first takes water from a stream and puts it to use gains the right to continue doing so. Later arrivals may appropriate only from what remains in the stream. When the ordinary flow of a stream is fully appropriated, then newcomers must either acquire an existing right to water, or take water during high flows and build reservoirs to store it.

A water right is a property right which may be sold or inherited, and includes four dimensions:

1. A fixed quantity (in cubic feet per second);
2. A priority date, referring to the beginning of work to divert and deliver water, diligently carried to completion;
3. A “beneficial use”: water must be applied, not wasted. Beneficial use must continue; non-use for a period of years will constitute abandonment, and the water will revert to the state. (“Abandonment” is a legal term, referring to relinquishment of water rights. When describing a particular unused ditch or part of a ditch system, it is best to limit description to physical conditions, avoiding any version of the word “abandoned” unless there is documentary evidence of legal abandonment.)
4. A diversion point: a water right allows water to be taken from a particular stream at a particular place. Once taken from the stream it may be delivered anywhere within a ditch system. But the point of diversion may only be changed (in the Colorado system as it has evolved) through a court proceeding meant to ensure that other water rights are not hurt.

The first territorial legislature, in November 1861, recognized the right to build ditches to serve lands not on a stream. Prior appropriation was recognized by the territorial legislature in 1864 and the U.S. Congress in 1866.³³ These measures acknowledged what was already practice throughout the territory, and an established practice in other parts of the country such as California and Utah. But prior appropriation departed from water rights as practiced in the East under the Riparian Doctrine in that water rights were not tied to land on the stream, or to any land at all. Prior appropriation was brought from California by Forty-niners who came to Colorado a decade later. It is a system of resource allocation that made sense to miners, by analogy from their mining claims. Like a mining claim, a water right vests in the person who takes it first.

Growth of the American West (New York: Pantheon, 1985); Mead, Elwood. *Irrigation Institutions: A Discussion of the Economic and Legal Questions Created by the Growth of Irrigated Agriculture in the West* (New York: MacMillan, 1903; reprinted New York: Arno, 1972); Robert G. Dunbar, “The Significance of the Colorado Agricultural Frontier,” *Agricultural History* 1960 34(3): 119-25; Dunbar, “The Origins of the Colorado System of Water Right Control,” *Colorado Magazine* 27 (October 1944) 241-62; Dunbar, “Water Conflicts and Controls in Colorado,” *Agricultural History* 22 (July 1948) 180-86; G. E. Radosevich, K. C. Nobe, D. Allardice, and C. Kirkwood, *Evolution and Administration of Colorado Water Law: 1876-1976* (Fort Collins: Water Resources Publications, 1976).

³³ McHendrie, *A hundred years of irrigation in Colorado*, 17; Colorado Territory, Laws, 1864, p. 49, cited in John T. Ganoë, “The Beginnings of Irrigation in the United States,” *Mississippi Valley Historical Review* 25:1 (June 1938), 69; Steinel, *History of Agriculture in Colorado*, 221.

“Beneficial use” of water is analogous to the requirement that a mining claim be actively worked. In 1876 the new state constitution adopted the doctrine as the fundamental law of the land: “The right to divert unappropriated waters of any natural stream to beneficial uses shall never be denied. Priority of appropriation shall give the better right as between those using the water for the same purpose[.]”³⁴

The second basic part of the Colorado Doctrine, just as important as prior appropriation, is the state’s administration of the system through a state engineer and water commissioners. The problem is that water rights, if enforceable only at the pace and through the expense of lawsuits in the courts, are not usable rights at all. This is where Greeley made its contribution. In the drought year of 1874, Greeley irrigators found that no water was reaching them because the newer Fort Collins colony ditches upstream were taking it all. Under prior appropriation the Fort Collins ditches should have been the dry ones. But the only remedy, a lawsuit, would bring results only after crops had failed. Another approach, often advocated and occasionally put into practice, was violence. Representatives of the two communities reached a tenuous agreement to share the limited supply of water; conflict was averted by the coming of rain.³⁵

Nathan Meeker in an 1874 *Greeley Tribune* editorial expressed clearly the Greeley solution: a comprehensive system of water administration would “consolidate the interests of every ditch owner and to make the river an irrigation canal, subject to such superintendence as is established on our Number Two; for by this means everyone would have his rights, the supply of water would be constant, and all would know what to depend on.”³⁶ A second Irrigation Congress in Denver in December 1878 led to major irrigation legislation by the Colorado legislature the following year, amended and refined in 1881. It specified procedures for filing and adjudicating water rights. It created ten water districts, each with a water commissioner to administer priorities, and established the office of the state engineer to oversee the system.³⁷

Subsequent development of the water rights system refined the basic components of prior appropriation and state administration. The legislature regularized the process for appropriating water and strengthened the role of water commissioners and state engineer. An 1897 state law provided for the exchange of water between reservoirs, ditches and streams, formally recognizing and regulating a practice that had begun at least by the early 1890s. Courts and the legislature grappled with the distinction between direct flow rights and storage appropriations, eventually incorporating them into a single system. Rights to water within the state were balanced with rights in

³⁴ Article XVI, section 6.

³⁵ Norris, *Written in Water*, 116-18. Worster, *Rivers of Empire*, 93-95.

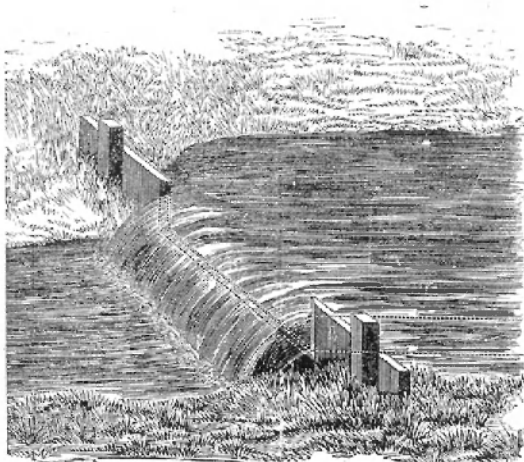
³⁶ Quoted in McKinnon, *A hundred years of irrigation in Colorado*, 35.

³⁷ Worster, *Rivers of Empire*, 94-95.

downstream states through U. S. Supreme Court decisions (starting with *Kansas v. Colorado* in 1907 and *Wyoming v. Colorado* in 1922)³⁸ and interstate compacts (most importantly the Colorado River Compact of 1926). More recently, Colorado has broadened the concept of beneficial use to include uses of water remaining in the stream for wildlife and for recreation. Water law remains in a contentious and lively state of evolution.

Water measurement

Prior appropriation commodified water in fixed quantities and thus assumed a measurement system. It would need to include physical instruments to gauge diversions into canals and division of waters distributed by the canal, and administrative systems for gathering, recording, and taking action based upon these measurements. When the Colorado system was being formulated, such a system did not yet exist.



WEIR DAM, FOR MEASUREMENT OF WATER.

Figure 3. “Weir dam, for measurement of water.”

Source: William E. Pabor, *Colorado as an Agricultural State* (1883)

The state of measurement in early years was described in 1883 by William E. Pabor in *Colorado as an Agricultural State*:

there are few farmers who, using the inch measure under pressure, know how much water they get or use, though they know how much they pay for. The grade, the size of the orifice through which the water flows, the depth and breadth of the channel, all affect the result, more or less. There is no one rule that governs all the canals in Colorado.³⁹

³⁸ *Kansas v. Colorado* (185 U.S. 125); *Wyoming v. Colorado* (259 U.S. 419); Steven L. Scott, “Abandonment in the Greeley-Poudre Irrigation District,” *Heritage of the Great Plains* 22:3 (1989): 24-29.

³⁹ William E. Pabor, *Colorado as an Agricultural State: Its Farms, Fields, and Garden Lands* (New York: Orange Judd, 1883), 47.

The uncertainties of water measurement undermined Colorado's system of water rights. As Donald Worster described it, appropriators "with no accurate sense of flow dynamics or crop requirements, with only a primitive means of measurement, made immense claims, Amazonian claims, calling for more water than any ten streams could carry, enough water to sail a clipper ship across the plains."⁴⁰ Elwood Mead tallied appropriations relative to actual streamflows on South Platte tributaries in 1891: on the Poudre, 4693 second-feet appropriated, out of a mean June streamflow of 2900, and an August flow of 265. On Boulder Creek, 4741 second-feet appropriated, out of a mean flow of just under 1000 in June, and 123 in August. Comparing the decrees with measurements of ditch capacities, he found that they were frequently two to three times what could fit in the channel. Examining appropriations relative to land irrigated produced the most dramatic discrepancies; some pioneer ditches held rights between 20 and 100 times the water that could realistically be used.

"Ditches," wrote Mead, "cannot divert more water than the stream carries, nor can the irrigators use more water than the ditches divert."⁴¹ The numbers simply were not accurate. In the pioneer period the question was of limited practical import – irrigators used the water they needed and the rest remained in the stream. Few appropriations had been quantified and these quantities remained abstractions. But in the commercial period the numbers mattered. Appropriations in excess of real use were bought and sold, becoming the subject of water speculation. Eventually the appropriations were taken out of the stream, and long-time irrigators could find themselves dry while new ditches carried supposedly senior water.⁴²

These problems persisted for decades, gradually improving on two fronts. First, available measurement technology came into use, district by district and headgate by headgate. An 1889 state law required the installation of headgates and measurement devices and gave water commissioners the right to install them at the expense of irrigators. Actual implementation lagged, in some places for decades. Droughts and water conflicts were frequently the catalyst for installation of better measurement devices. Another part of this larger system (beyond the scope of the present report) was measurement of stream flows. An 1897 Colorado state law required that irrigators using the public stream to exchange waters between reservoirs and canals install measuring devices in the streams so that water commissioners could regulate their exchanges.

A second approach to improved water measurement was the development of better technology. This was a national and international effort, in which Colorado played a leading role. For several decades it was pursued through specialized instrumentation

⁴⁰ Worster, *Rivers of Empire*, 95.

⁴¹ Mead, *Irrigation Institutions*, 150-151 (quote on 150).

⁴² Mead, *Irrigation Institutions*.

brought to a channel to measure flows, so that trained experts could calibrate the devices installed on a particular ditch. During the early twentieth century, Professor Ralph Parshall of Colorado State University solved the problem in a more permanent way with a measuring device, the Venturi flume or Parshall flume, whose design eliminated the variables that required field calibration.

Commercial canals

J. C. McKinnon in 1952 explained the origins of Colorado's commercial canals:

The success of the Greeley colony gave Colorado tremendous publicity. The whole world seemed to be watching the experiment. When the success of irrigation farming on the uplands seemed assured, there was a rush to build big ditches throughout the state. ... Most of the big ditches that followed the Greeley success were not built by colonists, but by corporations using British capital, however. ... An option would be taken on railroad lands. Without water these lands would bring from \$2.50 to \$4.00 per acre. With water available, the value would skyrocket to \$100 or more. ... After the land was sold it was confidently expected that the sale of water would give very liberal returns as a permanent investment.⁴³

After the example of Greeley itself, a second spur to large-scale canal construction was the 1881 Colorado Irrigation Act, born of the Greeley experience, which established the Office of the State Engineer and brought the prospect of clear water rights, efficiently administered. The early 1880s brought nationwide economic expansion after the depression of the 1870s. The 1880s saw years of above-average rainfall (ending in the drought of 1888). The early 1880s brought the Ute treaty that removed the tribes to Utah and southwest Colorado and opened northwestern Colorado for Euro-American settlement.

An early example of an investor-financed project was the **Larimer and Weld Canal**. Benjamin Eaton proposed it in 1878 as an extension of Larimer County Ditch No. 10, which watered the north side of the Poudre Valley at Fort Collins. Ditch No. 10 was begun in 1864, and had been enlarged three times, most recently by Eaton himself in 1875. Eaton then went on to complete the Greeley No. 2 Canal, and he saw that if Larimer No. 10 could be extended at its elevation for 50 miles all the way from Fort Collins to Greeley, it would water up to 50,000 acres of benchlands above Greeley No. 2. Much of this was land of the Denver Pacific Railway, which had been granted from the public domain as a subsidy for building the line. Eaton approached the railroad as a partner, and they secured financing from the Colorado Mortgage and Investment Company. Known locally as "The English Company," this was an outlet for British

⁴³ McKinnon, *A hundred years of irrigation in Colorado*, 34.

investment capital, with James Duff as its Denver representative. E. S. Nettleton surveyed and engineered the canal. It was so much bigger than anything yet constructed that its promoters seriously considered using it for navigation as well as irrigation. Up to 100 men worked on its construction, moving along in a camp with their animals and equipment, completing its full length by 1881.⁴⁴



Figure 4. High Line Canal flume in Platte Canyon, Douglas County. Photographer: William Henry Jackson.

Courtesy Colorado Historical Society Stephen H. Hart Library [CHS.J3607, detail]

The **High Line Canal** near Denver was built as another English Company project. It had been proposed in 1876 as a means of developing Kansas Pacific Railroad lands, but that effort failed through undercapitalization. By 1879 the Kansas Pacific was in merger talks with Jay Gould's Union Pacific. Gould sought out James Duff, who agreed to buy 120,000 acres of KP's land, and incorporated the Northern Colorado Irrigation Company to build a canal serving it. Duff engaged Nettleton as engineer, and construction – some of it by Eaton – began as soon as the railroad merger was completed in 1880. The High Line reached 44 miles to Cherry Creek

⁴⁴ Norris, *Written in Water*, 119-29; Cultural resource inventory forms 5WL842 and 5LR863 (Eaton Ditch/Larimer and Weld Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society.



Figure 5. High Line Canal in Platte Canyon, circa 1883. Photographer: William Henry Jackson. A wooden bench flume carries the canal on a shelf blasted into the side of the canyon.

Courtesy Colorado Historical Society Stephen H. Hart Library [CHS.J893]

by 1882, and was completed in 1883 to its full length of more than 70 miles, then the longest canal in Colorado. It cost \$652,000, including an expensive tunnel and flumes to take its water high enough in Platte Canyon for all the land it was meant to serve.⁴⁵

Like the Larimer and Weld, many investor canals were physical extensions of existing mutual ditches. For example, the Farmers High Line in Jefferson County began in 1886 by acquiring the Golden Canal, which dated at least to 1862 and perhaps 1859.

⁴⁵ FRASERdesign, "High Line: Historic American Engineering Record Documentation of the High Line Canal," (HAER CO-43); Pabor, *Colorado as an Agricultural State*, 15; Steinel, *History of Agriculture in Colorado*, 204; Norris, *Written in Water*, 140.

The Havemeyer-Wilcox Canal west of Rifle was developed beginning in 1902 as an extension of the 1893 Henry Hallett Canal. Commercial canals included not just new construction but also consolidation and reconfiguration of earlier ditches as more efficient systems.⁴⁶ In this, canal investments paralleled those in railroads and public utilities.

Investor canals were considerably more expensive than pioneer ditches, even on a per-acre basis. The easy sites had been developed. The commercial canal business model could anticipate revenues from three sources: annual fees for water carriage to cover operating expenses; payments from each irrigator upon connection to the system (opponents called these “royalties”), covering the company’s capital investment; and profits from land sales where the promoters owned or had optioned lands under the canal. Royalties and fees were the equivalents of capital and operating costs for mutual ditches, but irrigators found them more distasteful when imposed by profit-seeking investors. A populist backlash was reinforced when the investors were out-of-state or foreign. The English Company was the most conspicuous example, but not the only one. The Earl of Airlie and his son, Lord Ogilvie, with Abner S. Baker constructed Ogilvie Ditch near Greeley and developed other projects in the San Luis Valley. The Grass Valley Land and Water Corporation, near Silt, was also English-financed.⁴⁷ Carriage fees were regulated (under an 1861 territorial act) by county commissioners, who often allowed only the barest costs without much room for profits or even maintenance. The Colorado legislature outlawed royalties in 1887, and the state Supreme Court upheld the act the following year. And land sales, even when successful, were a one-time source of profits.⁴⁸

Land sales and outside investment succeeded in getting many canals built, but they quickly foundered on a scarcity of water and an abundance of maintenance costs. Colorado’s system of water rights protected the vested interests of those who came first; most commercial canals, especially on the Eastern Slope, were relative latecomers with junior appropriations. Pioneer ditches had fully appropriated the normal stream flow. Commercial canals might attempt to overcome this problem by absorbing earlier ditches into their systems, or buying some of their senior water rights. Sometimes this made water available through increased efficiency, but it also led to squabbles among users and a continuing drain of resources into legal costs.

⁴⁶ Silkensen, *Farmers’ High Line*, 7-9; Cultural resource inventory form 5GF654 (Havemeyer-Wilcox Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society; Don Davidson, “The Grand River Ditch: A Short History of Pioneering Irrigation in Colorado’s Grand Valley.” *Journal of the Western Slope* 1:4 (Winter 1986): 1-30; State Engineer, *Biennial Report, 1889-90*, 47.

⁴⁷ J. M. Dille, *Irrigation in Morgan County* (Fort Morgan: [Farmers State Bank], 1960), 17; Toni Rae Linenberger, *The Silt Project: a participating project, Colorado River Storage Project* (Denver: Bureau of Reclamation History Program, 1997).

⁴⁸ *Wheeler v. The Northern Colorado Irrigation Company* (10 Colo. 582); Roger Clements, “British-controlled Enterprise in the West Between 1870 and 1900, and Some Agrarian Reactions,” *Agricultural History* 27 (1953): 132-41.

Investors also hoped that the exaggerated quantities of early appropriations could be reduced through more accurate measurement and accounting. But earlier ditch companies proved unexpectedly adept at defending their water rights.⁴⁹

These new systems required reservoir storage, a fact that some canal developers understood and many apparently did not. Few recognized the magnitude of the task. Even Ferdinand V. Hayden, who between 1873 and 1876 surveyed reservoir sites for the federal government, thought that the necessity for using reservoirs was “far in the future.”⁵⁰ Systems initiated before 1888 discovered the problem in the drought of that year. The Northern Colorado Irrigation Company had sold 31,000 acres of land with High Line Canal water rights (and 30,000 without), but at best delivered enough for 25,000 acres, and in 1889 delivered only enough for 7500 acres. Water users successfully sued both the High Line and the Larimer and Weld for supplies inadequate to their obligations. Both eventually developed reservoirs. In the 1890s Eaton built Windsor Lake, and other irrigators built Terry Lake and Timnath Reservoir. On the High Line, a number of competing efforts to develop reservoir storage began in the 1880s, and finally produced Antero Reservoir, constructed from 1907 to 1909 near the South Platte’s headwaters in South Park. The Antero Company then purchased the High Line Canal the following year.⁵¹

After water supply, the second biggest financial headache was maintenance. Commercial canals generally were better engineered, and better constructed, than the early pioneer canals. This did not mean, however, that they worked flawlessly, and ongoing problems could overwhelm their finances. The High Line, despite Nettleton’s growing expertise, suffered from erosion due to excessive grade and sharp curves. Its wooden flumes and siphons quickly deteriorated under the pounding from fast-moving sediment-laden water. Its physical capacity was less than half its 1184 cubic feet per second (cfs) appropriation, and by 1907 its water right was reduced to 570 cfs. Because commercial canals were based in the cash economy, they could be vulnerable to a drying up of investment capital. For example, by the time the Havemeyer-Willcox Canal system opened in May 1912, it cost \$425,000. When Colorado River floods

⁴⁹ “The High Line, or English, Ditch May Go Dry Shortly,” *Denver Times*, 26 May 1902, quoted in HAER CO-43:20 n. 62: “A profound mistake was made in not first ascertaining that the water of the Platte River was all appropriated. In order to help the ditch out after it was constructed the legislature passed a law requiring the old ditch owners, who claimed an indefinite amount of water, to affirmatively prove the original appropriation of the quantities they claimed. It was expected by the friends of the ditch company, and by the owners of the land under the ditch, that these old ditch owners would fail to prove the appropriation of three-quarters of the water they claimed and that thus enough would be left unappropriated to adequately supply the English ditch. But contrary to expectations the old-timers proved that the entire river was theirs. Logically, not a drop of water was left for the ditch.” See also Silkensen, *Farmers’ High Line: Mead, Irrigation Institutions*.

⁵⁰ Quoted in Steinel, *History of Agriculture in Colorado*, 196.

⁵¹ “Highline Extension Canal (Doherty Ditch)” HAER CO-67: 5; HAER CO-43:11-14; James F. Sherow, “Watering the Plains: An Early History of Denver’s Highline Canal,” *Colorado Heritage* 1988 (4): 2-13; Norris, *Written in Water*, 197-202

damaged its headgate one month later, its New York backers decided not to repair it but to write off the whole investment.⁵²

Because of flaws in the business model and problems with water supplies and maintenance, few if any canals made money for their investors. Canal promoters and investors accomplished a great deal for Colorado, if not for themselves. Construction of these great canal and reservoir systems was itself a significant industry, and a significant part of the economy. Most systems were eventually taken over by their users – some through mutual ditch companies, and after 1901, through irrigation districts (see below). Most remain in use, often with supplemental storage through reservoirs constructed later or through additional supplies from Bureau of Reclamation projects.

Commercial canal and reservoir systems enabled the establishment and growth of the sugar beet industry in Colorado. The systems were sometimes built or expanded in conjunction with sugar enterprises. The legislature, the Colorado Agricultural College (now CSU), and others beginning in territorial days had pushed for development of a sugar beet industry. The first sugar beet plant in Colorado, developed by Charles Boettcher and John Champion, opened in 1899 in Grand Junction. They and others quickly followed with plants in the Arkansas, South Platte, and San Luis Valleys, making Colorado the leading beet-sugar state in the U.S. fifteen years later. Sugar beets required late-season irrigation, which became possible through development of reservoirs in the 1890s. The expanding beet industry in turn led to more reservoir construction. The sugar industry sometimes backed reservoirs and canal improvements that served their plants. The Havemeyer-Willcox Canal, for example, expanded a ditch developed for fruit orchards, with financing from the Havemeyer Sugar Company of New York.⁵³ Sugar beet plants also needed water for industrial processing – 19 gallons per pound of refined sugar – which became another water delivery purpose for canals.⁵⁴

The next few pages will examine major commercial canals and canal systems around Colorado by region, but first there is one individual - Theodore C. Henry - whose activities encompassed most regions of the state. T. C. Henry arrived in Colorado from

⁵² HAFR CO-43: 8; Cultural resource inventory form 5GF654 (Havemeyer-Willcox Canal).

⁵³ Joseph E. King, *Colorado Engineering Context* (Denver: Colorado Historical Society, 1984), 172-77; Steinel, *History of Agriculture in Colorado*, 281-308; Dena S. Markoff, "The Sugar Industry in the Arkansas River Valley: National Beet Sugar Company," *Colorado Magazine* 55:1 (1978), 69-92; Whitacre and Simmons, *Historic Farms and Ranches of Weld County*, 10-12; Mehls, *Colorado Plains Historic Context*, 97-103; Carter and Mehls, *Southern Frontier*, II-123-24; James F. Sherow, *Watering the Valley: Development Along the High Plains Arkansas River Valley, 1870-1950* (Lawrence: University Press of Kansas, 1990), 14-17; Cultural resource inventory form 5GF654 (Havemeyer-Willcox Canal).

⁵⁴ Markoff, "The Sugar Industry in the Arkansas River Valley," 78.



Figure 6. “A Colorado sugar beet field” in the South Platte Valley, irrigated by the Denver Reservoir Irrigation Company. Photographer: Louis Charles McClure.

Courtesy Denver Public Library, Western History Collection [MCC-1079]

Kansas, where he was known as the “Wheat King” for his role in introducing winter wheat there. In 1883 he set up the Colorado Loan and Investment Company, with backing from the Travellers Insurance Company of Hartford, Connecticut. He invested in the Uncompahgre Canal Company near Montrose, the Grand River Ditch Company near Grand Junction (now the **Grand Valley Canal**), and the Del Norte Ditch (now the **Rio Grande Canal**) and Citizens Canal in the San Luis Valley. Each of these four systems was then under construction. They quickly ran over budget and required additional capital from Travellers. The insurance company’s board sent more money but also sent representatives who tried to push Henry out of the projects. By 1885 they were in court, and they stayed there for years. Travellers finally sold its Colorado canals in 1892.⁵⁵

⁵⁵ James E. Sherow, ‘Marketplace Agricultural Reform: T. C. Henry and the Irrigation Crusade in Colorado, 1883-1914.’ *Journal of the West* (October 1992), 51-58.

Meanwhile, Henry found Colorado and Kansas backers for a new venture in the Arkansas Valley. The Arkansas River Land, Town, and Canal Company Ditch had been built beginning in 1883, diverting water on the north side of the Arkansas just west of La Junta and running about 20 miles by 1886. Henry incorporated the **Fort Lyon Canal** Company to extend it all the way to the Kansas line, which would make it the longest irrigation canal in the country. By 1890 it was completed to 113 miles in length, meant to irrigate over 40,000 acres. But the flow of the Arkansas, and the junior appropriations that made up most of the Fort Lyon water rights, were not adequate to supply this much land. Henry's investors, as well as the Fort Lyon water users, fought him in court until the users finally achieved control of the system in 1903. Henry envisioned solving the water shortage with reservoirs to catch the flood waters of the Arkansas, and "highline" canals watering up to a million acres on each side of the river. He began the Bob Creek Canal, above the Fort Lyon, in 1889 (it was later called Twin Lakes Canal, and is now known as the **Colorado Canal**). Even as the Fort Lyon Canal was spinning out of his control, Henry optioned thousands of acres of state lands and sold water rights far to the east, with a promise of delivery in time for spring planting. After the turn of the century he proposed equally ambitious plans for the South Platte Valley, to take water through a tunnel from the Western Slope, but by this time investors had downgraded his schemes from highly speculative bonds to swindles.⁵⁶

Henry died in 1914, largely discredited and financially ruined. His few remaining funds were all invested in canal company bonds – he was a true believer. Almost all of Henry's canals remain in operation today, mostly through the efforts of successors who completed the storage and other corrections to make the systems work.

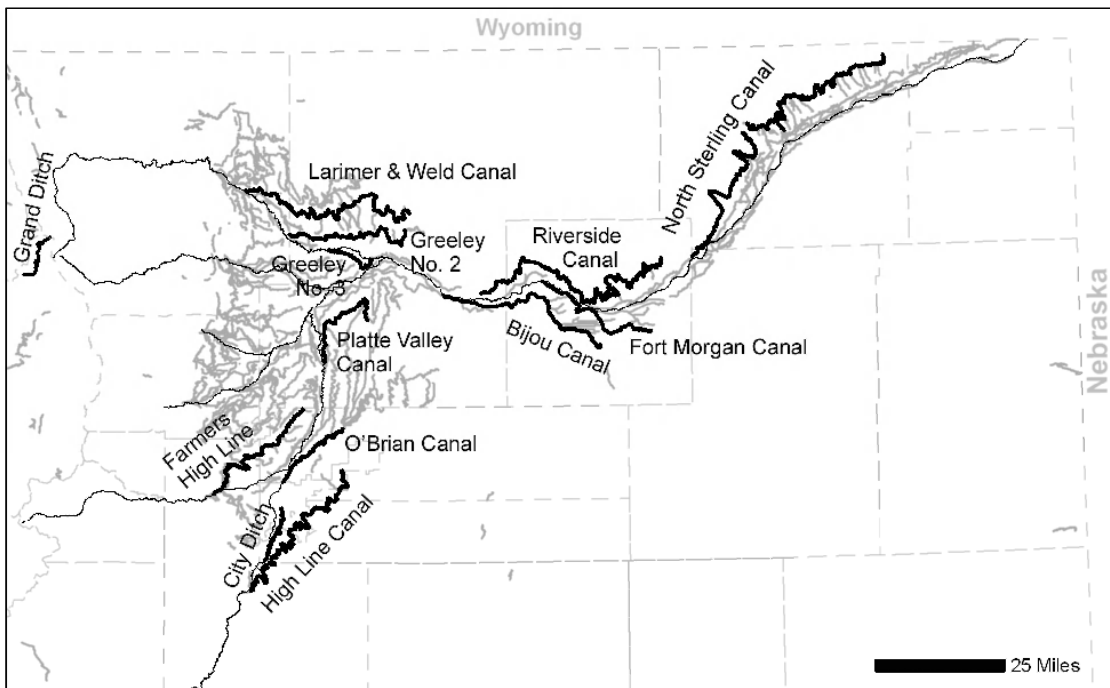
South Platte Valley

The South Platte Valley and its tributaries upstream from the Poudre River to Denver were fairly thoroughly served by ditches from the pioneer and colony periods. Commercial canal development supplemented and rationalized this network of early ditches. The Larimer and Weld and High Line Canals are described above. Other English Company ditches included the Loveland and Greeley Canal from the Big Thompson River and the **Platte Valley Canal** which waters the east side of the valley from Fort Lupton toward Greeley. The **Farmers Highline** Company in 1885 began

⁵⁶ Sherow, "Marketplace Agricultural Reform"; Sherow, *Watering the Valley*, 17-20; Joseph O. Van Hook, "Development of Irrigation in the Arkansas Valley," *Colorado Magazine* 10 (1933), 10-11; Cultural resource inventory form 5CW51 (Lake Meredith), Office of Archaeology and Historic Preservation, Colorado Historical Society.

seeking a ditch on Clear Creek that could be extended to water Jefferson and Adams counties between Golden and what is now Thornton.⁵⁷

One later system is particularly worth mentioning: the Farmers Reservoir and Irrigation Company (FRICo), incorporated in 1902 by Joseph Standley, Milton Smith, and Thomas B. Croke. They consolidated early ditches while building new reservoirs and canals, first on the west side of the South Platte in Jefferson and Adams counties, and then on the east side as well, extending to Weld county. They began construction in 1909 on an enlargement of the Burlington Ditch into the **O’Brian Canal** (named after its engineer, Peter O’Brian) and an enlargement of Barr Lake. By 1910, FRICo was in financial trouble – the company owed its Kansas City contractor \$900,000 – and it reorganized. FRICo has since grown into the largest private ditch company operating today in Colorado, and one of the largest in the country, largely through



Map 1. Ditches in the South Platte Valley. For this and the next three maps, solid gray lines show all ditches that are in use today and big enough to appear at this scale. Heavy black lines show some of the ditches mentioned in the text.

Data: U.S. Geological Survey. Cartography: Michael Hinke, Colorado Center for Preservation Research, University of Colorado at Denver and Health Sciences Center

astute partnerships with urban municipalities, tapping their financial reserves to develop reservoir sites that the company already controlled.⁵⁸

⁵⁷ HAER CO-43-A:7; Silkensen, *Farmers’ High Line*.

⁵⁸ “O’Brian Canal,” HAER CO-46; Cultural resource inventory forms 5AM457 (Bull Canal), 5AM516 (Neres Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society. The Neres Canal was built

The real growth along the South Platte in the commercial canal period was in the downstream end of the valley from Fort Collins and Greeley to the east. The Weldon Valley Ditch, Platte and Beaver Ditches (Upper and Lower), **Fort Morgan Canal** and Bijou Ditch were all incorporated in the early 1880s. Weldon Valley and the Platte and Beaver system were each delivering water by 1884, both constructed by Abner S. Baker of Greeley, and his brothers. The Baker brothers began the Fort Morgan Canal in 1882, but ran into financial difficulties that led to its takeover by T. C. Henry and the Travellers Insurance Company. Travellers ran the canal from 1886 to 1894, when it turned the system over to its users, organized as the Ft. Morgan Reservoir and Irrigation Company. The Bijou system began with incorporation of the Kiowa and Bijou Irrigation and Land Company (another Baker brothers project) in 1884. The effort did not progress far; its bondholders foreclosed and it was reorganized by D. A. Camfield in 1889 as the **Bijou Canal**. Water finally flowed in 1904, and the system was only completed after Camfield organized the Bijou Irrigation District in 1905.⁵⁹

The major canals east of Greeley have junior appropriations relative to ditches in the Denver area and those along South Platte tributaries closer to the Front Range; the river was fully appropriated by the 1870s. Irrigation development in this enormous area from the 1880s through about 1910 was made possible, first, by the return flows that grew over time as upstream irrigators saturated riparian aquifers. This slow replenishment of streamflows – it could take a decade or more - may help explain the persistent optimism of ditch builders.⁶⁰ Next, South Platte irrigation developers built reservoirs – only a few of the oldest ditches attempted to operate as run-of-river ditches, and they were not very successful. Jackson Lake, Riverside Reservoir and Empire Reservoir were all built in the first decade of the twentieth century.⁶¹

After rural electrification began in the 1930s, many farmers in the eastern South Platte Valley installed supplementary wells using electric pumps, sometimes abandoning ditches altogether. Finally, as the Bureau of Reclamation began operating the Colorado-Big Thompson system in 1947, the remaining large canal and reservoir companies used this supplemental water to make up deficiencies in their operations.⁶²

in 1889 as the West Hudson Lateral by the Hudson Ditch and Reservoir Company. FRICo enlarged it in 1909 to 55 miles at a cost of \$175,000 as part of the Standley Lake system.

⁵⁹ Cultural resource inventory forms 5MR480 (Fort Morgan Canal) and 5WL2429.1 (Bijou Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society; Dille, *Irrigation in Morgan County*, 24-26.

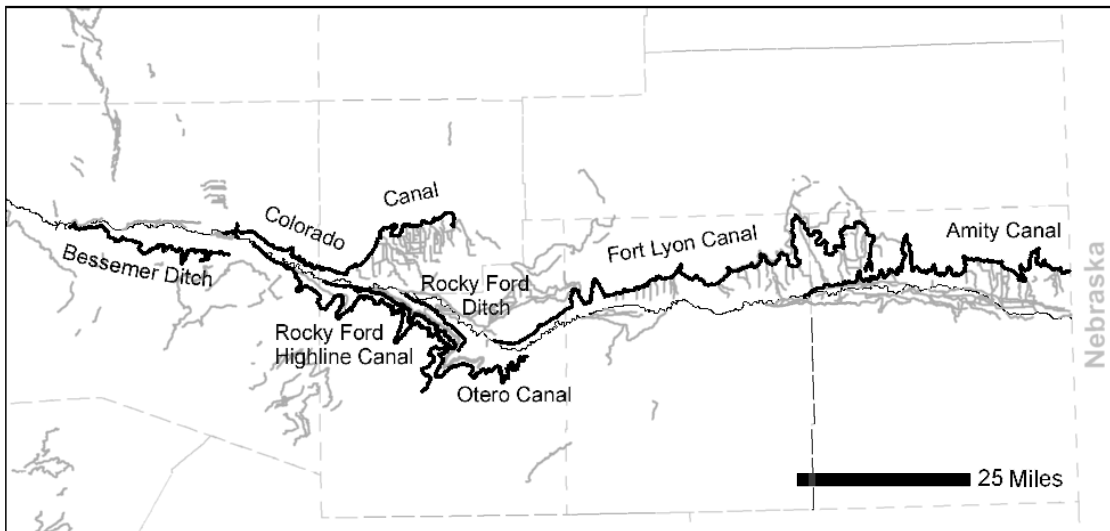
⁶⁰ Steinel, *History of Agriculture in Colorado*, 225-27; Mark Fiege, *Irrigated Eden: The Making of an Agricultural Landscape in the American West* (Seattle: U. Washington Press, 1999).

⁶¹ Dille, *Irrigation in Morgan County*.

⁶² Dille, *Irrigation in Morgan County*; Daniel Tyler, *The Last Water Hole in the West: The Colorado - Big Thompson Project and the Northern Colorado Water Conservancy District* (Niwot, Colorado: University Press of Colorado, 1992).

Arkansas Valley

Like the South Platte, the upper Arkansas Valley was developed early and thoroughly with pioneer ditches. Larger canals began with the **Rocky Ford Ditch**, built by George Swink and others with a priority date of May 15, 1874, diverting water upstream of the town of Rocky Ford and originally extending about ten miles. In 1887-88 they extended it to 16 miles, watering almost 8,000 acres. The 50-mile-long **Rocky Ford High Line Canal** was built in the early 1880s to water 30,000 acres. The Arkansas River Land, Town, and Canal Company Ditch on the north side of the river was begun in 1883, and then extended by T. C. Henry as the **Fort Lyon Canal** beginning in 1886. Henry also developed the Bob Creek Canal, later called the Twin Lakes Canal and now the **Colorado Canal**, and the **Otero Canal** on the south side of the river. The 40-mile-long Catlin Consolidated Canal (Catlin was the former name of Manzanola) was constructed in 1884-87 at a cost of \$60,000, to irrigate 20,000 acres. The **Bessemer Ditch** extends 35 miles, some of it through the city of Pueblo, and was completed in 1890 at a cost of \$450,000 to irrigate 20,000 acres.⁶³



Map 2. Ditches in the lower Arkansas Valley.

Data: U.S. Geological Survey. Cartography: Michael Hinke, Colorado Center for Preservation Research, University of Colorado at Denver and Health Sciences Center

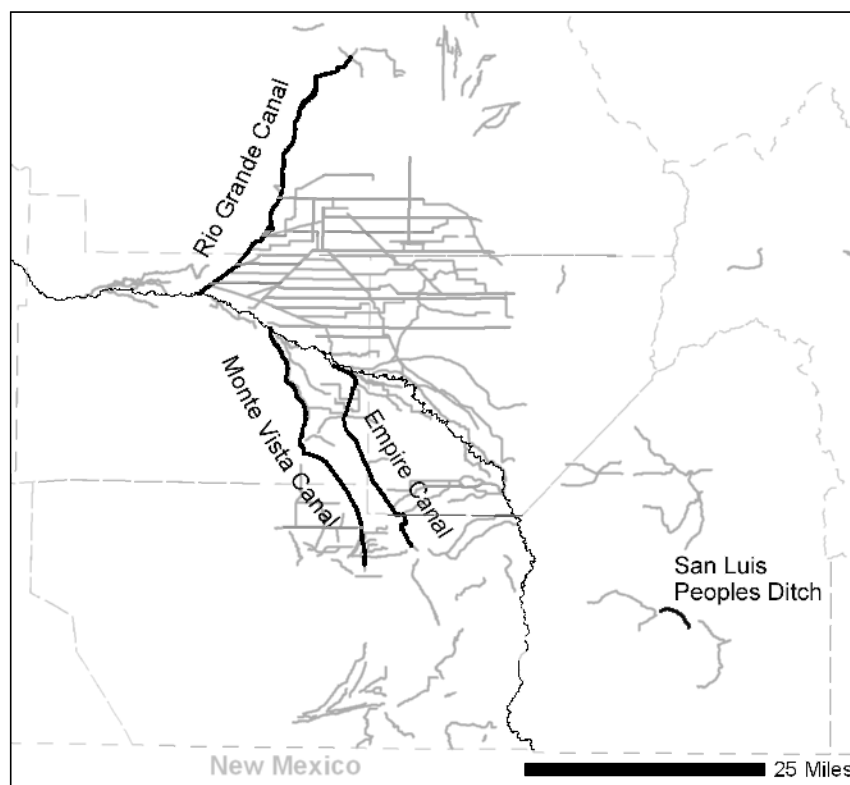
A second wave of commercial canals, after the depression of 1893, coincided with the advent of the sugar beet industry. The Great Plains Water Storage Company of Denver, beginning in 1896, built a system of large reservoirs on the plains - Neesopah, Neegronda, Neenoshe, Neeskah, and King. The reservoirs took their supply through T.

⁶³ Van Hook, "Development of Irrigation in the Arkansas Valley," 10-11; Sherow, *Watering the Valley*, 12-14; Cultural resource inventory forms 5CW28.1 and 5PE1667.1 (Colorado Canal) and 5OT120 (Catlin Consolidated Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society.

C. Henry's Fort Lyon Canal, and then distributed water farther east through the Comanche and Pawnee Canals to the **Amity Canal**. The system was completed by 1902 at a cost of over \$2 million. Soon afterward it was acquired by the Arkansas Sugar Beet and Irrigated Land Company, and then by the Amity Mutual Irrigation Company. The Twin Lakes Reservoir Company was established by some of T. C. Henry's Bob Creek Canal backers to supply the water needed by that project by building a reservoir near Leadville. The same investors then incorporated the National Beet Sugar Company to create a profitable market for their water.⁶⁴

San Luis Valley

The first acequias were in the southern part of the valley. Pioneer ditches soon appeared in the north as well. The San Luis Valley began as Colorado's most subsistence agricultural region. The expense of irrigation works led to more intensive market agriculture. The Denver and Rio Grande Railroad promoted potato, onion, and carrot cultivation.⁶⁵



Map 3. Ditches in the San Luis Valley

Data: U.S. Geological Survey. Cartography: Michael Hinke, Colorado Center for Preservation Research, University of Colorado at Denver and Health Sciences Center

⁶⁴ Markoff, "The Sugar Industry in the Arkansas River Valley," 76-79; Carter and Mehls, *Southern Frontier*, II-47, 123; Cultural resource inventory form 5KW63.1 (Lone Wolf Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society.

⁶⁵ Carter and Mehls, *Southern Frontier*, II-47.

T. C. Henry expanded the **Rio Grande Canal** – originally the Del Norte Canal – as one of his first projects with Travellers Insurance Company. Henry also built the **Empire**, Citizens, and **San Luis** canals. The advent of large irrigation canals in the flat valley led to waterlogging and alkali flats in low-lying lands, some of which were abandoned or became less productive. In the 1930s the Federal Relief Administration built drainage ditches to address these problems.⁶⁶

Western Slope

Most of northwestern Colorado was part of the Ute Reservation until 1881, and opened for settlement with the relocation of the Utes in that year. The major low-altitude valleys – the Grand Valley in Mesa County and the Uncompahgre in Montrose

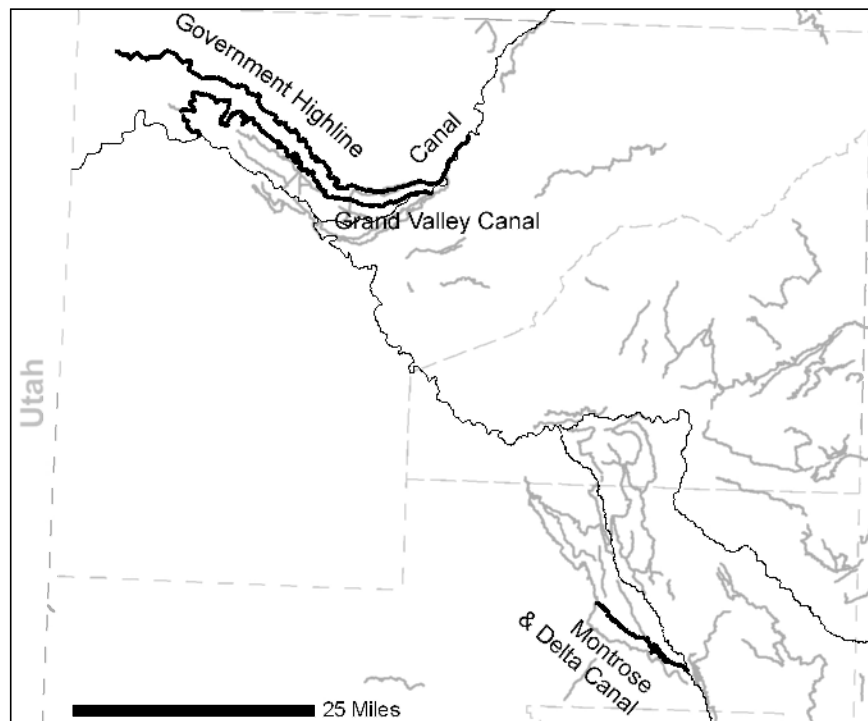


Figure 7. Grand Valley Canal, with irrigated orchards in the background and Grand Mesa in the distance. Photographed July 12, 1911, by Louis Charles McClure (one of a 4-panel panorama).

Courtesy Denver Public Library, Western History Collection [MCC-4943]

⁶⁶ Cultural resource inventory forms 5RN63 and 5SH1033 (Rio Grande Canal) and 5RN510.1 (Empire Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society; Clements, “British-controlled Enterprise” 138 n. 46; “San Luis Valley Resettlement Project.” *San Luis Historian* 21:2 (1989).

and Delta counties – quickly proved to be ideal sites for fruit-growing, which demanded intensive and reliable irrigation. These areas largely skipped the pioneer stage of small bottomland ditches. Their initial development came during the period of investor-built canals.⁶⁷



Map 4. Ditches in the Grand and Uncompahgre Valleys

Data: U.S. Geological Survey. Cartography: Michael Hinke, Colorado Center for Preservation Research, University of Colorado at Denver and Health Sciences Center

The Grand River Ditch (now the **Grand Valley Canal**) was begun in 1881, and reorganized in 1883 by Matt Arch and W. E. Pabor (then of Denver) with \$200,000 in stock. The first part opened that year, but the company ran out of money. T. C. Henry bought them out and finished the 49-mile canal in 1884. He in turn sold out to his backers, the Travellers Insurance Co., the following year. By 1888, the Grand River Ditch was insolvent and Travellers sold it at auction. In 1894, at a second auction, the water users bought the ditch.⁶⁸In the Uncompahgre River Valley, large canals were begun quickly in the 1880s, and by 1903, settlers had claimed 100,000 acres and irrigated 30,000 acres through canals up to 40 miles long. As in much of the eastern half of the state, this ambitious development outstripped available water supply. In the drought of 1888, the Uncompahgre carried only enough water for 10,000 acres. A few miles to the east, the Gunnison River carried more water with less irrigable land in its valley. F. C. Lanzon in 1890 proposed to divert water from the Gunnison through a tunnel to the Uncompahgre Valley. In 1894 he ran level lines proving that the elevations were

⁶⁷ Husband, *Colorado Plateau Historic Context*, 78-88.

⁶⁸ Davidson, "Grand River Ditch."

feasible. A survey team led by William W. Torrance, “Father of the Gunnison Tunnel,” entered the Black Canyon in 1900, but gave up after four weeks.⁶⁹ The project would be revived by the state and then by the federal government (see below).

Colorado ditches mapped by decade

The map series on the following pages shows a dot for each ditch diversion, mapped by decade according to the year of the earliest appropriation for that ditch (many ditches have multiple appropriation dates for each enlargement of capacity).⁷⁰

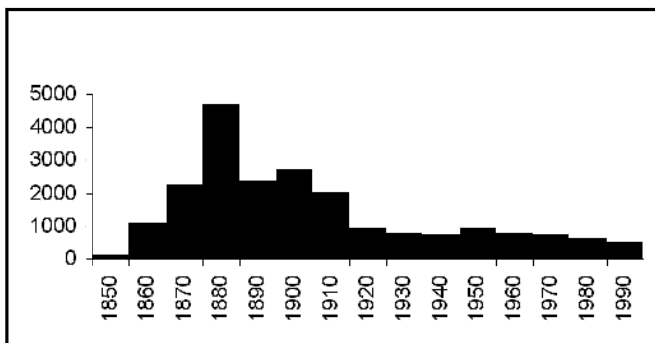


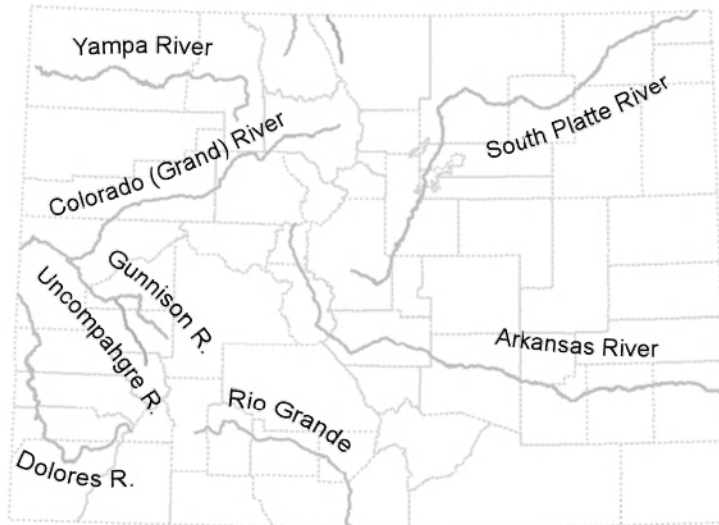
Figure 8. Colorado Ditches by decade of first appropriation.

Data: Colorado Water Resources Department. Data analysis by Manish Chalana, Colorado Center for Preservation Research, University of Colorado at Denver and Health Sciences Center

⁶⁹ “Historic Canals on the Bureau of Reclamation’s Uncompahgre Project, Montrose and Delta Counties, Colorado (South [5MN1851], East, and Montrose and Delta Canals [5MN1855])”, NRHP nomination, at Office of Archaeology and Historic Preservation, Colorado Historical Society.

⁷⁰ The information comes from the Colorado Water Resources Department’s structures database and appropriations database, and was compiled and analyzed by Manish Chalana and Michael Holleran. These databases provide no information about the length or course of the ditch. Our sort did not attempt to compile the often complex information about the volume of each appropriation, water transfers into and out of each ditch, and whether an appropriation was subsequently abandoned at some later date.

All of these uncertainties, and others, mean that the data are not necessarily definitive for any particular ditch, and for that reason we have chosen not to publish the full dataset. Appropriation dates for water rights are a serious business. For surveys of individual ditches, we recommend that surveyors consult the Colorado Water Resources Department for appropriation records. If they are complicated, seek expert help in interpreting them; they will tell a great deal about the evolution of the ditch. The data set that we have mapped is accurate as a chronological and spatial pattern of development, for the state and for any particular region.



Map 5. Colorado Major Rivers (key for the decade-by-decade maps that follow)

Cartography by Michael Hinke, Colorado Center for Preservation Research, University of Colorado at Denver and Health Sciences Center

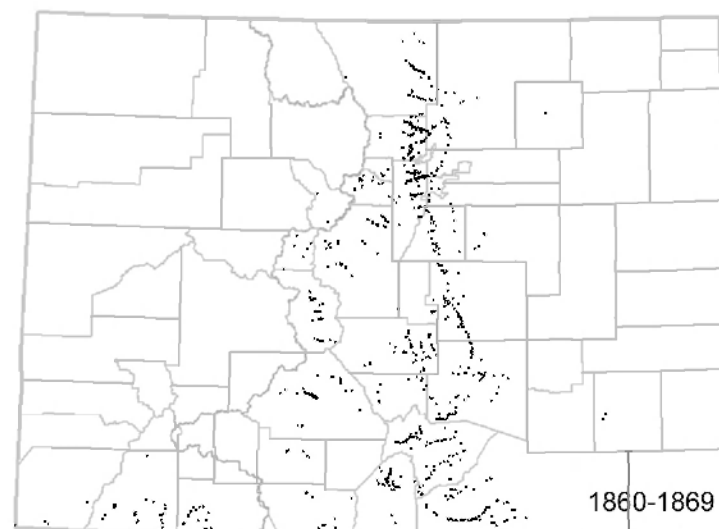


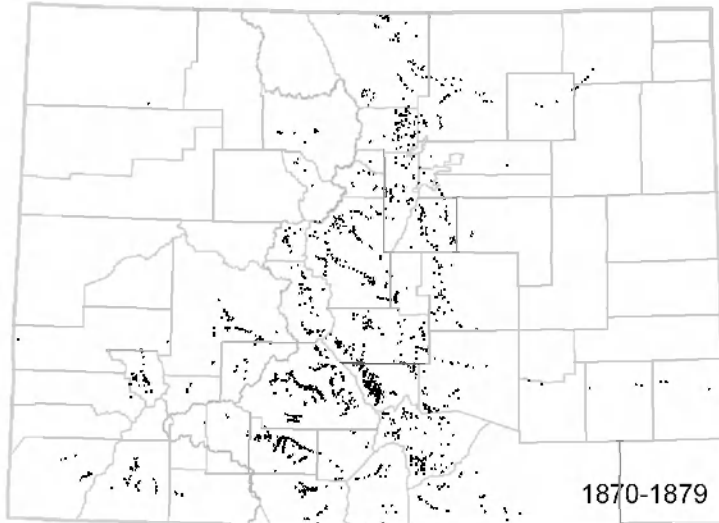
Maps 6-7:

1850s: Early acequias in the San Luis Valley and Arkansas Valley. First pioneer ditches along the Front Range.

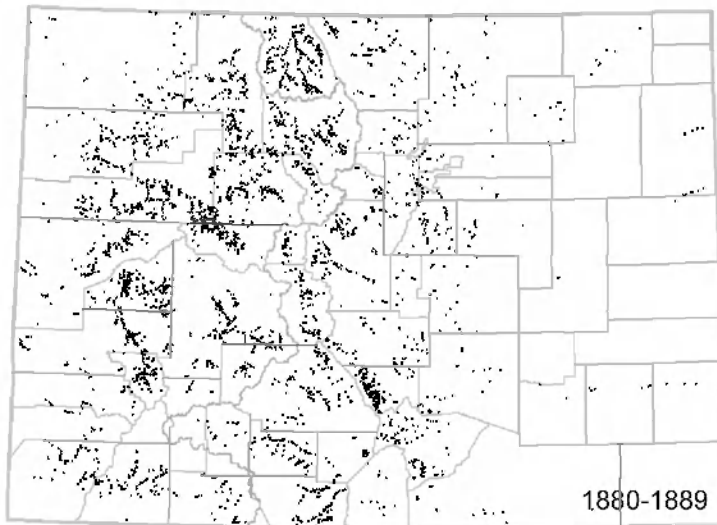
1860s: Pioneer ditch period encompasses all of the Front Range where streams leave the canyons. Some pioneer ditches in mountain valleys, and in Archuleta, La Plata, and Montezuma counties in the southwest.

Cartography by Manish Chalana, Colorado Center for Preservation Research, University of Colorado at Denver and Health Sciences Center

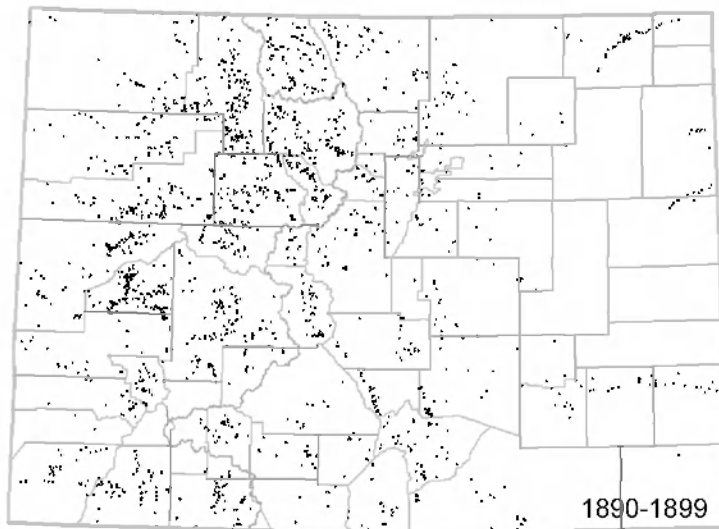




1870-1879



1880-1889



1890-1899

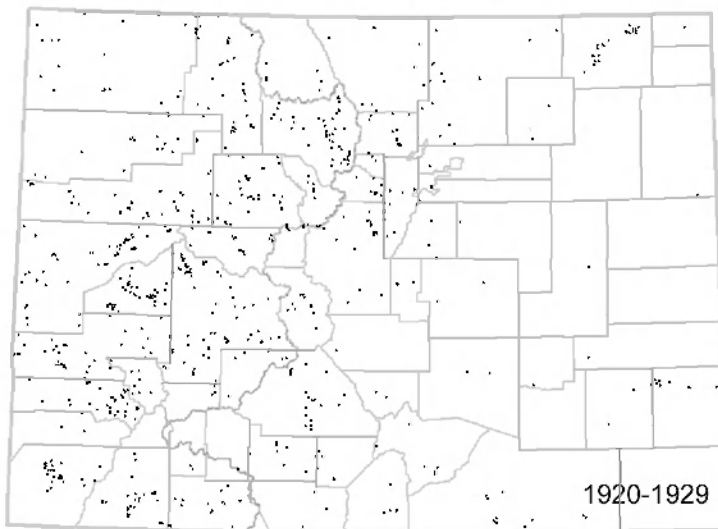
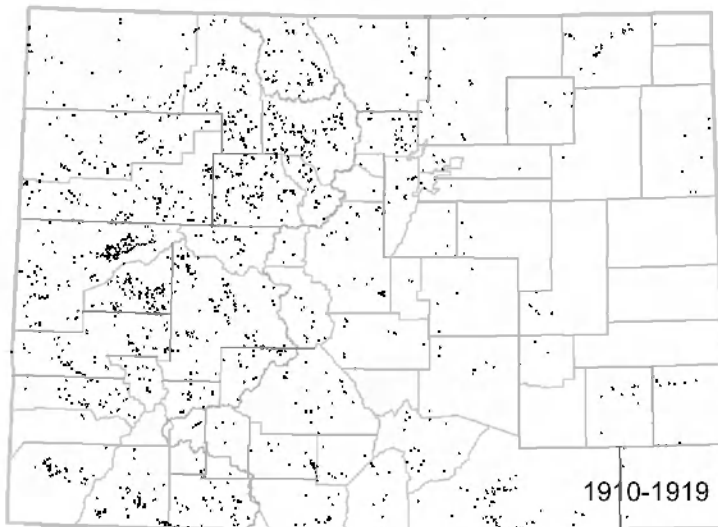
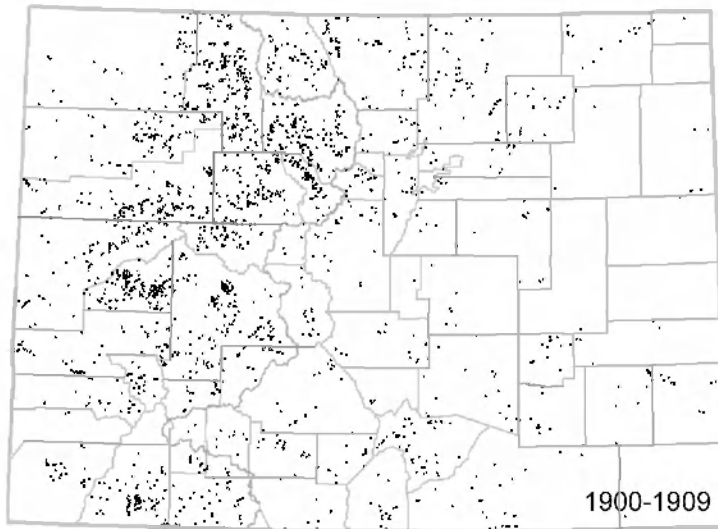
maps 8-10:

1870s: Irrigation development continues, less intensively, along the Front Range. It begins to extend out the South Platte (including the development of Greeley), and along the Arkansas all the way toward Kansas. A few of these are the earliest big investor canals. More intensive development in South Park, and the northern and western San Luis Valley. The first appropriations along the upper Gunnison and Uncompahgre.

1880s: Former Ute lands opened to an explosion of development on the Western Slope. Front Range and eastern development has thinned out – minor ditches with junior appropriation dates, and a few big canals beginning to be developed in conjunction with reservoirs.

1890s: Beginning to thin out statewide – fewer, sometimes bigger ditches. Note strong development still making its way downstream on the South Platte and Arkansas.

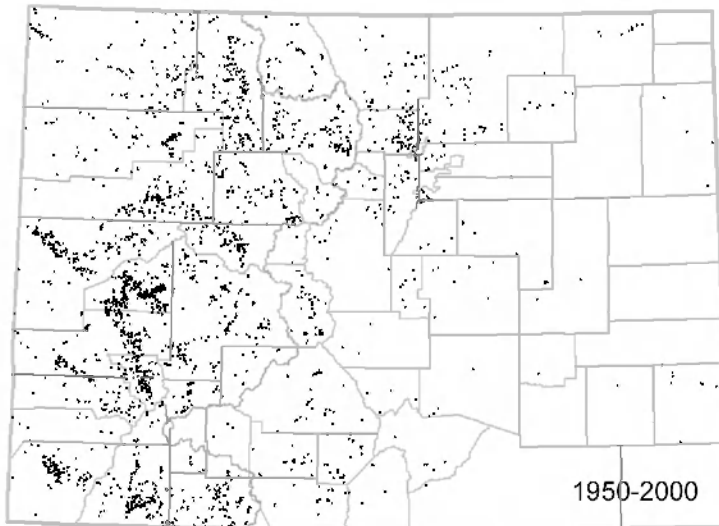
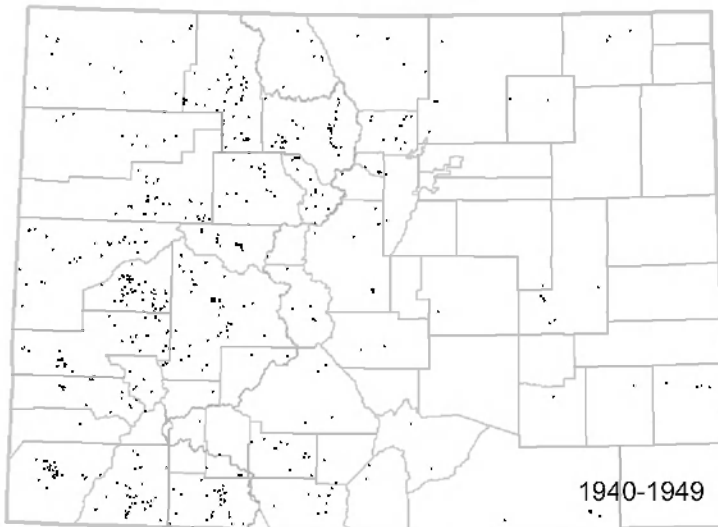
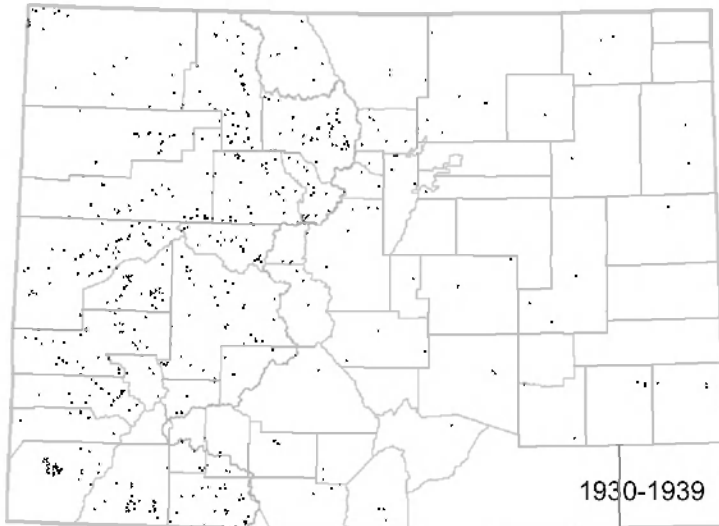
Cartography by Manish Chalana, Colorado Center for Preservation Research, University of Colorado at Denver and Health Sciences Center



maps 11-13:

1900-1920s: Development continues on the Western Slope, where streams are not all fully appropriated.

Cartography by Manish Chalana, Colorado Center for Preservation Research, University of Colorado at Denver and Health Sciences Center



maps 14-16:

1930s-1940s: Scattered development, mainly on the Western Slope.

1950-2000: The past fifty years: mostly modest filings, but still quite a few of them, especially in the western half of the state.

Cartography by Manish Chalana, Colorado Center for Preservation Research, University of Colorado at Denver and Health Sciences Center

Federal, state and municipal systems

“Almost everything that could be done to rivers with limited funds, on local capital, had been done by the last decade of the century,” writes Donald Worster. “What was required next, if the state was to escape from its plateau of water development, was to find the money to buy more advanced engineering.”⁷¹ Between the 1880s and the twentieth century, in Karl Wittfogel’s terminology, irrigation in Colorado moved from the “local subsistence mode” to the “capitalist state mode,” in which government and the private sector together accomplished hydraulic control on an unprecedented scale. This new phase was well underway by the time of investor-financed canals in the 1880s. The financial failure or difficulties of every such enterprise showed the limits of private capital in further developing Colorado’s water resources, and led to demands for government action.

Federal aid for irrigation development was on the agenda of Colorado’s boosters at least since 1864, when William N. Byers’ *Rocky Mountain News* called on Congress to encourage canal building, as it did railroad building, through grants of public land. In 1873, President Ulysses S. Grant endorsed the booster fantasy of a canal from Denver to the Missouri River, and proposed federal land grants to get it built (the High Line Canal descended from this scheme, watering railroad land grants rather than any grants of its own).⁷²

The Desert Land Act of 1877 was an effort at encouraging private irrigation efforts, authorizing the sale of up to 640 acres of arid lands to individuals provided that the land be irrigated within three years. The original legislation did not apply to Colorado. It was in any case ill-suited to the realities of irrigation – far too much land to work as an irrigated farm, not enough land to build a ditch system. After years in which the Act was used more by cattlemen and speculators than by irrigators, Congress in 1891 reduced the acreage to 320 but allowed farmers in groups to make larger claims together, and at this time extended it to Colorado. The results were still disappointing.⁷³ Around the West, advocates of government-sponsored irrigation turned their attention from the federal level to the states, including Colorado.

⁷¹ Worster, *Rivers of Empire*, 110.

⁷² Steinel, *History of Agriculture in Colorado*, 190-91.

⁷³ Brookings Institution, *The U. S. Reclamation Service: Its History, Activities and Organization* (New York, 1919): 4; Worster, *Rivers of Empire*, 156-57.

State irrigation projects

Colorado Governor Alva Adams convened a “Reservoir Convention” in 1888 which recommended that the federal government build reservoirs and canals. When Congress took no action, the state legislature in 1889 appropriated funds for several reservoir and canal projects. State Engineer J. P. Maxwell found feasible only one of them, which proceeded as State Canal No. 1, to be constructed near Cañon City by local convict labor, diverting water from the Arkansas River after it left the Royal Gorge. Maxwell laid out a canal 30 miles long, designed to irrigate 27,000 acres of state land, and work began in 1890. The 1891 legislature authorized several reservoirs around the state, as well as a State Canal No. 2, to take water from the Colorado and irrigate the Grand Valley from a high elevation. State Canal No. 1 continued slowly and costs mounted to \$200,000 with no end in sight. By 1895 a few small reservoirs had been built but the canals had not.⁷⁴

Agitation for federal action grew in the 1890s. A drought depopulated some of the Great Plains. The Populist reaction against perceived exploitation by commercial canal-builders won significant victories in the late 1880s, but that together with the national depression of 1893 drove investors away from irrigation.⁷⁵ Colorado’s experiments with state-financed irrigation were not encouraging. The state was financially no more capable than private capital. Colorado and other western states needed a new model of irrigation development, and increasingly looked to the national government.

Congress in 1894 passed the Carey Act, which provided for grants of federal lands to states for state or private irrigation projects. The experiment was not taken up as widely as expected, and was little used in Colorado. By the time the U.S. Reclamation Service was founded in 1902, no lands had yet been patented under the Carey Act in Colorado. By 1917, Colorado had patented 11,511 acres, the smallest total of any of the six participating states.⁷⁶

Colorado tried one more irrigation venture, the Uncompahgre valley project that was to take its water through a tunnel from the Gunnison River canyon. State Canal No. 3 began in 1901 with a \$25,000 appropriation, and was meant to be otherwise self-financing. By the end of the year a route was surveyed for a 3-mile tunnel feeding a 12-mile ditch to the Uncompahgre River, and construction began with an estimate of \$1.5 million. The project was abandoned within a year, after building 900 feet of

⁷⁴ State Engineer, *Biennial Report, 1889-90*, 613-14; Donald A. MacKendrick, “Before the Newlands Act: State-sponsored Reclamation Projects in Colorado, 1888-1903.” *Colorado Magazine* 52:1 (1975): 1-21.

⁷⁵ Worster, *Rivers of Empire*, 131. Steinel, *History of Agriculture in Colorado*, 208-09.

⁷⁶ Brookings Institution, *The U. S. Reclamation Service*, 6.

tunnel. Private funding had dried up, partly because of early indications that the new federal Reclamation Service might take over the project, as in fact it soon did.⁷⁷

Irrigation districts

Irrigation districts were a financing and management mechanism pioneered by Utah in 1865 and adopted in California in 1887. In 1901, the Colorado General Assembly passed a District Irrigation Law. Irrigation districts could be organized by a majority of landowners within their boundaries, with acquisitions and construction financed through bonds paid off by assessments on all irrigated lands in the district.⁷⁸ Within a decade, one or more irrigation districts had been organized in most regions of Colorado. They were a means of organizing user takeover of canal systems at a scale commensurate with large commercial operations, and of financing their completion through bonds. In some places districts were organized to build reservoirs independently of ongoing commercial operations that had failed to provide them. Irrigation districts became a vehicle for developers of new commercial systems to finance portions of their works through public-private partnerships.

Some of the first irrigation districts were in the South Platte Valley, including the Fort Morgan (1903), Hillrose (1903), Riverside (1904), and Bijou (1905) districts. D. A. Camfield was an active organizer, and sold district bonds to Eastern investors. The Hillrose district included 11,000 acres under the Lower Platte and Beaver Ditch in Morgan and Washington counties, organized to finance the purchase of shares in Jackson Lake Reservoir. The Bijou district took over the partially-constructed Bijou Canal and brought the project to completion. The Riverside district constructed the **Riverside Canal** in 1907-08. The district found itself in financial difficulties because its ambitious storage and distribution system suffered heavy losses to seepage and evaporation, and it was unable to serve the whole area except in years when water was plentiful enough to allow a late spring refill of the reservoir.⁷⁹ The Hillrose, Bijou, and Riverside districts continue in operation.

Farther up the South Platte, High Line Canal irrigators between 1903 and 1907 made an unsuccessful effort to organize an irrigation district to build reservoirs. The Henrylyn Irrigation District was incorporated in 1907 by Clarence M. Ireland to irrigate 100,000 acres of South Platte lands downstream from the High Line by diverting water from the Western Slope – the plan later adopted by the Denver Water

⁷⁷ MacKendrick, "Before the Newlands Act," 18-20.

⁷⁸Radosevich et al., *Evolution and Administration of Colorado Water Law*, 162-63; Gordon M. Bakken, "The Development of Law in Colorado, 1861-1912." *Colorado Magazine* 53: 1 (1976): 63-78; Mead, *Irrigation Institutions*; Worster, *Rivers of Empire*, 108, 139, 215. Dille, *Irrigation in Morgan County*, 25.

⁷⁹ Dille, *Irrigation in Morgan County*, 15, 26, 33-39; Cultural resource inventory form 5MR563 (Riverside Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society.

Department as the Jones Pass Tunnel. The Henrylyn district succeeded in constructing a canal and reservoir system within the South Platte Valley, part of which it operates today jointly with the Farmers Reservoir and Irrigation Company. On the Western Slope, Arthur and Raymond Havemeyer established the Grand Valley Irrigation District in 1909 to develop the Willcox-Havemeyer canal system.⁸⁰

The Greeley-Poudre Irrigation District contributed to the evolution of western water law, but not in the way its promoters might have hoped. The district was formed in 1911 to irrigate 125,000 acres north of Greeley by diverting water to the Poudre River through a tunnel from the headwaters of the Laramie River. The plan could only work by ignoring the rights of irrigators downstream in Wyoming. The U.S. Supreme Court in 1922 decided in *Wyoming v. Colorado* that those rights could not be ignored, establishing that prior appropriation applied across state lines. Most of the new towns and farms in the Greeley-Poudre district were eventually abandoned; some areas continue in use with water from the later Colorado-Big Thompson project.⁸¹

In 1921, Colorado's irrigation district law was amended to require that new irrigation districts submit a plan, the feasibility of which would be evaluated by the state engineer. As of 2003, sixteen irrigation districts continue operating in Colorado.⁸²

Bureau of Reclamation

The National Reclamation Act of 1902, known as the Newlands Act for its sponsor, U.S. Representative Francis Newlands of Nevada, began a new era for western irrigation. Donald Worster has called it “the most important single piece of legislation in the history of the West, overshadowing even the Homestead Act in the consequences it has had for the region's life.”⁸³ The Reclamation Service (renamed the Bureau of Reclamation in 1923) would build reservoirs, hydroelectric plants, and canal systems throughout the western states. They would be financed by the federal

⁸⁰ HAER CO-43: 13; HAER CO-67: 7-8; Cultural resource inventory forms 5AM517 (Denver Hudson Canal) and 5GF654 (Havemeyer-Willcox Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society; Everett Kissler, “Whiskey's Fer Drinkin', Water's For Fightin'” Colorado Water Conservation Board: *Educational Resource Guide* (CD 2000).

⁸¹ Steven L. Scott, “Abandonment in the Greeley-Poudre Irrigation District,” 24-29.

⁸² Radosevich et al, *Evolution and Administration of Colorado Water Law*, 162-63; Data from the Colorado Department of Local Affairs: Bijou Irrigation District (Morgan and Weld counties), Henrylyn Irrigation District (Weld), Hillrose Irrigation District (Morgan, Washington), Iliff Irrigation District (Logan), Julesburg Irrigation District (Sedgwick), Logan Irrigation District (Logan), Maybell Irrigation District (Moffat), Mesa County Irrigation District (Mesa), North Sterling Irrigation District (Logan), Orchard City Irrigation District (Delta), Orchard Mesa Irrigation District (Mesa), Palisade Irrigation District (Mesa), Pine River Irrigation District (Archuleta, La Plata), Pioneer Irrigation District (Yuma), Riverside Irrigation District (Morgan, Weld), San Luis Valley Irrigation District (Alamosa, Rio Grande, Saguache)

⁸³ Worster, *Rivers of Empire*, 130-31.

government, with their costs to be repaid by users interest-free, and would then be turned over to user-organized irrigation districts.

Uncompahgre Project

One of the first five projects selected in the country was the Uncompahgre project (the Reclamation Service originally called it the Gunnison Project), already begun but unable to be completed by the State of Colorado.⁸⁴

Construction, suspended by the state in 1902, was authorized by the Reclamation Service in 1903 and resumed in 1905 with a \$2.5 million budget. The original tunnel alignment proved impractical and a new location was selected for a six-mile-long tunnel. By 1906, its west portal was a temporary town with a population of 800. President William Howard Taft opened the Gunnison Tunnel, the longest irrigation tunnel in the world, in 1909. Before the project began, the Uncompahgre Valley contained 110 ditches, totalling 405 miles. The Reclamation Service set out to buy them in order to unify the system. The **Montrose and Delta Canal**, purchased in 1908 for \$110,000, became the first canal operated by the Reclamation Service. The Gunnison Diversion Dam was completed in 1912. By 1925, the whole system – including coordination and improvement of the valley’s ditch distribution system – was largely completed, at cost of \$6.8 million.⁸⁵ The project was transferred from the federal government to the Uncompahgre Valley Water Users Association in 1932.

Grand Valley Project

The Grand Valley project was the second Colorado project among the first six selected by the Reclamation Service. It was originally proposed and surveyed in 1897 as a commercial initiative. The Reclamation project was put on hold while private investors considered reviving it, but when this avenue proved unlikely, the Reclamation Service approved the project in 1907. Construction began in 1912, with the first deliveries of water in 1915 and the project completed in 1917. It included a low (14-foot) diversion dam in the Colorado River upstream from Palisade, and a new **Government High Line Canal**, 55 miles long, above the 1880s canals on the north side of the Grand Valley. The project also delivers water through a siphon under the Colorado River to Orchard Mesa Canals numbers 1 and 2 on the south side of the

⁸⁴ David Clark and William Joe Simonds, “The Uncompahgre Project,” Bureau of Reclamation History Program Research on Historic Reclamation Projects (Denver, 1994); MacKendrick, “Before the Newlands Act,” 18-20.

⁸⁵ “Historic Canals on the Bureau of Reclamation’s Uncompahgre Project,” NRHP nomination; MacKendrick, “Before the Newlands Act.”



Figure 9. Grand Valley Diversion Dam on the Colorado River, photographed 1916.

Source: Bureau of Reclamation

river. This phase, completed in 1924, accommodated a competing project being pursued by the Orchard Mesa Irrigation District.⁸⁶

Colorado- Big Thompson

The Colorado-Big Thompson project, authorized in 1935, was among the biggest, most complex Reclamation projects anywhere. It does not include any single great dam, but gathers water through an extensive collection system in the upper Colorado River Valley, brings it under Rocky Mountain National Park to the Eastern Slope, and distributes it through an extensive system of canals and 60 reservoirs from Boulder nearly to Wyoming, from the Front Range foothills all the way to the Nebraska state line. The project serves 720,000 acres and 400,000 people and spans 250 miles west to

⁸⁶ William Joe Simonds, "The Grand Valley Project," Bureau of Reclamation History Program Research on Historic Reclamation Projects (Denver, 1994).

east and 65 miles north to south. Drilling began in 1940 on the 13-mile Alva Adams tunnel; it was completed in 1947. The whole project was finished by 1959.⁸⁷

Other Reclamation Projects

The Bureau of Reclamation began work on several other projects in the 1930s: Pine River (authorized 1936, constructed 1937-41); Fruitgrowers Dam (authorized and constructed on an emergency basis by the Works Progress Administration (WPA) in 1938 to replace a dam that failed in 1937); Mancos (authorized 1939, constructed first by the Civilian Conservation Corps (CCC) and WPA, then as a Conscientious Objector camp during the Second World War, and finally completed by contractors between 1947 and 1949. The San Luis Valley project was authorized in 1939, but construction of Platoro Dam waited to begin in 1949 and was completed in 1952.⁸⁸

Also during the 1930s, Reclamation carried out investigations into a number of potential projects in Colorado, some of which were realized decades later. The first were the Paonia project (authorized in 1947 and its first phase completed in 1953), and Collbran (Vega Reservoir), authorized in 1952, and constructed from 1957 to 1961. In 1956, Congress authorized the mammoth Colorado River Storage Project (CRSP), which bundled together reservoirs throughout the upper Colorado River basin so that hydroelectric generation at some of the large dams could help subsidize construction of storage elsewhere. In Colorado it included the Wayne N. Aspinall Storage Unit on the Gunnison River, consisting of the Blue Mesa Dam (constructed 1962-66), Morrow Point Dam (constructed 1963-68), and Crystal Dam (constructed 1973-76). Among the other participating projects were Florida (constructed 1959-62), Smith Fork (constructed 1960-62), Silt (constructed 1964-68), Bostwick Park (constructed 1966-72), and an enlargement of the Paonia project (constructed 1959-62). Congress enlarged the CRSP in 1962 to include the San Juan-Chama project in Colorado and New Mexico, and in 1968 to include the Dolores, Dallas Creek, and Animas-La Plata projects.⁸⁹

⁸⁷ Robert Autabee, "Colorado-Big Thompson Project," Bureau of Reclamation History Program Research on Historic Reclamation Projects (Denver, 1996); Tyler, *The Last Water Hole in the West*; Rocky Mountain National Park Multiple Properties Nomination (1988), 36-37.

⁸⁸ William Joe Simonds, "The Pine River Project" (1994); Simonds, "The Fruitgrowers Dam Project" (1994); Eric A. Stene, "The Mancos Project" (1994); William Joe Simonds, "San Luis Valley Project" (1994). All in the series: Bureau of Reclamation (Denver) History Program Research on Historic Reclamation Projects.

⁸⁹ Thomas Latousek "The Paonia Project" (1995); Toni Rae Linenberger "The Collbran Project" (1997); Robert Autabee, "The Florida Project" (1995); Thomas Latousek "The Smith Fork Project" (1995); Toni Rae Linenberger "The Silt Project" (1997); Linenberger, "Bostwick Park Project" (1999); William Joe Simonds, "Dallas Creek Project" (1999). All in the series: Bureau of Reclamation (Denver) History Program Research on Historic Reclamation Projects. See also Bureau of Reclamation (Denver), 'Animas-La Plata Project Chronology of Events' [2002?]

The most important of the new projects outside the CRSP is the Fryingpan-Arkansas (“Fry-Ark”), supplementing both agricultural and urban supplies in the Arkansas River Valley. This too resulted from Reclamation studies carried out in the 1930s, but was not authorized until 1962.⁹⁰

Reclamation projects often served to correct the water supply deficiencies of earlier canal systems. Most dramatically, the Fruitgrowers Dam project northeast of Delta in 1938 rebuilt a dam originally constructed in 1898 by the Fruit Growers Ditch and Reservoir Company and then enlarged several times before failing in 1937. For a more typical example, the Riverside Irrigation District north of Fort Morgan early sought Colorado-Big Thompson water to remedy its shortages from leakage and evaporation.⁹¹

Other federal programs affected ditches and canals, particularly during the New Deal era in the 1930s. The Public Works Administration (PWA) financed Denver’s completion of the Moffat Tunnel built some reservoirs, and surveyed sites for others.⁹² The PWA’s successor, the Works Progress Administration, rebuilt parts of ditch systems, covered ditches in some urban settings (particularly City Ditch in Denver), and built many bridges. The Federal Relief Administration, through the San Luis Valley Project, built drainage ditches in low-lying parts of the valley and rebuilt irrigation laterals there. The Soil Conservation Service assisted ditch companies and individual farmers with designs for improving irrigation structures. The Rural Electrification Administration provided a new power source for farm irrigation from wells rather than ditches.⁹³

Non-agricultural water use and municipal water systems

The great majority of water delivered by ditches was and is for agricultural purposes. But Colorado from its early days was also an urban state. Ditches delivered water for a variety of non-agricultural purposes, and many Coloradans experienced ditches as part of the urban landscape. Denver had at one time 1100 miles of street laterals carrying water for a variety of urban purposes in addition to urban agriculture such as vegetable gardens and livestock. Most Colorado cities and towns had similar systems. Just as on the farm, the ditch was often the first urban infrastructure to be completed. Eaton,

⁹⁰ Carter and Mehls, *Southern Frontier*, 11-117.

⁹¹ Tyler, *The Last Water Hole in the West*; Dille, *Irrigation in Morgan County*, 33-39.

⁹² Paul William Turelli, “Denver’s Water Supply: From City Ditch to Two Forks” (Denver: University of Colorado History History masters thesis, 1991), 17; Husband, *Plateau Country Historic Context*, 104; Autabee, “Florida Project.”

⁹³ “San Luis Valley Resettlement Project” *San Luis Historian* 21:2 (1989); Dille, *Irrigation in Morgan County*, 50.

Colorado, at its beginnings had “newly plowed ditches marking both sides of cactus-covered streets.”⁹⁴

William E. Pabor described Greeley in 1883:

The waters flow through the streets of Greeley, furnishing the inhabitants with water for household purposes as well as for the irrigation of trees that line each street, and the flowers that bloom so profusely about the houses. Greeley has been termed the Garden Town of Colorado because of the multitude of gardens within its limits, and the Forest City on account of the trees that abound in it.⁹⁵

This was the place that Union colonists had encountered just thirteen years earlier as a treeless and barren plain. One of the most important roles of urban ditches was the creation of a cultural landscape that fit the expectations of migrants from the humid green East. Benjamin Eaton transplanted cottonwoods to streets in Eaton, Colorado, in 1881 even before houses went up.⁹⁶ Street laterals also served as dust control, very important for unpaved streets, and as a source of water for firefighting.

Ditches provided domestic water supply in town as on the farm. The Pacific Slope Ditch was Grand Junction’s first source of domestic water, delivered through street laterals running east and west from a main lateral flowing south down Seventh Street. Households might use a well for human consumption, especially where the purity of ditch water was in doubt, but the depth of the well and the weight of the bucket made ditches attractive sources of water for other household uses.⁹⁷ Even as cities and towns installed municipal systems of treated water, street laterals remained as a secondary distribution system for untreated water. The arrangement continues today in many places, mainly for urban irrigation.

Industrial power and process water are a relatively small but sometimes important use of ditch water. Grist mills were essential to the viability of early settlement. Littleton’s Rough and Ready Mill took the unused section of City Ditch as its power canal. Boulder’s Yount Mill ran from a flume off Farmers Ditch. Drops on ditches could be planned for water power potential rather than as protective features only. An example was the Pioneer Extension Ditch in Grand Junction, designed as a major industrial power source, though its big water-powered mills were never developed.⁹⁸

⁹⁴ Norris, *Written in Water*, 150.

⁹⁵ Pabor, *Colorado as an Agricultural State*, 77.

⁹⁶ Norris, *Written in Water*, 112; Pauline Allison, “The Founding and Early Years of Eaton, Colorado,” *Colorado Magazine* (1941), 57.

⁹⁷ Davidson, “Grand River Ditch,” 3; District 6 Water Adjudication case no. 4842, Evidence and Abstract Book 2 (1904), in Boulder Carnegie Library.

⁹⁸ Steinel, *History of Agriculture in Colorado*; Davidson, “Grand River Ditch,” 3, 10.

The successor to mechanized waterpower is hydroelectric generation, which relies on the same inputs – the volume of water and ability to control it; the height (or “head”) of its fall – but can transmit its output over great distances to be used where convenient. This makes the power more valuable. The Bureau of Reclamation early learned that it could finance the irrigation, flood control, and recreation branches of its mission with “cash-register” hydroelectric dams.



Figure 10. Yount Mill, Boulder, Photographed in 1900. The mill is powered by water from Farmers Ditch passing through a wooden flume and falling back into Boulder Creek.

Courtesy Boulder Public Library Carnegie Branch Library for Local History.

Urban interactions with ditches went beyond the use of water to include problems and opportunities as it was conveyed through the city. Hazards of drowning and flooding led to periodic campaigns to fence or pipe ditches in towns. These efforts did not accomplish much statewide, because of the extraordinary expenses, but they had effects in particular localities, most notably in getting most of Denver’s City Ditch put underground. Irrigators were often sympathetic with these goals, because of what they saw as the urban issues of water quality and service disruptions from town residents dumping trash in or otherwise interfering with the ditch. However, irrigators and town residents typically did not agree who should pay for the fences and pipes.

While some townspeople saw ditches as hazards, others saw amenities. At the largest scale, they could become an element of urban design, as in Denver where City Ditch was incorporated as a median canal in the Marion Street Parkway. Frederick Law Olmsted, Jr., in 1910 proposed a “Beasley Ditch Parkway” in Boulder.⁹⁹ Ditches provided the opportunity for ornamental bridges in Rocky Ford and many other towns. Photographer “Rocky Mountain Joe” Sturtevant used a ditch lateral to create the “Boulder Cascade” as a backdrop for his portraits.

⁹⁹ Frederick Law Olmsted, Jr. *The Improvement of Boulder, Colorado. Report to the City Improvement Association* (1910).



Figure 11. Marion Street Parkway, Denver, Colorado. Photo c. 1913-1920 by Louis Charles McClure. City Ditch serves as a water feature in the parkway median.

Courtesy Denver Public Library Western History Collection [MCC-1938]

Nor were ditches as amenities a merely urban phenomenon. At McGraw Ranch, now part of Rocky Mountain National Park, a ranch ditch was rebuilt to serve as a “babbling brook” for dude ranch cabins.¹⁰⁰ Many ditches in every part of the state have elicited expressions of folk art – footbridges, benches and adornments, ornamental water wheels and other flights of whimsy. This folk art is a rich vein of expressive material culture.

Municipal water systems are the most important non-agricultural use of water in Colorado. They figure in the history of Colorado’s ditches in three main ways: First, most municipal systems began by cities buying into or taking over existing ditches. In several cases cities and ditch companies have co-developed reservoir or distribution systems, as the companies had reservoir sites and the cities had money. Second, cities built their own systems, some of them moving water through canals. Finally, municipalities have come to hold the fate of historic ditches in their hands, by dewatering them through water transfers, but also sometimes by preserving them through open space programs.

¹⁰⁰ Cultural resource inventory form 5LR1131.26 (McGraw Ranch Ditch System), Office of Archaeology and Historic Preservation, Colorado Historical Society.

The earliest, biggest, most important municipal system is Denver's. The city bought Smith's Ditch – thereafter called City Ditch – in 1875. Water supply for the growing city continued to be developed by a succession of competing private companies, consolidated in 1892 as the Denver Union Water Company, with Walter Cheesman as president. The company built Cheesman Reservoir on the South Platte from 1900-1905. After Cheesman died in 1907, Mayor Robert Speer sought city purchase of the company, finally accomplished in 1918 with the creation of the Denver Water Department. The city contracted to buy the High Line and High Line Extension Canals, and the new Antero Reservoir, in 1915. After extensive litigation, Denver took possession of the High Line in 1924.¹⁰¹ The Denver Water Department went on to construct an extensive network of trans-divide diversions, starting with the Moffat Tunnel, which first delivered water in 1936.

A number of other Colorado cities went through some of the same stages as Denver: early private water companies; municipalization of water supply and acquisition of local ditches (or shares in them); and more extensive development of new facilities later as the cities grew. Loveland, for example, bought the 1903 Eureka Ditch, a trans-divide diversion in what is now Rocky Mountain National Park, in 1914. The Big Dam west of Loveland, built in 1880 and rebuilt in 1895 for the Home Supply Ditch Company, now also supplies the Loveland Water Treatment Plant.¹⁰²

Municipalities have contracted for water supply from Reclamation projects. In recent decades, cities have become major competitors with agricultural users for water, buying water rights and transferring them from ditches to municipal pipelines. Colorado Springs began buying water rights in South Park in the 1950s as the city's postwar growth spurt began. In the same decade the Denver Water Department faced legal difficulties over its plans to build Dillon Reservoir and the Roberts Tunnel, and for several years stopped extending water lines into suburban areas beyond a "Blue Line." This forced outer suburban communities to look for their own supplies, mainly through purchases of agricultural land or water rights that they could transfer out of the ditches.

By the middle of the twentieth century, almost all of Colorado's irrigation ditches and canals had been constructed. The system continued to evolve with new Reclamation and municipal water supply projects. Ditch companies and individual irrigators refined and improved their facilities.

¹⁰¹ Turelli, "Denver's Water Supply"; HAER CO-67: 9-10.

¹⁰² Rocky Mountain National Park Multiple Resource Nomination, 30-31; Cultural resource inventory form SI.R.509 (The Big Dam), Office of Archaeology and Historic Preservation, Colorado Historical Society.

Many parts of the historic system have been shrinking. Irrigated agricultural lands along the Front Range, in the Grand Valley, and elsewhere are the scene of Colorado's fastest urban growth, consuming farms and their laterals, putting ditches underground and eventually doing away with them altogether. Urban water demands lead to water transfers out of irrigation ditches into municipal pipelines. Where land continues in agricultural use, some farmers have shifted to groundwater irrigation, and some who still use ditch water have replaced surface systems with pipe laterals or drip irrigation.

If parts of the water system are changing out of existence, it is also remarkable how much remains stable. Ditches that date from the first years of settlement continue to flow, sometimes through much-changed surroundings, sometimes delivering water for much different uses, but still serving vital purposes.

2. Associated Property Types

This section focuses on property types that occur mainly as components of ditch or canal systems (e.g., headgates, laterals). It also includes others that exist in other contexts but may be associated with ditch and canal systems (e.g., dams, bridges). It is organized by groupings of functions within the water delivery system:

- diversion structures
(headgates and headworks; diversion dams);
- water conduits
(main canals and ditches; flumes; tunnels and rock cuts; pipes and culverts; siphons; laterals; pumps and sprinkler systems);
- protective and cleaning features
(sand traps; debris grates; waste and overflow gates; drop structures; overchutes);
- water storage (reservoirs);
- control and measurement features
(turnouts or lateral headgates; weirs and checks; non-structural field control devices; water measuring and recording devices);
- associated properties
(camps and buildings; borrow pits and quarries; power stations and mills; bridges, retaining walls; access roads; communication lines; drains; vegetation; ditching machinery).

Diversion structures

Headgates and headworks

A *headgate* is a single structure controlling water flow into a ditch. The *headworks* refers to a complex including a headgate and additional components (the word “headgate” is often used for a lateral turnout, especially to a large lateral. Lateral headgates typically have few if any additional headworks components). The modern ditch headworks, common by the early 20th century, may include an outside headgate structure (primarily intended to keep excess water and debris out of the ditch); a spillway back to the stream and inside gates, which are the mechanism for fine control of water flow; usually a sand trap, frequently combined with the spillway; a measuring



Figure 12. Headworks of the Croke Canal on Clear Creek in Jefferson County. Photograph by Louis Charles McClure c. 1900-1920.

Courtesy Denver Public Library Western History Collection [MCC-1873]

flume and recording apparatus. Most headworks include at least a low dam in the stream to channel water toward the ditch. Where there is no dam there may be some manipulation of the streambed for the same purpose, especially during periods of low flow. A roadway provides vehicular access to the headgate, even if the ditch right-of-way itself has no such access.

The earliest ditches, especially small ditches on small streams, might get by without headworks or headgates at all. “The river ran bank full,” wrote William E. Pabor in 1883, “and filled these ditches without the requirement of dams.”¹⁰³ Headgates function not only to keep out excess water and debris, but also to shut off the ditch when it has no right to run water; thus the impetus for installing headgates has not always come from the ditch users. An 1889 Act required every ditch to erect and maintain a headgate, upon order by the district water commissioner. Long after the South Platte was fully appropriated by ditches in the Denver area and farther north,

¹⁰³ Pabor, *Colorado as an Agricultural State*, 76.

ditches at the headwaters in South Park had no headgates and therefore took water throughout the season regardless of their junior appropriations.¹⁰⁴ Downstream users pressured the state engineer to enforce the law requiring headgates.

Ditch headgates were initially made of wood. Some, especially on large canals, used supplementary steel. In the 1880s, on the privately-built canals in Montrose and Delta counties that later became part of the Bureau of Reclamation's Uncompahgre Project, "the headgates were made entirely of wood with a few steel straps (to hold the gate leafs together) and perhaps a threaded steel shaft with a wheel on top to run the wooden gate up and down through wooden slots." One of those headgates, on the East Canal, survived in operation at least until 1980.¹⁰⁵

The cost of concrete came down in the 1880s and 1890s, and it began to come into common use on ditches in the 1890s. Headworks were most likely to be the first component rebuilt in concrete and steel, usually after damage by a flood. The Grand Valley Ditch was built with a wooden headgate in 1883. When a flood destroyed it in 1898, it was rebuilt with steel gates set in stone masonry (completed 1901, and still in service 1986). Large ditches and canals began using radial steel gates around the turn of the twentieth century.¹⁰⁶

Diversion dams

Dams that impound water to create reservoirs are considered separately below. *Diversion dams* do not store an appreciable amount of water, but rather regulate the water level in the stream to supply the headgate reliably. The earliest diversion dams were brush or cobble, rearranged each year as needed. Even large canals might adopt this system, so long as stream levels were adequate. On the pre-Uncompahgre-project canals in the 1880s, "a diversion weir or dam was not built across the river, but rocks were simply piled in the stream to force the water to a high enough elevation so that it would flow through the headgates into the ditch."¹⁰⁷ The Grand River Ditch in Grand Junction had no diversion dam, but in the drought of 1888, the managers built wooden cribbing into the river to direct water toward the headgate.¹⁰⁸

¹⁰⁴ State Engineer, *Biennial Report, 1889-90*, 13; Colorado Agricultural Experiment Station Bulletin 67 (1901): 9; Silksensen, *Farmers' High Line*.

¹⁰⁵ "Historic Canals on the Bureau of Reclamation's Uncompahgre Project," NRHP nomination.

¹⁰⁶ Farmers High Line first began replacing wooden structures with concrete and steel c. 1910. Silksensen, *Farmers' High Line*, 79 n. 6; Davidson, "Grand River Ditch," 13, 27.

¹⁰⁷ "Historic Canals on the Bureau of Reclamation's Uncompahgre Project," NRHP nomination.

¹⁰⁸ Davidson, "Grand River Ditch," 21.



Figure 13. Headgate for Mutual Ditch on Buzzard Creek in Plateau Valley, Mesa County. Photographed by Louis Charles McClure c. 1911. Headgate is wooden with steel control mechanisms. Diversion works consist of a temporary rubble dam in the stream.

Courtesy Denver Public Library Western History Collection [MCC-1471]

On the Weldon Valley Ditch in Morgan County, built in 1881, “[i]n the early days the diversion dam was built of brush, rock and piled up river sand. Many car loads of rock were shipped in on the new railroad to maintain and rebuild this structure and protect the headgate after every flood in the river.”¹⁰⁹ The railroad permitted an industrialized version of the ancient pre-industrial system of temporary diversion works.

By the early twentieth century, concrete dams were common as ditch headgates were built or rebuilt for major ditches. They ranged from low weirs in small streams to the Reclamation Service’s Grand Valley diversion dam in the Colorado River, the largest roller-crest dam in the world when it was completed in 1914 (it is National Register-listed, and visible from Interstate 70).¹¹⁰

¹⁰⁹ Dille, *Irrigation in Morgan County*, 10.

¹¹⁰ Silkensen, *Farmers’ High Line*, 83-84; Simonds, “The Grand Valley Project.”

Water conduits

Main canals and ditches

There is no clear definition distinguishing “canals” from “ditches,” yet the two terms are not quite interchangeable. *Ditch* is the more inclusive term, and is sometimes used to refer to all water conveyance channels no matter what size. *Canal* generally refers to a larger channel, but that may mean anything from 10 to 150 feet in width.

Earthen (and clay-lined) channels

Almost all early ditches, and most Colorado ditches to the present, are earthen channels. Their section is typically trapezoidal, with side slopes depending on the stability of the ground, and generally in the range from 1:1 to 1:2, vertical to horizontal.

Ditches typically drop 1 to 5 feet per mile. Large canals will be at the lower end of the range because the water flowing in them is subject to less hydraulic friction from the channel. Any drop greater than the norm increases erosion, creating maintenance headaches both where the erosion occurs, and where the sediment is deposited. Ditch builders sought shallow grades in order to water as much land as possible from a given diversion point, but too little slope would not allow the ditch to flow. Setting the grade of the ditch was not at first an exact science. A pan filled with water might serve as a level. Surveying instruments were sometimes available, but not always in skilled hands. Smith’s Ditch (later City Ditch) in Denver needed to be rebuilt when it would not flow. Twenty years later in 1881-82, the original survey for Grand Valley Ditch ran the channel uphill. Less dramatic grading errors needed to be corrected in the early Greeley canals, and probably many others.¹¹¹

Ditching techniques varied with terrain and available labor and technology. Mining ditches were constructed by miners, conveniently since they often needed to cut through rocks (see *Tunnels and Rock Cuts*, below). On the plains, the first step was breaking sod, sometimes with great ten-oxen teams. Then horse-drawn *fresnoes* (scrapers) could excavate the earth. Observers described a rhythm of pulling along the bottom of the ditch, up the bank to dump, then back down, over and over.¹¹² On sloping ground the earth was dumped mainly on the downhill side to build up an embankment. Over the years, spoil from ditch clean-out would be placed on the same side to maintain the embankment.

¹¹¹ Silksens, *Farmers’ High Line*, 28; Worster, *Rivers of Empire*, 76; Davidson, “Grand River Ditch,” 4, 6.

¹¹² Norris, *Written in Water*.



Figure 14. Ditch construction by teams of horses with fresno scrapers. Photographed 1918.

Courtesy California Digital Library [I0026719A]

Large canals drew upon the techniques of railroad construction. This most often meant the organization and deployment of large numbers of men and animals, rather than the application of mechanized power. The construction of reservoirs in the 1880s and 1890s began to employ steamshovels for the massive excavations required to build earthen dams, and steamshovels sometimes worked on the big canals that were parts of the same systems. One very large canal, the Grand River Canal, was enlarged in 1888 using a steam-powered dredge floating in the canal itself.¹¹³ For smaller ditches, patented ditchers aimed for greater efficiency through continuous rotary action.

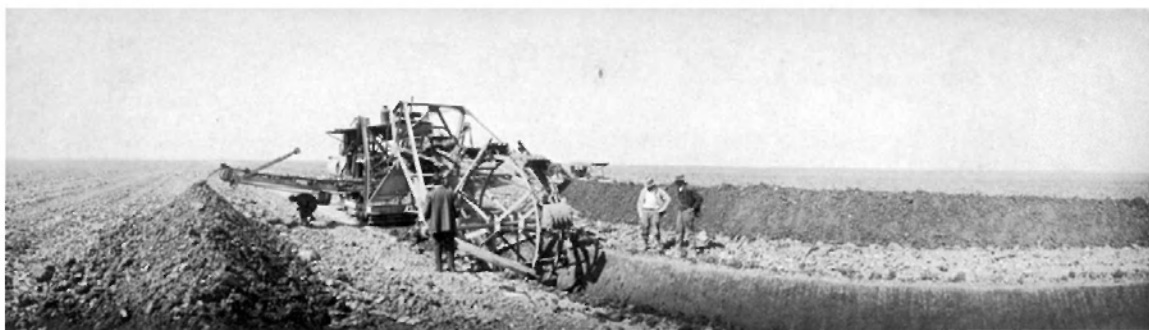


Figure 15. Austen Ditcher, photographed 1910.

Courtesy California Digital Library [I0027761A]

Ditches from the period of mechanized excavation sometimes include deep cuts through high ground, similar to railroad or highway construction. Such cuts were rare on earlier hand-dug ditches. When Americans returned from the First World War in 1918, many brought back experience with treaded vehicles, some of which were available as Army surplus. By the 1930s mechanized excavation became the norm. Over the succeeding decades, troublesome segments of ditch that had been tolerated

¹¹³ Davidson, "Grand River Ditch," 21.

were sometimes reconstructed or realigned.¹¹⁴ Untroublesome segments were not likely to be changed.

New ditches could be thirsty, losing much of their water to seepage. This problem usually became less severe over time, partly through rising water tables fed by the ditches, partly as fine silt from the leaking water permeated the soil and began to seal the ditch. In porous ground or leaky segments of ditch, ditch builders “puddled” the ditch by soaking it and working in imported silt to seal it. Even porous rock, such as Grand Junction’s blue shale, could require puddling, which might cost as much per mile as the excavation itself.¹¹⁵ Such clay lining remains an important tool of seepage control.

Lined

Lining is intended to keep water in the ditch, to reduce annual maintenance, and to reduce hydraulic friction and thus increase the capacity of a given channel size. Lining includes the whole surface below the water line – the bottom as well as both sides of the channel. Retaining walls, by contrast, are meant to support the ground behind them, and may be installed on one or both sides of the ditch. They do not necessarily include a bottom though they may be installed with a bottom lining.

Lining is usually of concrete or applied cementitious coatings.¹¹⁶ The South Canal, constructed 1904-09 on the Bureau of Reclamation Uncompahgre Project, included segments lined with 10-inch thick concrete. The Havemeyer-Willcox canal system was concrete-lined when it was built in 1911. The expense of concrete lining made it rare as a treatment for whole ditches, and more common for particular segments subject to leaks, erosion, or other problems. By 1915, *Irrigation Age* featured the “cement gun” as an economical means of applying a lining (now called “Gunitite” or “shotcrete”) without formwork.¹¹⁷ Later solutions, which relied on mechanization of the jobsite, included movable, re-usable formwork, and pre-cast concrete linings, mostly for smaller ditches and laterals.

In the past 50 years, rubberized fabrics have come into use to reduce seepage where no structural reinforcement is needed. Fabric lining is not a substantial modification to the ditch; while it may have a visual impact, it is structurally minor and reversible.

¹¹⁴ See, for example, Silkensen, *Farmers’ High Line*, 108.

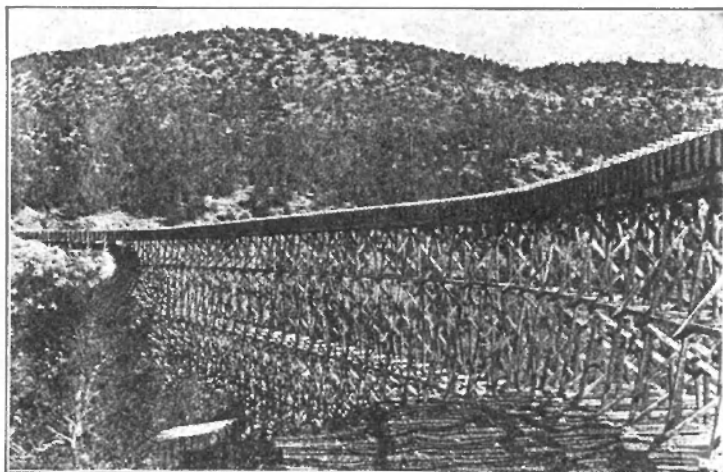
¹¹⁵ Davidson, “Grand River Ditch,” 17-18.

¹¹⁶ Early ditches in California included stone or clay tile linings; JRP Historical Consulting Services, *Water Conveyance Systems in California*. Small laterals in Colorado were sometimes lined in stone or wooden planks.

¹¹⁷ Cultural resource inventory form 5GF654 (Havemeyer-Willcox Canal); Silkensen, *Farmers’ High Line*, 83; “Shooting Cement Lining in Ditches” *Irrigation Age* 30:7 (May 1915): 215-17.

Flumes

Flumes carry water across ravines or depressions, at the grade of the ditch. *Bench flumes* carry water along a slope that is too steep or unstable for canal construction (see figure 5).



Pinon Canal, Flume, Colorado.

Figure 16. Cottonwood Trestle, constructed 1903, Pinon, Colorado

Source: *Irrigation Age* 21:12 (1906)

Flume walls (whether of wood or especially of metal) provide less hydraulic friction than canal walls, so water flows faster and the cross-sectional area of the flume is typically about half that of the canal. The beginning and end of a flume thus involve changes in water velocity and canal section, resulting in turbulence. Flumes usually include some headworks and tailworks, intended to avoid washouts at these points.



It is easily and quickly erected; the joint is simple, strong and watertight; it has the smoothest interior surface and therefore the highest carrying capacity. The question of *durability* is settled by employing for all the sheet metal portions—

Rust Resisting “Armco” (American Ingot) Iron

Figure 17. Armco Metal Flume advertisement, showing a “half-round” flume, with sheetmetal hydraulic surface and wooden structure.

Source: *Irrigation Age* 33:7 (1918) [detail]

Like other early canal structures, most flumes initially were built of wood. Early Hispanic acequias in New Mexico sometimes employed *canoas*, or hollow-log flumes. No examples are known in Colorado. Wooden flumes deteriorated quickly, in part

because of wear by fast-moving water. Wooden trestles were vulnerable to fire. Iron and steel flumes, most commonly with semicircular section, began to replace them by the end of the nineteenth century; they still relied on wooden trestles. Larger systems sometimes used reinforced concrete flumes, standing on concrete supports.



Figure 18. Large wooden flume on Orchard Mesa Canal, Mesa County. Photographed by Louis Charles McClure, c. 1911. The flume crosses a natural drainage and protects the canal from washing out.

Courtesy Denver Public Library Western History Collection [MCC-1481]

Flumes could be among the most dramatic of all irrigation and water supply structures. The Hanging Flume on the Dolores and San Miguel Rivers was built in 1889-91 for a hydraulic placer mining operation. An eight-mile-long structure pinned to sheer canyon walls, it operated for only three years. In 1883 Frank E. Baker, a Fort Morgan contractor who specialized in wooden ditch structures, built a 2100-foot-long flume across Bijou Creek for the large (400 cubic feet per second) Fort Morgan Canal. In 1895 a flood washed it out and Baker rebuilt it. This one washed out in 1935, and was

replaced by galvanized metal flume from the Hardesty Manufacturing Company in Denver. In 1949 part of this flume washed out and was replaced.¹¹⁸

Tunnels and rock cuts

Small *tunnels* and *rock cuts* could substitute for flumes where construction was difficult. Larger tunnels were built as parts of major engineered systems, particularly for inter-basin transfers. The Gunnison Tunnel on the Uncompahgre project is one example, the Moffatt Tunnel Pioneer Bore in the Denver Water system is another.

Colorado's hard-rock mining tradition may make water-supply tunnels more prevalent here than they would otherwise be. Water tunnels originated mainly from miners and mining technology. Handy Ditch in Berthoud includes a tunnel constructed in 1883 by miners who had worked in Sunshine. On Boulder's Silver Lake Ditch, the availability in the 1930s of an out-of-work miner allowed the ditch owners to replace a troublesome 1888 wooden flume with a short tunnel.¹¹⁹

Pipes and culverts

Nineteenth-century water *pipes*, and many large pipes into the twentieth century, were of wooden stave construction. Sheetmetal pipes for water transport were one of the technological innovations of the California gold rush, and miners brought the technology to Colorado. By the end of the nineteenth century, corrugated piping was common, allowing pipes to support the weight of fill above them. Short lengths of pipe are common at lateral turnouts to run under a built-up embankment, protecting the main ditch from washouts. On the Sand Creek Lateral of Denver's High Line Canal, lateral turnouts all ran through vitrified clay pipes, ranging from 6 to 20 inches in diameter.¹²⁰

Sheetmetal and corrugated pipes carried gravity-flow water. When elevated they were called pipe flumes or "full-round" flumes. Small pipe flumes are common as crossings to carry a lateral over a ditch (not uncommon in areas where more than one ditch irrigated the same service area).

Piping was also made of heavier iron and steel. As a flume, it could then support itself for longer spans between trestles. Heavy pipes (iron, steel, or wooden with steel

¹¹⁸ Cultural resource inventory form 5MN1840 (Hanging Flume), Office of Archaeology and Historic Preservation, Colorado Historical Society; Dille, *Irrigation in Morgan County*, 18-22.

¹¹⁹ Cultural resource inventory forms 5LR1710.1 (Handy Ditch) and 5BL3813 (Silver Lake Ditch), Office of Archaeology and Historic Preservation, Colorado Historical Society.

¹²⁰ HAFR CO-43-A: 18.

reinforcement) could also carry water under pressure. Pressurized piping was necessary for siphons.



Figure 19. Wood-stave siphon pipe on the Montezuma Valley irrigation system, constructed c. 1885, photographed in 1951.

Source: Historic American Engineering Record

Culverts are covered channels, often with fill above. They are commonly used as crossings under roads or railroads. Sometimes culverts are employed to gain usable space above the ditch in urban areas or elsewhere where space is at a premium, or to protect a reach of ditch from foreign material that might fall in, to protect people or animals from falling in. Early culverts were most often stone retaining walls with stone or wooden covers. Later versions are either pipe culverts (concrete or corrugated metal) or concrete box culverts.

Siphons

Siphons are closed conduits (pipes or culverts) that carry water under pressure, allowing it to dip below ditch grade. The *invert* is the vertical difference between elevations at the ends and at the low point. Long siphons (sometimes with a deep invert as well) avoided or replaced trestles to cross ravines or depressions, or circuitous ditch routes to go around them. These siphons are pressurized pipes, usually of steel, sometimes steel-banded wooden stave or reinforced concrete. Shorter siphons became common at railroad crossings, and at road crossings as highway grades became more controlled. Siphons could also cross streams, substituting for a flume and reducing the risk of flood damage. The High Line Canal was built in 1880-83 with

wood-stave siphons under creeks. Farmers High Line installed a wooden siphon at Ralston Creek in 1899, and added an additional 46-inch siphon pipe in 1902. The company installed another siphon under the Union Pacific Railroad tracks around 1911.¹²¹ Many stream crossings have a shallow invert and are built as pressurized concrete box culverts.



Figure 20. Mutual Ditch siphon, Sunnyside, in Plateau Valley, Mesa County. Photographed by Louis Charles McClure, c. 1911. A lower ditch crosses the siphon on a wooden flume, feeding a lateral that crosses the siphon again, on an earthen berm.

Courtesy
Denver Public
Library
Western
History
Collection
[MCC-1470]

¹²¹ HAER CO-43: 8; Silkensen, *Farmers' High Line*, 79-81.

Distribution

Laterals

Laterals refer to any water conduit distributing from the main ditch or canal. The term is thus elastic, depending on the scale of the system. Main laterals or branches from a large canal may be bigger than most main ditches. At the other end of the scale, the term “lateral” may refer to channels just inches wide, or to distribution pipes. The term lateral denotes function within a system rather than any absolute form or dimensions.

Ditch companies were generally responsible for the main ditch, and company responsibility ended at the lateral headgate (some complex systems might include company responsibility for main laterals as well). Laterals, even miles long and serving many users, were usually administered informally and were much less likely than the main ditch to be documented.

Once water was delivered to a particular user it needed to be brought to the fields and crops, or other points of use. Small channels called *field laterals* and *spreaders* distributed the water within a farm or ranch. The smallest field laterals brought the water to the tops of individual furrows for row crops, and spreaders were turned with a plow to carry water across a pasture for flood irrigation. These field spreaders may be replaced today with flexible perforated hoses.

Laterals may be lined before main ditches because of the comparative ease of working with concrete or other linings at a smaller scale. Poured-in-place or precast concrete lining was common in some areas by the first half of the twentieth century. Laterals in yards or urban areas might be stone- or plank-lined, probably less for hydraulic performance than for landscape tidiness.

Pumps and water wheels, sprinkler systems

The great majority of Colorado ditches and canals are gravity systems. Exceptions included the Price Ditch in the early 1890s and the Stub Ditch in 1903, which pumped water from the Grand Valley Canal system in Grand Junction, and two other ditches pumped from the south side of the Colorado River in 1910. Pumps became fairly common in the mid-20th century for short rises to water lands above ditch. Before that time they were rare, in part because of the difficulty and cost of applying large amounts of power.¹²²

¹²² Simonds, “Grand Valley Project”; King, *Colorado Engineering Context*, 10-15.

One solution was the *current wheel*, using the flow of water in the canal itself as a power source. The most spectacular example was John Wellington's Wheel, constructed in 1894 near Grand Junction, lifting water 25 feet above the Grand Valley Canal to a 160-acre orchard. Using an ancient technology, the canal turned a water wheel which lifted water to a flume that brought it to the orchard ditch. Current wheels were also reported on the South Platte River. The Sharrard Park Pumping Station on the Havemeyer-Willcox Canal used a 50-foot drop on the Havemeyer Ditch to pump some of the water to two smaller ditches, 75 and 200 feet above the ditch. It operated for only a month in 1912 (the pumphouse was demolished in 1980 for the construction of Interstate 70).¹²³



Figure 21. John Wellington's Wheel, constructed in 1894 to lift water from the Grand Valley Canal to his orchard above. Photographed c. 1907 by Louis Charles McClure.

Courtesy Denver Public Library Western History Collection [MCC-1123]

Pumps were also used to lift water to tanks or reservoirs from which it could be delivered through sprinklers. Sprinkler delivery could be accomplished without pumping where lands were sufficiently below ditch. Such systems generally included at least a small regulating reservoir below ditch to maintain uninterrupted supply and pressure.

Irrigation pumping from groundwater is beyond the scope of this historic context. The first irrigation wells were shallow and steam-powered. Irrigation wells increased tenfold from 1929 to 1959, first through rural electrification and then through the advent of center-pivot irrigation systems in 1952.¹²⁴ It would be worthwhile to prepare

¹²³ Davidson, "Grand River Ditch," 24-26; King, *Colorado Engineering Context*, 10; Cultural resource inventory form 5GF654 (Havemeyer-Willcox Canal).

¹²⁴ Steinel, *History of Agriculture in Colorado*; Dille, *Irrigation in Morgan County*.

an additional historic context to identify historical resources remaining from this early period.

Protective and cleaning features

Sand traps

Sand traps, sometimes called “stilling basins,” allowed water velocity to slow down enough for suspended particles to settle, at a place where it was convenient to remove them. The sand trap would typically be incorporated into the headworks where a gate at the bottom of the trap could be opened to flush (or “sand out”) the sediment, rather than removing it mechanically. A waste gate back to the stream, a hundred yards to a mile or more from the headgate, might serve a similar purpose, allowing a periodic flushing of sand and gravel that had settled, making the ditch itself a sand trap that was at least partially self-cleaning. Other traps might be installed at stream crossings to flush sediments that entered the ditch later. Sand traps sometimes played a role in protecting water quality, when the “sand” included mine tailings or street runoff.¹²⁵

Debris grates

Debris grates were often incorporated into headworks, sometimes sized for whole trees and cow carcasses rather than anything smaller. Smaller ones were often hinged to permit cleaning without having to step into the ditch. Debris grates are also common at siphon and culvert intakes.

Waste gates or overflows

Waste gates were frequently incorporated in headworks to flush sediment. At stream crossings, they might also serve as an *overflow* to shed excess water – ditch builders early learned that excess could be as disastrous as shortage of water. Washouts were hazardous to the ditch and to life and property below it. An influx of runoff water could completely fill whole reaches of ditch with sediment. Historical patterns of runoff to ditches have increased insidiously in volume and velocity and decreased in wholesomeness, with the paving of roads and development of additional impervious surfaces. Waste spillways have been part of good ditch design from the earliest times, but they have also been added frequently in retrofits.

¹²⁵ See photos in “Historic Canals on the Bureau of Reclamation’s Uncompahgre Project,” NRHP nomination. Farmers High Line installed a discharge weir in 1918 to flush tailings from the first mile of the canal. Silksen, *Farmers’ High Line*, 90.

Drop structures

Ditch gradient much greater than the norm of one to five feet per mile greatly increases erosion. Where topography requires that flow move to a lower elevation, well-engineered ditches concentrate the elevation change in a vertical or near-vertical *drop*, or a sloped *chute*, where a structure can absorb the energy of the falling water. Some drop structures are retrofits after early maintenance experience revealed which reaches of ditch were prone to erosion.



Figure 22. Simple wooden drop structure on a ditch on the eastern plains. Photographed c. 1900-1920 by Louis Charles McClure.

Courtesy Denver Public Library Western History Collection [MCC-2403]

Nineteenth-century drop structures, like most early ditch structures, were built of wood. Drops took the hardest wear and tear of any ditch structures, with a useful life even shorter than the 15-20 year span for flumes and headgates. For example, the Golden Canal in an 1872 extension descended Semper Hill in Westminster in an unlined channel. Some time during the next few years, according to irrigation historian Greg Silkensen, the company built

a series of weirs and wooden flumes hundreds of feet long to convey irrigation water down the hill. A year after Farmers' High Line purchased the Golden Canal in 1886, the company rebuilt the existing 750-foot wooden chute [A]fter the 1898 irrigation season the weirs and chutes once again needed repairs. In 1911 after high water from a series of storms washed out a number of the canal's checks and weirs, Farmers' High Line began to slowly replace the remaining wooden structures with concrete.¹²⁶

The wooden structures were not completely replaced until the completion in 1920 of a concrete chute. It was still in use in 2000. For smaller drops, Farmers High Line had

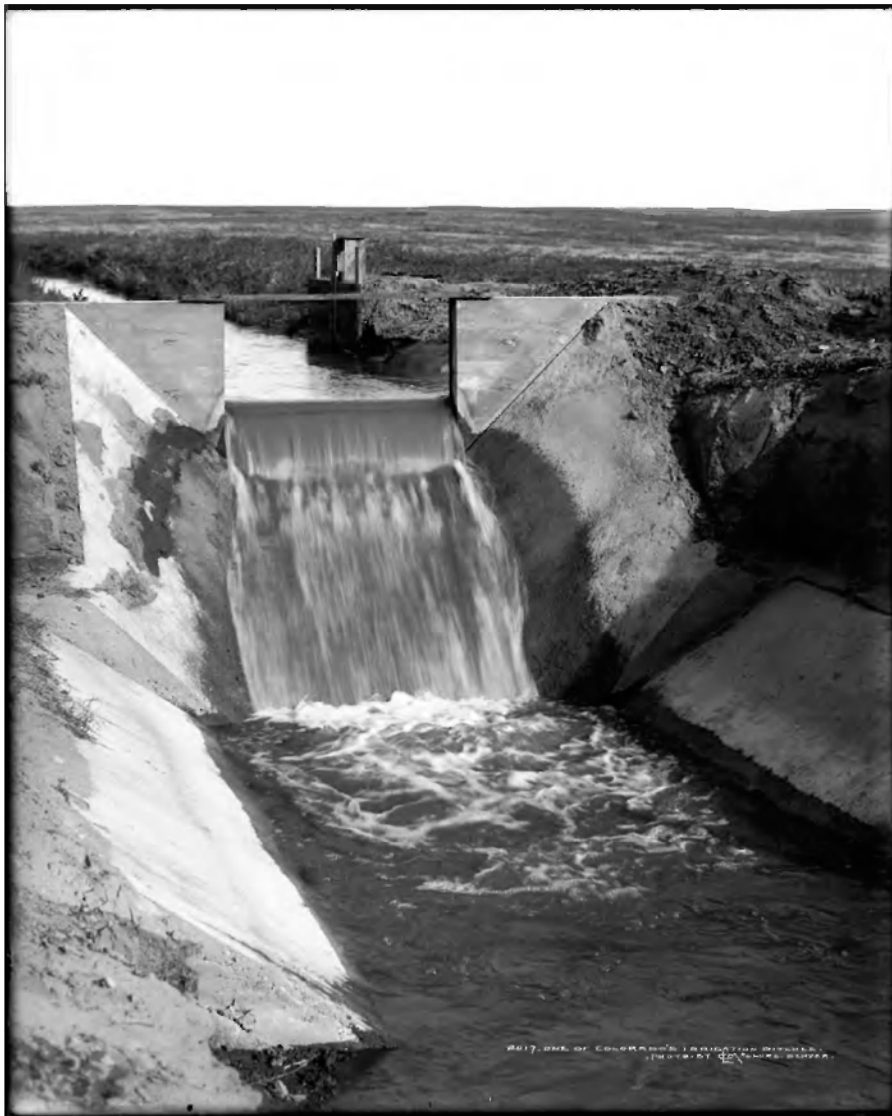


Figure 23. Simple concrete drop structure. Note headgate above – a typical relationship, taking advantage of the elevation in the main channel before reducing it. Photographed c. 1890-1920 by Louis Charles McClure.

Courtesy Denver Public Library Western History Collection [MCC-2017]

¹²⁶ Silkensen, *Farmers' High Line*, 81.

begun replacing wooden drops with concrete around 1900. The Grand Valley Canal's "Great Drop"¹²⁷ was built of wood, later replaced by concrete.

It is unlikely that any wooden drops over fifty years old survive unless as ruins on unused stretches of ditch.

Overchutes

Overchutes carry drainage water over the ditch channel. They are less common than culverts beneath the ditch. Their use depends on the relationship of the ditch to the surrounding topography.¹²⁸

Water storage

Reservoirs (and dams) are covered in the Colorado Engineering Context.¹²⁹ This section considers their relation to ditch and canal systems.

Reservoirs

Within a ditch system, reservoirs may be either below ditch – storing water between the headgate and the user – or above ditch, releasing water to the stream to be taken out at the ditch headgate. Below-ditch reservoirs range from farm ponds to large artificial lakes. Reservoirs are as old as ditches and canals in Colorado. They were part of Mesa Verde's water system, and the first in historic times was constructed in Jefferson County in 1859.¹³⁰

Above-ditch reservoirs became feasible once there was a working system of water rights administration to ensure that water released to the stream would not be taken out somewhere along the way to its intended users. The first substantial high-altitude reservoir was Chambers Lake, begun in 1882 on the upper Poudre River.¹³¹

Within the area that became Rocky Mountain National Park, the United States Forest Service approved 19 dams before the park was established in 1915. Only five were eventually built. The first was Lawn Lake, approved in 1903 and completed 1911 by the Farmers Ditch and Reservoir Company in Loveland. Lawn Lake Dam burst in

¹²⁷ Silkensen, *Farmers' High Line*, 34, 82-83; Davidson, "Grand River Ditch," 3 (photo page 9).

¹²⁸ JRP Historical Consulting Services, *Water Conveyance Systems in California*, 80.

¹²⁹ King, *Colorado Engineering Context*, 1-9.

¹³⁰ On Coal Creek. McKinnon, *A hundred years of irrigation in Colorado*, 37.

¹³¹ McKinnon, *A hundred years of irrigation in Colorado*, 37.

1982. Two others, begun in the same decade, became part of Longmont's municipal supply system in the 1930s.¹³² High-altitude reservoirs were particularly suitable for municipal supply because they captured water before it had much chance to pick up impurities. They also minimized losses to evaporation.

Control and measurement features

Control of water flow is essential for its use. Control and measurement are essential for sharing water among multiple users, whether on a single ditch, or along the length of a whole river. Control required communication (see *Communication lines* under *Associated properties*).

Turnouts or lateral headgates

Lateral headgates range from little gates off the ditch, to complex structures that divide the main ditch among several major channels. They differ from ditch



Figure 24. The simplest turnout: a small plank moved by hand in a wooden track. "Irrigation in Routt County," photographed by Louis Charles McClure, c. 1908-1915.

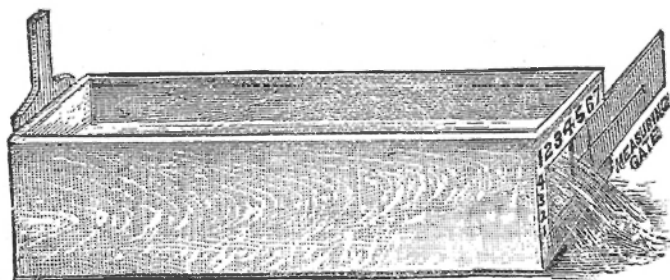
Courtesy Denver Public Library Western History Collection [MCC-1349, detail]

¹³² Rocky Mountain National Park Multiple Resource Nomination, 34-36.

headworks in that the incoming flow is normally controlled, so they do not need to be armored against flooding and debris.

The simplest durable lateral turnout is a wooden control box: flow is started or stopped by a plank sliding in a wooden track. The box holds the track in place and keeps the water from flowing directly against the earthen bank and washing it out. Variants may add a simple mechanism such as a lever to lift the gate. Such wooden boxes were used in Colorado's first ditches, and they are still being built today. They are not particularly durable but they are easy to construct and cost little.

Simple wooden gates could vary the flow, but the results had to be judged by eye. Many early innovations in control boxes aimed to add some means of measurement. An early version was the "Max Clark water box" developed by J. Max Clark, a member of the Union Colony. They were widely used by the 1880s, but not particularly accurate.



CLARK'S METHOD OF DIVIDING WATER.

Figure 25. Max Clark water box.

Source: William E. Pabor, *Colorado as an Agricultural State* (1883)

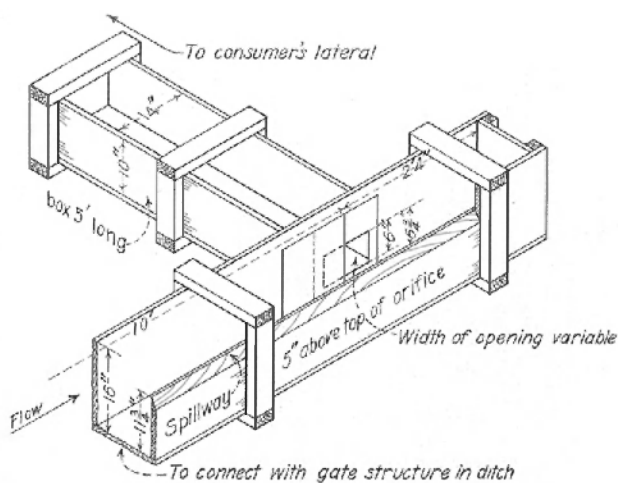


Figure 2. Some details of the Uncompahgre orifice.

Figure 26. Uncompahgre orifice. A standardized lateral turnout for the Reclamation Service project.

Source: Colorado Agricultural Experiment Station *Bulletin* 207 (1915)

While wooden gates were being refined, their short lifespan led to increasing popularity of more durable materials. One alternative was manufactured patent iron and steel gates, common by the 1890s. Hardesty Manufacturing Company of Denver was one major supplier. Manufactured gates in the twentieth century were usually set

in concrete headwalls, though earlier construction was often stone, which continued to be used. Steel gates often fed a pipe that extended beyond the ditch embankment.

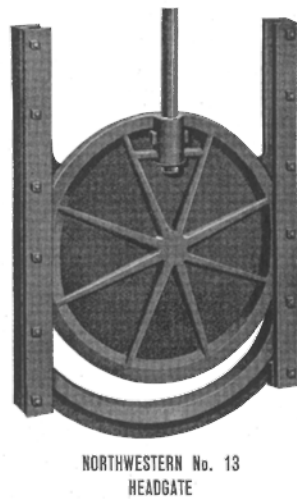


Figure 27. Northwestern iron headgate (advertisement detail)

Source: Irrigation Congress program (1910).

Junction boxes or “hydrants”

As some lateral systems moved into underground pipes, “hydrant” junction boxes made controls accessible to people above the ground. One example, promoted by the Colorado Agricultural Experiment Station, was the *Azusa Hydrant*.¹³³ Concrete junction boxes also became common for small surface laterals.

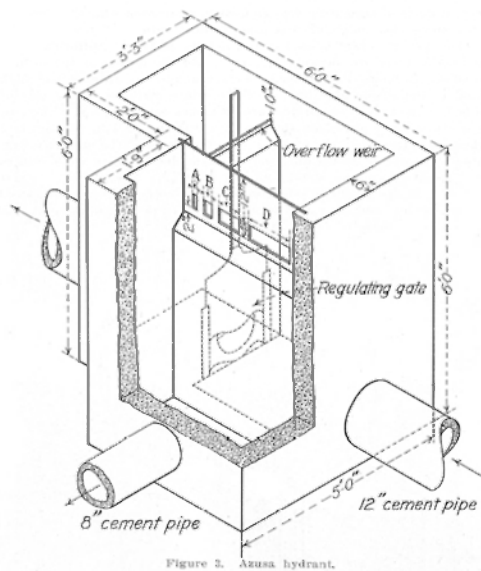


Figure 28. Azusa hydrant.

Source: Colorado Agricultural Experiment Station *Bulletin* 207 (1915).

¹³³ Colorado Agricultural Experiment Station *Bulletin* 207 (1915): 14.

Weirs and checks

Weirs or checks are little dams that raise the water level in a reach of canal behind them. Typically they include removable planks in a frame of wood or concrete to raise the water level between a few inches and a couple of feet, ensuring a level high enough for gravity flow through turnouts to fields or other destinations. Weirs could also impound water for other purposes, such as flow for sediment clean-out. Diversion dams in streams are sometimes called weirs as they too may take the form of a permanent structure below the waterline with removable planks to control water height.

Field control (non-structural)

The smallest ditches – field spreaders – also required control of water flow, but not necessarily with fixed structures. The simplest, most ancient means of control was to move earth with a shovel, opening a channel here and closing one there. Sandbags worked the same way, and once filled were less work to move from one channel to another. Another alternative was a plank or piece of sheetmetal pushed or pounded into the earthen channel. A *tappoon* was a canvas flap, attached to a rod, which served as a movable gate in field spreaders, damming water so that it would overflow the spreader banks and flood a section of field.

Water measuring devices

Most early attempts at water measurement involved efforts to calibrate lateral turnouts and other gates (treated above in *Turnouts or lateral headgates*). These tended to be unreliable. Hydraulic variables made actual flow vary not in linear relationship to the gate openings, and the gates left uncontrolled variables that made their absolute measurements dependant upon installation and therefore not consistent from one site to another. William E. Pabor described the problem in 1883: “The grade, the size of the orifice through which the water flows, the depth and breadth of the channel, all affect the result, more or less.”¹³⁴ More accurate measurement of flow required a measurement structure separate from the control gate.

One common device was the *Cipoletti weir*, a measured opening across the flow of the ditch. Cipoletti weirs required calibration by temporarily installing a measuring device to determine actual ditch flow. The weir would then lose accuracy as sediment or other factors changed the channel.

¹³⁴ Pabor, *Colorado as an Agricultural State*, 47.

The *Parshall flume* was developed by Professor Ralph Parshall of Colorado State Agricultural College (now Colorado State University). Parshall refined the design over the decades from the 1920s to the 1940s. The flume's throat (intake) and afterbay remove the hydraulic variables so that, properly constructed and installed, it is pre-calibrated to give a true flow measurement at a range of volumes. It is also self-cleaning.

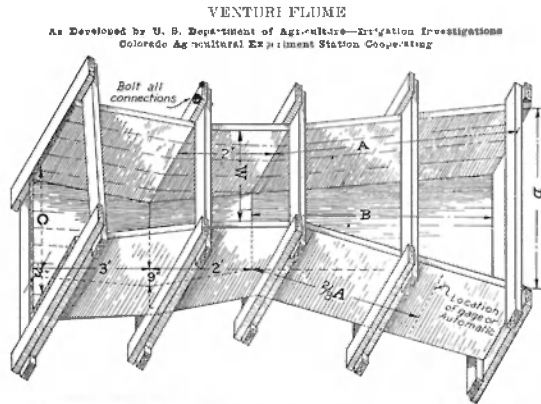


Figure 29. Venturi measuring flume.
Design by Ralph Parshall.

Source: State Engineer's Report, 1926

Parshall flumes may be installed at a variety of scales. They may be constructed of wood, sheetmetal, or concrete.



Figure 30. Professor Ralph Parshall
with a concrete Parshall measuring
flume, 1946.

Courtesy Colorado State University Water
Resources Archive

Recording structures

Measurements that required human observation could only be checked from time to time. Locking a gate in position was one more-or-less reliable means of ensuring that a measurement held steady, but it was dangerous to lock a headgate in an open position. By the 1880s, “clock-work” (spring-driven) and electric “registers” or “continuous self-recording gauges” were available to make a record of water level on a rotating

spool of paper (these devices were developed first for use at stream gauging stations). Water commissioners gradually required that such gauges be installed at ditch headgates. They were located in a recording house, usually not a building but a small shed or a cylindrical metal structure 2-3 feet in diameter and 4-6 feet tall.¹³⁵

Associated properties

Camps and buildings

Construction camps

Major canals shared with railroads the process of construction by large crews, often immigrants, and large collections of draft animals. Some were built from a single encampment that moved along as the right-of-way progressed. The Boulder and White Rock Ditch, for example, was built in 1874 with 35 men and 42 horses in an “encampment after the style of railroad grading,” and during construction an observer reported it “now the busiest point in the county.”¹³⁶ Other well-capitalized ditches used multiple camps to work on different segments simultaneously. Grand River Ditch in Mesa County, for example, was under construction in 1883 with 17 grading camps, including 110 teams of horses and 150 men, spread over 20 miles of ditch.¹³⁷

Grand Ditch, in present-day Rocky Mountain National Park, was under construction on and off from the 1890s to the 1930s, with new camps built as late as 1938 because of its remote location. Some ditch camps remain only as archaeological sites. Others, including several of the Grand Ditch camps, include remnant cabins or ruins. Some buildings continued in use, such as the La Poudre Pass Barn, built in 1892 or 1893 for the construction of Grand Ditch, and demolished in 1986.¹³⁸

Houses and maintenance buildings

Before automobiles, the length of even a medium-sized ditch could be the better part of a day’s travel. Ditch companies sometimes provided houses for ditchriders, particularly on remote parts of a system. There is no evidence that ditchriders’ houses

¹³⁵ Colorado State Engineer, *Second Biennial Report, 1883-1884* (Denver, 1884), 7; State Engineer, *Biennial Report, 1889-90*, 18.

¹³⁶ Unidentified news clipping, Feb. 13, 1874, Carnegie Library.

¹³⁷ Davidson, “Grand River Ditch,” 12.

¹³⁸ Rocky Mountain National Park Multiple Resource Nomination, 8-10; Cultural resource inventory form 5GA301.7 (Grand River Ditch Camp 7), Office of Archaeology and Historic Preservation, Colorado Historical Society.

differ in type or arrangement from other contemporary modest housing. Their origin and siting make them potential associated properties. A variant with specific siting is the headgate operator's house. Ditch companies also built and used other buildings – tool houses, barns and garages, shops.¹³⁹

Administration buildings

Ditch offices do not necessarily differ from other contemporary administration buildings, but may take their significance from canal system. They are the one ditch-associated property that may be located in no particular proximity to the ditch system itself, but rather in town. The Bureau of Reclamation's Uncompahgre Project headquarters in Montrose, constructed in 1905, is listed on the National Register.

Borrow pits and quarries

Canals are large engineering works, comparable to railroads and highways, and even small ditches could involve a great deal of earthmoving, especially when they crossed uneven terrain. Borrow pits provided earthen fill, and quarries provided stone for constructed features such as retaining walls. The McGraw Ranch ditch system in Rocky Mountain National Park includes an apparent borrow pit.¹⁴⁰

Power stations and mills

Power could be taken from a drop on the main ditch or as a lateral dropping from the ditch back to the stream. Early grist mills were water powered and often took their water supply from an irrigation ditch. Examples include the Rough and Ready Mill in Littleton and the Yount Mill in Boulder. At the Hayden Ranch outside Leadville, a water wheel on a lateral operated a sawmill and hay baler. The Grand Junction system was designed in the early 1880s for water-powered industry – it included large drops to give high head. Joseph King's *Colorado Engineering Context* describes the technology of water wheels and turbines.¹⁴¹

Later systems pursued the same general arrangements for the purpose of hydroelectric power. Reclamation projects such as the Colorado-Big Thompson were engineered for multiple purposes, including hydroelectric generation.

¹³⁹ Farmer's High Line built a four-room house at the headgate in Golden for the headgate operator in 1926, built a new one in 1967, purchased a tool house near Standley Lake c. 1912 and constructed a garage in 1916; Silkensen, *Farmers' High Line*, 83.

¹⁴⁰ Cultural resource inventory form 5LR1131.26 (McGraw Ranch Ditch System), Office of Archaeology and Historic Preservation, Colorado Historical Society.

¹⁴¹ King, *Colorado Engineering Context*, 38-44.

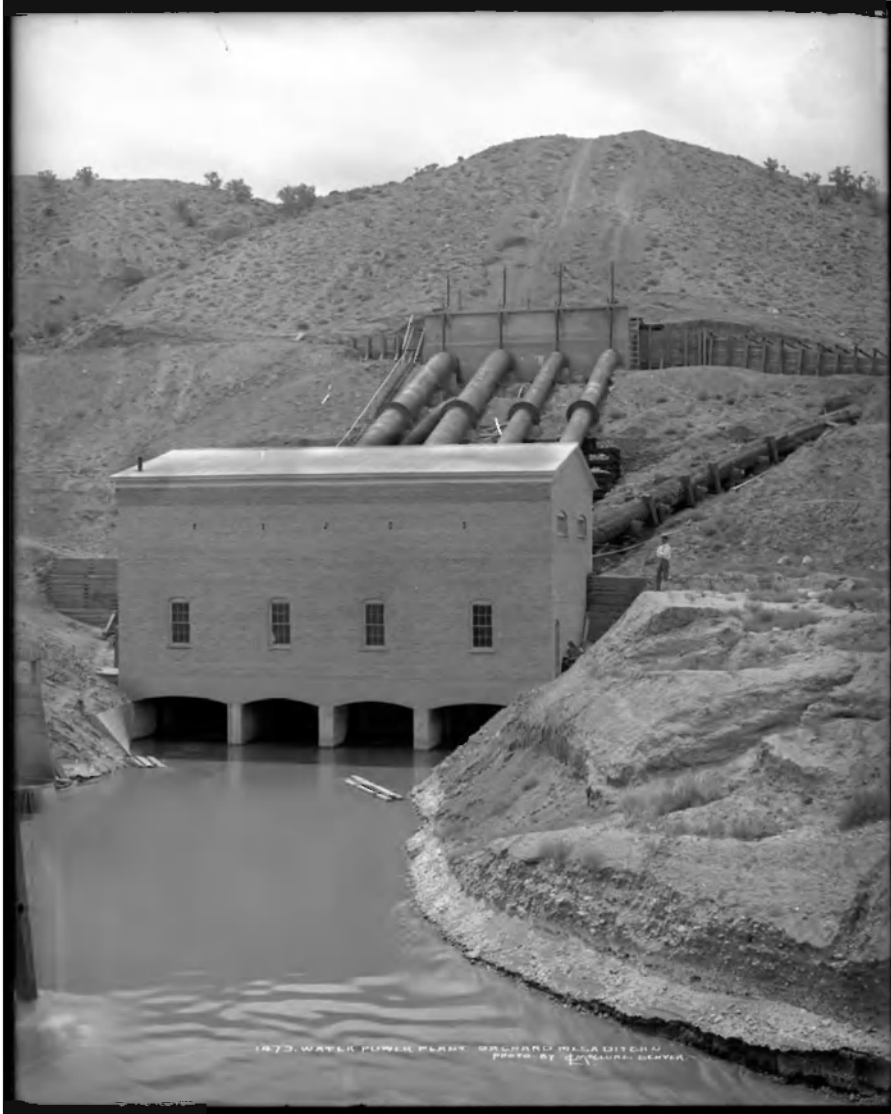


Figure 31.
Hydroelectric
plant on
Orchard Mesa
Canal.
Photographed c.
1911 by Louis
Charles
McClure.

Courtesy Denver
Public Library
Western History
Collection [MCC-
1479, detail]

Bridges

Bridges are typically part of a road or railroad system (and those systems provide the historical context for these structures). Ditch and canal crossings generally did not need to be designed with capacity for the high flows of floods, and therefore bridges are lower and openings narrower, and culverts more likely to be employed than on a natural stream of comparable size. Pedestrian bridges are relatively common because they can be small and close to the water with little chance of washing out.

Some bridges are functionally part of the ditch system: for example access road crossings, or pedestrian bridges for access to control structures.

Retaining walls

Walls may be in the ditch, retaining the sides of the ditch; or outside the ditch to retain the ditch bank or to retain sides of cuts above the ditch. Walls may be of stone, log (Grand Ditch), or concrete.

Access roads

Access roads are usually on the below-ditch bank (for access to lateral gates, which are located on this side, and to monitor for leaks and maintenance, mainly on this side). Occasionally they are on the uphill side for some local reason. Sometimes they are omitted, where nearby roads provide access, or topography or development make a road infeasible.

Communication lines

Farmers High Line Canal, in Jefferson County, in 1902 installed its own telephone service along the ditch, mostly strung along fenceposts, in use until 1912.¹⁴² Telephone lines may be an associated property along ditch access roads and rights-of-way.

Drains (desagues)

Complete ditch systems include *drains* for removing excess water from irrigated lands (in Hispanic systems, *desagues*). Water pooling and evaporating produces salinization, the most long-term irremediable hazard of irrigated agriculture. Drains are ditches, typically less finished than supply ditches, and depending on topography they are sometimes deeper. Drains do not require control structures but simply provide channels leading toward a natural drainage. Drains were also employed in hydraulic mining operations.¹⁴³

Vegetation

Ditch managers have been of two minds about vegetation. For the most part they try to minimize vegetation, especially phreatophytes, or water-consuming species such as willows. But they also frequently encourage or tolerate mature cottonwoods and other

¹⁴² Silkensen, *Farmers' High Line*, 78 n. 3.

¹⁴³ JRP Historical Consulting Services, *Water Conveyance Systems in California*, 48.

trees, as shade for livestock and people. The cultural landscape functions of ditches were not limited to urban street trees. Benjamin Eaton transplanted 45,000 cottonwoods along the Larimer and Weld Canal and the laterals under it.¹⁴⁴

Ditching machinery

Ditchers, dredges, fresnoes, if located in association with a ditch system, are potential associated *objects*.

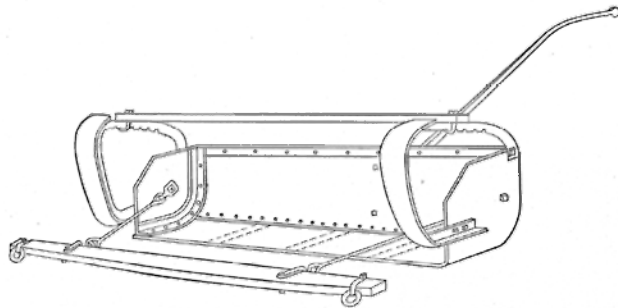


FIG. 26.—Fresno scraper.

Figure 32. Fresno.

Source: Samuel Fortier, *Use of Water in Irrigation* (1915)

¹⁴⁴ Allison, "The Founding and Early Years of Eaton"

3. National Register of Historic Places Registration Requirements

Ditches and canals are best understood as parts of functional *systems*. For even the simplest farm ditch, the system includes a source of water, a means of diversion, a conduit – the ditch itself – for carrying the water, and a means of controlling the flow, which may be a shovel in the farmer’s hand. The system also includes a use for which the water is delivered. That use – the farm or ranch – is part of a larger system, whether a subsistence community or an agricultural market.

The value of a systems approach in understanding ditches increases with the complexity of the system. Most major canals after the pioneer period relied upon water storage in reservoirs. The reservoir might be distant from the canal itself, at a high altitude for example; the canal cannot function and cannot be understood without it. The natural stream serves as a conduit in such a system. Water rights law and administration is an essential part of this system; a high-altitude reservoir would be constructed only with confidence that waters released into the stream may be withdrawn downstream at the canal headgate. Law and administration are intangible, but they have tangible expressions in measuring and recording devices on the ditch and gauging stations in the stream. Most areas of extensive irrigation now function as complex systems in which direct-flow and stored water are traded up and down the stream to get water to the right place at the right time for use. Almost all of Colorado’s surface water is delivered by gravity (irrigable land is referred to as “below ditch”), and water traders must end up with water that is physically above their point of use. Systems have evolved toward versatility in this respect; thus the several “high line” canals capable of delivering water to any of the earlier ditches below them.

Surveying a segment of a ditch: Ditches and canals are linear resources, like railroads or trails. A single linear property may be many miles long. A survey for a federal undertaking, as required in section 106 of the National Historic Preservation Act, may concern itself only with a project’s Area of Potential Effect (APE), for example, the boundaries of a highway right-of-way that crosses a ditch (the ditch segment surveyed should extend a minimum of 200 feet farther in either direction in order to include physical context). Even a survey of a whole municipality or county may include only a portion of a canal or canal system. How do we survey and evaluate a portion of a single structure?

Significance, for the purpose of National Register of Historic Places eligibility, should be evaluated with respect to the complete resource. That generally means the whole

ditch or canal; it may mean a segment of a canal if it has a distinct historical origin and identity (for example, the Upper and Lower Platte and Beaver Ditches in Morgan County). The surveyor should consider the significance of the whole resource, and then the integrity of the segment being surveyed. Significance should be evaluated with respect to at least a rudimentary historic context of a larger system. Survey projects that will include multiple ditches in a particular area should begin with such a context. The definition and scale of the system may be flexible depending upon the nature and function of the resources being studied. A consideration of significance for a small pioneer ditch in an isolated valley may look only at the farms that it served. A canal in the lower South Platte or Arkansas Valley should provide some understanding of its relationship to the history and function of the great Bureau of Reclamation plumbing systems that supply those regions.

National Register classifications: A ditch channel itself is a *structure*. It may be a single complex structure many miles long, including a headgate, lateral turnouts, embankments and an access drive. Some parts of the system, such as a diversion dam, tunnels, major siphons or flumes (but not minor components such as lateral gates or a recording shed), may be of sufficient magnitude that they can be classified as separate structures in their own right. A ditch may be treated as a *district* if it includes multiple resources as components, or if it includes additional component landscapes such as farm fields or ditch camps.¹⁴⁵

Significance criteria

National Register eligibility begins with significance, ascribed to resources meeting at least one of the National Register's four significance criteria:

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

Water is essential to life in semi-arid Colorado, and the development of water resources is central to the state's history. Ditches and canals were the most important factors in the development of Colorado's agriculture. Water supply was also a prerequisite for urban development. Many primarily agricultural systems also provided water for urban irrigation or municipal supply, for industrial power or process, or for hydroelectric generation, any of which, evaluated in context, may constitute a basis for significance under criterion A. Later parts of ditch systems may be associated with later phases of historical development – for example, the sugar beet industry.

¹⁴⁵ 'Linear Resources: Beware the Snake in the Grass,' *The Camera and Clipboard* 1 (Nov. 2002, Colorado Office of Archaeology and Historic Preservation): 6-7.

Criterion B. Resources that are associated with the lives of persons significant in our past.

Ditches were among the first works undertaken by Colorado's settlers, some of whom went on to achieve great significance in the history of their communities or of the state. Ditches like other properties may be eligible for their association with significant persons. Ditch and canal systems are often large and complex parts of their communities, involving many people in many ways – as advocates, promoters, land developers, ditch company officers or managers, for example. Individuals served as leaders or organizers for political, economic and legal actions, sometimes with significance far beyond any individual ditch. Where such an individual is historically important, a ditch's significance under criterion B will depend upon the strength of the person's association with the resource, and whether other resources better embody the association with the portions of the person's life or work that are historically important. Some examples of individuals important in Colorado (or national) irrigation history include Benjamin Eaton, T. C. Henry, Elwood Mead, J. Max Clark, Ralph Parshall, E. S. Nettleton, William E. Pabor, David Boyd, and James Duff.

If a person's place in history comes primarily from designing or building the ditch, then the ditch itself should be evaluated under criterion C. If the designer or builder is individually important as an irrigation engineer or contractor, then the ditch should be evaluated under criterion C as the work of a master.

Criterion C. Resources 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.

Ditches and canals may be eligible under Criterion C for distinctive engineering or for design innovations. They may be eligible as the work of a known irrigation engineer (if they exemplify the quality of the engineer's work) or as the work of an unknown builder when the work itself attests to the quality of mastery of design or construction. High artistic values may refer to the engineer's art. The quality of the design may reside in individual components, or in the arrangement of the whole system. High artistic values may also refer to landscape or architectural design, where a ditch or ditch components were treated aesthetically, in vernacular or in high style.

Ditches may be eligible as an important example or as a rare remaining example of an important type of construction (for example mining diversions). They may be eligible as well-preserved and characteristic examples of a type that is not rare (for example pioneer ditches or commercial canals). They may be eligible for departures from a type that demonstrate formal evolution, or that demonstrate adaptation to the circumstances of a particular function or place.

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

Traces of ditches from early or underrepresented periods of Colorado's history may be eligible under criterion D. For example: early placer mining ditches or ditches from trading posts or pioneer-era homesteads all may yield information from periods and settlement types that are otherwise undocumented. Associated properties, for example ditch construction camps, may yield important information about historical groups such as immigrant labor populations or early federal construction activities. Later ditches may also yield information unavailable elsewhere – ditch laterals, for example, whose location and arrangement is seldom documented, may provide information on the historical arrangement of agricultural lands, irrigation methods, and changing crop cultivation patterns. Remnant lateral turnout gates, where the laterals themselves have disappeared, may be the only evidence of previous development patterns.

Underground pipes and culverts are not visible and thus cannot convey historical significance; they can have integrity only under criterion D.

Level of significance may be local, state, or national. Under criterion A, for example, “the broad patterns of our history” may refer to an individual community's history, and a ditch may be significant for its importance in development of that community. State-level significance may be achieved through importance in the development of a large region that includes a number of communities or multiple counties, or that crosses major watersheds. Particularly important ditch and canal systems (Colorado-Big Thompson) or particular ditch innovations (the Colorado Doctrine of prior appropriation, the Parshall measuring flume) may be of a national level of significance.

Period of significance: The period of significance is important because it becomes a standard for determining which changes are to be treated as part of the evolution of the historic resource and which are to be treated as alterations that may contribute to a loss of integrity.

The period of significance must bear a logical relationship with the significance criteria under which the ditch is eligible. Eligibility under criterion A should be reflected in a period of significance corresponding to the historic events, or broad historical patterns, from which the ditch's significance derives. Under criterion B, the period of significance should reflect the dates of association with the important individual. If a ditch is eligible under criterion C for its design or engineering, the period of significance will ordinarily be the period of construction. It may include the dates of later alterations if they are significant in their own right. This might mean that they exhibit important qualities similar to those of the original construction, or that they represent important new advances in design or engineering. A ditch may have

two distinct periods of significance reflecting original construction and a second phase of alterations (for example, incorporation within a Bureau of Reclamation project). If the later alterations destroy the integrity of the original construction, then the ditch may be eligible under criterion C only for the period of the significant alterations. Where criterion C eligibility arises from the characteristics of an historical vernacular type of construction, the period of significance may include the entire period from which these methods of construction are evident in the resource.

Integrity

To be eligible for the National Register, a property with significance must also possess *integrity*. The integrity of a property, according to the National Register Bulletin *How to Apply the National Register Criteria for Evaluation*, is its “ability to convey its significance.” Assessing integrity requires an understanding of the property’s significance and which physical features are essential to conveying that significance. “They are the features without which a property can no longer be identified” as, for example, a nineteenth-century pioneer ditch.¹⁴⁶

While significance should be judged for the property as a whole, integrity must be judged solely for the portion under study (it could not be otherwise, since an assessment of integrity requires detailed scrutiny of the physical resource). Where the ditch is being surveyed as a structure, the question will not technically be whether it is “contributing” (because only districts have contributing and non-contributing components) but whether it exhibits integrity supporting the eligibility of the structure (or fails to exhibit such integrity).¹⁴⁷

The National Register criteria list seven aspects of integrity. The property and its reasons for significance will determine which are most important. “To retain historic integrity a property will always possess several, and usually most, of the aspects.”¹⁴⁸ See *How to Apply the National Register Criteria* for a general discussion of integrity. Below are some issues in applying the aspects of integrity to ditch and canal systems.

Seven Aspects of Integrity

Location – The ditch should remain on the original alignment from its period of significance. It is rare for a significant length of ditch to be re-routed. Alignment changes for short lengths of ditch are more common: a ditch may have washed out and been re-excavated farther into a hillside; a highway crossing may have reconfigured a

¹⁴⁶ National Register Bulletin, *How to Apply the National Register Criteria for Evaluation*.

¹⁴⁷ ‘Linear Resources: Beware the Snake in the Grass,’ 7.

¹⁴⁸ *How to Apply the National Register Criteria*.

channel; headworks may have been rebuilt with new diversion points; leak-prone or meandering segments may have been cut off by the use of heavy excavating machinery. Such minor realignments do not ordinarily compromise the integrity of the whole resource. Occasionally a longer alignment will be changed by the addition or elimination of a siphon, or a long segment will be realigned for some other reason; then the effect on integrity must be judged in relation to the ditch's overall significance and the period of that significance.

Design may refer to the engineering or technology of specific components, or the arrangement of the system as a whole. Where the ditch is significant for its design or engineering, the characteristic qualities or features of that design should remain evident. Integrity of design may be evaluated at the scale of individual ditch components, if that is where significance resides, or at the scale of the whole system. At the system scale, replacement of components may not diminish integrity if they are replaced in kind, the system functions in the same way, and its function remains evident. A systems approach, applied at the scale of the single ditch, can help keep clear the relative importance of component features when assessing integrity.

Setting – In urbanizing areas, open agricultural settings may have changed dramatically. Integrity does not require that the entire historic landscape remain, but rather that the features defining the ditch's significance are not rendered imperceptible by changes in the setting. Changes in a ditch's setting will not be fatal to integrity unless a contemporary from the period of significance would be unable to recognize the ditch. A well-preserved setting may contribute to integrity. Consider what the setting relationships were during the period of significance: some ditches passed through urban areas or non-irrigated areas with no integral relationship to the ditch. Setting may be relevant at various scales; it may consist of the ditch corridor itself, particularly where the ditch was historically vegetated and thus the character of the corridor was linear and self-contained.

Materials – Earthen channels ought to remain primarily earthen. Lining of segments in order to correct leaks, or as part of highway crossings or other short segments, do not fatally undermine integrity. Clay lining in particular has no effect on the integrity of an earthen channel. Wooden structures of all kinds were subject to such rapid wear and deterioration in the ditch that they were essentially temporary, typically replaced every 15 to 20 years. The absence of original wooden structures cannot be fatal to integrity, and the survival of any wooden ditch structure more than 50 years old, especially in functioning condition, is highly unusual. The gradual replacement over time of wooden by more permanent structures is characteristic of the evolution of almost all ditches. Concrete lining of whole ditches was practiced as early as the turn of the twentieth century, and concrete and steel structures of all kinds were common by the 1910s and 1920s. In short, the mere presence of metal gates or concrete lining does not necessarily undermine the integrity of a ditch system.

Workmanship may be exhibited in the maintenance of traditional earthen channels, or the craft of rock cuts or the formwork of concrete structures. For vernacular construction, workmanship does not require that quality be exceptional, but rather that the characteristic methods and quality of the type should be evident.

Feeling – Flowing water in an arid environment is evocative. The sight and sound of water, and our awareness that it is on its way to be useful, may help a ditch express its essential significance, and thus retain integrity in the face of other changes. The lack of flowing water does not mean that a ditch has lost integrity of feeling. Most active ditches are dry for periods each year. Ditches or portions of ditches that no longer carry water may retain integrity if enough remains of their physical fabric to convey their function and significance. Non-operating ditches may be subject to losses through natural erosion or human development, but may also retain original features unmolested by periodic replacement.

Association – Where a ditch is significant for an important historic event (criterion A) or the activities of an important individual (criterion B), it “retains association if it is the place where the event or activity occurred and is sufficiently intact to convey that relationship to an observer.”¹⁴⁹

Registration requirements for ditch laterals: Isolated laterals are unlikely to be National Register eligible by themselves. They should be evaluated within a larger context – either the ditch system of which they are a part or a larger land use context such as the fields that they watered. A lateral system need not be functioning or capable of functioning but should retain sufficient integrity to convey its function. Survival of some control structures is helpful in this regard but not essential. In a rural or urban district eligible for other reasons, even fragmentary traces of a lateral system may convey information about earlier landscape relationships and functions, and thus may be contributing features.

¹⁴⁹ *How to Apply the National Register Criteria.*

4. Research Guide

A guide to sources for researching Colorado ditches

Research on the history of a particular ditch may turn up mountains of material or very little. The best sources in one case may be no help in another. As a general rule, any research ought to include: 1) the ditch company; 2) local libraries and historical collections; 3) the State Engineer's Office; 4) standard online indices, such as *Prospector*, which will show the holdings of major research libraries; and 5) a variety of other sources discussed below.

Some general guidance:

- the most helpful research aids will be human: be sure to talk to reference librarians, archivists, and others who know their way around a collection.
- When using a catalog or index, try as many variant terms as you can think of – not just 'ditch,' but also 'canal,' 'water,' 'irrigation.' Try not only the ditch or ditch company name, but also the names of ditch company officers or major shareholders.

Ditch company resources

No ditch history can be complete without consulting the ditch company. That includes written records, and also oral histories. No one knows the ditch better than the people who use it and run it, and no one better appreciates its history.

Ditch records are not generally public, but some have been donated to public collections. The Ditch and Reservoir Company Alliance (DARCA) is working to assist its members with transfer of records to archives at either Colorado State University Water Resources Archive (<http://lib.colostate.edu/archives/water/index.html>) or the Denver Public Library Western History Collection. Documents are often stored with current officers of the ditch company. Some companies will make their records accessible for historical research, others will not. You ought to make your research available to them in any case; they may correct errors or point out omissions, and they might even get interested and change their minds.

Ditch company records vary in quality and completeness. At their best, they will contain an annual report of work done on the ditch and communication with others (for example developers, the Colorado Department of Transportation) about proposed changes to the ditch. Even minimal records, concerned mainly with annual assessments, can provide an indication of events such as washouts and major construction.

DARCA lists its members on the web at www.darca.org. Water Colorado lists its members, primarily in the South Platte River Basin, at www.watercolorado.com. Ditch company contact information is often on file in County Clerks' offices or County Planning offices.

Local Libraries, Archives, Museums

Local libraries, museums and archives can vary greatly in what resources they have and how they are organized and catalogued. Most municipal libraries have online catalogs, but the oldest materials often do not appear online. Holdings may include local newspapers (often also at the Colorado Historical Society), photographs, family collections, local government documents, ditch company records, books and manuscripts. Some ditches

are subjects of locally-published histories or manuscript reminiscences.

The following is a sample of facilities with irrigation holdings in their collections:

Canon City Public Library

516 Macon
Canon City, CO 81212
719-269-9020
ccpl.lib.co.us

Collection includes government documents, family collections, photographs and books. Indexes are available.

Jefferson County Archives

100 Jefferson County Parkway, Ste. 1500
Golden, CO 80419-1500
303-271-8446
www.co.jefferson.co.us/ext/dpt/techsvcs/archives/index.htm

This is one of two countywide archives with a full time archivist. Records include county property records, county surveyor records, water board base maps, place names directory and aerial photographs. Index of collections is online.

Clear Creek County Archives

405 Argentine St.
PO Box 2000
Georgetown, CO 80444
303-679-2357
www.co.clear-creek.co.us/depts/records.htm

This is one of two countywide archives with a full time archivist. Records include county mining, ranching and land records.

Denver Public Library Western History Department Boulder Public Library – Carnegie Branch Library for Local History

Both are accessible statewide through *Prospector*, and are described below in that section.

Colorado Division of Water Resources/Office of the State Engineer:

1313 Sherman St., Rm 818
Denver, CO 80203
303-866-3585 Main
303-866-3447 Records Section
www.water.state.co.us

The Office of State Engineer was created in 1881. It merged with other departments to become the Division of Water Resources in 1969. The DWR has a central office in Denver and one office in each of the state's seven water divisions. The State Engineer's office in Denver maintains records of every water diversion right, water storage right, and water right transfer, organized by water division and water district, and indexed by name and location. An index keys water rights to the court decrees that adjudicated them, and microfilms of those decrees sometimes provide additional information. Some recent information is available online. Earlier information can be found in the State Engineer's Biennial Reports (published since 1881) and other publications.

Water division offices

South Platte River Basin, Water Division 1
810 9th Street, 2nd Floor
Greeley, CO 80631
970-352-8712

Arkansas River Basin, Water Division 2
310 East Abriendo, Suite B
Pueblo, CO 81004
719-542-3368

Rio Grand Basin, Water Division 3
301 Murphy Drive
Alamosa, CO 81101
719-589-6683

Gunnison River Basin, Water Division 4
1871 East Main Street
PO Box 456
Montrose, CO 81401
970-249-6622

Colorado River Basin, Water Division 5
50633 US Hwy 6 & 24
PO Box 396
Glenwood Springs, CO 81601
970-945-5665

Yampa River Basin (includes White River Drainage), Water Division 6
505 Anglers Dr., Suite 101
PO Box 773450
Steamboat Springs, CO 80477
970-879-0272

San Juan/Dolores River Basins, Water Division 7
701 Camino Del Rio, Suite 205
Durango, CO 81301

Online catalogs: *Prospector*

www.prospector.coalliance.org

Prospector is an online searchable database of 23 member research libraries. The advantage of using *Prospector* is that you can search all 23 libraries simultaneously. You can access *Prospector* either through the website above or from any of the sites of participating members.

Denver Public Library, Central Library, Western History Department (Prospector)

10 W. 14th Avenue Parkway
Denver, CO 80204
720-865-1111
www.denver.lib.co.us

The Western History Department has one of the most extensive collections on Colorado history, including books and documents on irrigation in Colorado. The collection includes journals (Irrigation Age, Journal of the West and Agriculture History, San Luis Historian), maps including a circulating set of USGS 7.5-minute topographical quadrangles, and photographs (in the process of being digitized). The library is actively seeking collection materials and is working with the Ditch and Reservoir Company Alliance (DARCA) to serve as a repository for ditch company materials.

Boulder Public Library - Carnegie Library (Prospector)

1125 Pine Street
Boulder, CO 80302
303-441-3110
www.boulder.lib.co.us

Collection includes several sources on irrigation including oral histories and photographs.

Fort Lewis College, Center for Southwest Studies (Prospector)

1000 Rim Drive
Durango, CO 81301
970-247-7010
www.swcenter.ftlewis.edu

The Center for Southwest Studies focuses primarily on the culture and history of southwest Colorado and New Mexico. It actively pursues collection materials including ditch company records. Collections are indexed online, have finding aids and some

materials are digitized and available through their web site. Records of interest include (but are not limited to):

- Hayden Survey Maps – 1877
- Early versions of USGS maps for the southwest
- Animas – La Plata Project Collection
- Andy Gulliford Oral History Collection
- Local Durango records
- Pine River Irrigation District records (Vallecito Reservoir)
- Vallecito Dam Oral History Project
- Water resources research collection
- Southwest Water Conservation District records

University of Colorado, Boulder (Prospector)

1720 Pleasant St.
Boulder, CO 80309-0184
303-492-8705 Information
303-492-7477 Norlin, Circulation
303-492-7521 Reference
www.ucblibraries.colorado.edu

Western Americana Collections: The Archives started in 1917 to collect manuscript material on the settlement and growth of Colorado. The collection includes diaries and papers of Colorado settlers. Mining papers include company ledgers and files as well as the correspondence, journals, and records of early mine owners. The archives hold historical maps of varying types: railroad and trail maps, topographic maps, geologic maps, mining maps, property maps, and Sanborn fire insurance maps. Photographic sources include portraits, landscapes and urban scenes dating from the 1880s.

University of Northern Colorado Michener Library (Prospector)

20th Street and 14th Avenue
Greeley, CO 80639
970-351-2854 Archives and Special Collections
970-351-2671 Circulation
www.unco.edu/library/

The Michener Library is the sole repository for the James A. Michener Special Collection that includes all his research material on the history of northeastern Colorado used for the book *Centennial*. The Centennial collection is indexed (online, much of it annotated by Michener), and a dedicated archivist works the entire James A. Michener Special Collection. Photographs in the collection include a series

taken by Michener between 1936-1938 of various areas of northeastern Colorado. In addition to being an author, James Michener was a teacher at the University of Northern Colorado (then the Colorado State Normal School) and had a strong interest in irrigation and other agricultural issues. Michener was appointed by Governor Love in the 1970s to serve on a state historic sites preservation commission.

The Michener Library also has archeology records, a bibliography of irrigation and water in Weld County, and K-12 teaching guides on irrigation.

Colorado School of Mines (Prospector)

1400 Illinois St
Golden, CO 80401
303-273-3911
www.mines.edu/library

The Colorado School of Mines is an institution devoted to studies associated with geology. The library has a collection of maps, oral histories, reports, photographs, letters, research studies, manuscripts and publications associated with irrigation in Colorado. CSM's collection is searchable online.

Colorado State University, Fort Collins (Prospector)

501 University Ave
Fort Collins, CO 80523
970-491-1842 Circulation
970-491-1841 Reference
www.manta.library.colostate.edu

Colorado State University in 2001 launched the Water History Archive (<http://lib.colostate.edu/archives/water/index.html>). Other special collections include documents from the State Board of Agriculture. The collection includes numerous primary materials associated with all aspects of water in Colorado. Materials include photographs, maps, audio tapes (oral histories, meetings), reports and correspondence. There is some information on these collections through their online database. Collection materials are cataloged. Colorado State University is working with DARCA to be a repository for ditch company records.

Online catalogs: Colorado Historical Society Stephen H. Hart Library

1300 Broadway
Denver, CO 80203
303-866-2305
www.coloradohistory.org/chs_library/library.htm

The Colorado Historical Society Library is the official state repository for historical documents. Government and legal documents are generally housed at the Colorado State Archives (see below); however, there are often exceptions so research at both locations may be necessary.

The Society's substantial collection includes corporate records, books, manuscripts, government maps, stock certificates, irrigation district records and surveys. Some of the collection material is unprocessed and therefore unavailable to the public. An online catalog is available through the CHS web site.

Other collections

Local: County Clerks and Recordors

The Clerk and Recorder office is the location of all land deeds. Some of their material may be archived either within the county or with State Archives. If deed research is necessary, sufficient time to retrieve records should be allotted. Occasionally a ditch company will record a plat of some or all of the ditch's length.

State: Water Courts

Most of the legal records pertaining to actions remain with the courts; however, some have been transferred to the Colorado State Archives. Each water court should have a listing of cases and record locations.

South Platte River Basin
Water Court, Water Division No. 1
PO Box 2038
Greeley, CO 80632
970-351-7300, ext 4500

Arkansas River Basin
Water Court, Water Division No. 2
320 West 10th St.

Pueblo, CO 81003
719-583-7048

Rio Grande Basin
Water Court, Water Division No. 3
702 4th St.
Alamosa, CO 81101
719-589-9107

Gunnison River Basin
Water Court, Water Division No. 4
1200 N. Grand Ave., Bin A
Montrose, CO 81401-3146
970-252-4335

Colorado River Basin
Water Court, Water Division No. 5
108 8th St., Suite 104
Glenwood Springs, CO 81601
970-945-5075

Yampa River Basin
Water Court, Water Division No. 6
PO Box 773117
Steamboat Springs, CO 80477
970-879-5020

San Juan/Dolores River Basins
Water Court, Water Division No. 7
PO Box 3340
Durango, CO 81302
970-247-2304

State: Colorado State Archives

1313 Sherman Street, Room 1B20
Denver, CO 80203
303-866-2358
www.colorado.gov/dpa/doit/archives

The Colorado State Archives is the official state repository for legal, governmental and institutional historical documents. Historical documents are also housed at the Colorado Historical Society Stephen H. Hart Library and research at both locations may be necessary. Items in the State Archives that may be useful to researching irrigation may not be cataloged, and creativity is key in using this facility. An online searchable index is available through their web site. Some collections have inventories and the State Archives is considering digitizing some of its finding aids and making them available on the web. Some collections are measured in cubic feet. One c.f. is equal to one standard file box. Records that can be found at the archives include:

- Business incorporation records
- Maps

- State Engineer's Reports and Records
- Civilian Conservation Corps Records. This collection is the largest set of records regarding the activities of the Corps in Colorado. The collection does not have a finding aid and is minimally indexed. Records may include Soil Conservation Service documents. There is 80 c.f. of material from 1933-1942.
- Water Decrees, 1899-1926, Water District 1, not inclusive.
- Arkansas River Diversion Decrees, 1884 (available on their web site)
- Water court records. Cataloged by court case number. Contact the water district first for listing of cases. Many of the water courts have not deposited cases with the State Archives.
- Legislative records.
- Colorado Supreme Court Exhibit Files. These include maps and other historic material. The majority of the files are regarding irrigation or railroads.
- Local government records. Counties and municipalities may deposit records with the State Archives.
- Railroad Maps
- State Plan Maps
- Ditch Claim Statements for Routt County
- Spanish-Mexican Land Grant Records
- County Clerk and Recorder Records

The State Archives will allow public access to unprocessed materials; however, they have limited staffing resources to assist with research.

Universities and Colleges not in Prospector

Adams State College

208 Edgemont Blvd
Alamosa, CO 81102
800-824-6494
719-587-7011

www.library.adams.edu

Some resources are in their Colorado Collection, primarily on the San Luis Valley. Information is not indexed online.

Colorado College, Tutt Library and Special Collections

1021 North Cascade Ave
Colorado Springs, CO 80903
719-389-6184 Circulation
719-389-6662 Reference

www2.coloradocollege.edu/library (catalogued material is searchable online)

There are several records on water rights, irrigation, flumes and canals, primarily associated with Colorado Springs and the mining areas to the west. Collection includes maps.

Colorado State University, Pueblo

2200 Bonforte Boulevard
Pueblo, CO 81001
719-549-2386 Circulation
719-549-2333 Reference

www.library.colostate-pueblo.edu

There are numerous government publications, reports, books and other resources focused primarily on irrigation in southern Colorado.

Federal Libraries and Archives

Federal libraries and archives have a variety of scientific and historic information aimed at the mission of the given agency. While all the major libraries with land use records are listed here, some are better than others for finding relevant information on specific ditches. Other libraries and archives should be consulted first before a visit to one of the federal repositories. Creativity is sometimes key in working with these facilities. For example, canals and ditches may be identified on a map in the USGS library; however, the map will not be cataloged as an irrigation record. In addition, not all information at these facilities is available for the general public's use, and an appointment may be necessary with an agency employee or archivist/librarian to access the information.

Bureau of Land Management

National Science and Technology Center
Denver Federal Center, Bldg. 50
West 6th Avenue and Kipling
PO Box 25047
Denver, CO 80215

www.co.blm.gov

The BLM Library in Denver has over 40,000 volumes and over 250 periodical subscriptions in its collection. These materials cover all aspects of land management, natural resources, minerals and administration. The Library's collection is arranged according to the Library of Congress Classification System and is cataloged through OCLC, the Online Computer Library Center, Inc.

The BLM manages an online searchable database of land patents (homestead records). This database can be found at www.glorerecords.blm.gov. A collection of

historic photographs can be found at www.photos.blm.gov.

Bureau of Reclamation Library

Denver Federal Center, Bldg 67 Room 167
West 6th Avenue and Kipling
PO Box 25007,D-7925
Denver, CO 80225
303-445-2072

USBR has reports, publications, maps, books, journals and other resource materials regarding irrigation in Colorado. In addition to the main branch in Denver, there are regional libraries that may have more localized information. All libraries are searchable from the same online database. Many of the materials date back to the late 19th century. Some materials are available only for USBR employees. The web site has links to the National Agriculture Library. The National Agriculture Library (www.nal.usda.gov) has links to several search engines including Agricola and Science.gov that include reports and journals from a variety of government agencies.

National Archives, Denver Federal Center

Denver Federal Center, Bldg 48
West 6th Avenue and Kipling
PO Box 25307
Denver, CO 80225
303-407-5700

The National Archives holds records and collection materials from a number of federal agencies. The facility in Colorado has records primarily from the western United States. It is important to note that some Colorado records are housed at the National Archives in Washington D.C. so initial online research should occur at both sites. Collection size is measured in cubic feet. One c.f. of record is equivalent to one standard business file storage box. Finding aids range in quality from lists of files in a box to annotated aids with descriptions of records. Online search of record types is available. Record collections that may be pertinent to further study on this topic include:

- Federal Land Records, dating back to the 1800s.
- General Land Office Records (predecessor to the Bureau of Land Management).
- Department of Agriculture Records.
- Bureau of Reclamation (USBR) 1887-1995. Collection includes maps, photographs, and sketches. Organized by regional office.
- Bureau of Land Management (BLM) 1854-1993. Collection includes district land office

records (1860-1960) that include title transfer from federal government to entryman (person filing land claim), abstract books, administrative records, correspondence, cancelled land entry case files, serial registers and track books. Grazing Division records (1935-1976) include documents that record the establishment and administration of grazing districts and the range of improvement activities of the CCC camps. State and regional office records (1946-1992) include river basin studies and land acquisition case files. A 1949 finding aid is available.

- Farmers Home Administration (FHA) 1934-1946. Collection includes land records and documents associated with resettlement projects.
- Forest Service (USFS) 1898-1995. Collection includes aerial photographs and maps for National Grasslands (reclaimed farm and ranching land).
- U.S. Geological Survey (USGS) 1874 –1970. Collection includes surveys, maps, and water resource division records, and copies of the Hayden and Powell surveys (also in the USGS library). The focus of the collection is mineral resources.
- Bureau of Outdoor Recreation/Heritage Conservation and Recreation Service (dismantled, responsibilities transferred to the National Park Service) 1972-1981. Collection includes archeological surveys.
- National Resources Planning Board 1939-1943. Collection includes information on river drainages.
- Soil Conservation Service (SCS) 1933-1971. Collection includes CCC surveys, maps and watershed documentation. Colorado material is very limited. CCC records for Colorado are at the Colorado State Archives. National Archives in Washington D.C. has a substantial collection of SCS records.

United States Geological Survey (USGS)

Denver Federal Center
Bldg 20, 2nd Floor
PO Box 25046, MS914
Denver, CO 80225
303-236-1004 Librarian
303-236-1015 Circulation
303-23-1010 Photo Library

While this library has the least amount of information regarding irrigation, it does have some sources that may prove worth a visit. The USGS Library has a reasonably full set of all maps it has produced since the late 1800s.

Major geologic survey series from the late 1800s are housed at the library. The 1876 Powell Survey contains maps that may include locations of canals and ditches. Collection includes water resource investigation reports, water supply papers, irrigation well maps, annual reports and state engineer records. There is a substantial photo collection (300,000 photographs) at the library. A visit in person is suggested for research in the photo collection. More current aerial photographs are available through the Earth Science Information Center and is searchable online. It is important to note that records associated with this topic may be housed in Reston, Virginia, or another USGS library so online searches should not be limited to the Denver site.

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University of Colorado at Denver
and Health Sciences Center

June 2005

supported by the Colorado State Historical Fund
(2001-02-068)

cover: *Harper's Weekly*, June 20, 1874.