Fryingpan-Arkansas Project[1]

Colorado: Eagle, Pitkin, Lake, Chaffee, Fremont, El Paso, Pueblo, Otero, Crowley, Bent, Prowers, and Kiowa counties.

Great Plains Region, Eastern Colorado Area Office
Bureau of Reclamation

The Fryingpan-Arkansas Project is a multi-purpose transmountain, trans-basin water diversion and delivery project in Colorado. It makes possible an average annual diversion of 69,200 acre-feet of surplus water from the Fryingpan River and other tributaries of the Roaring Fork River, on the western slope of the Rocky Mountains to the Arkansas River basin on the eastern slope.

Water diverted from the western slope, together with available water supplies in the Arkansas River Basin, provides an average annual water supply of 80,400 acre-feet for both municipal/domestic use and the supplemental irrigation of 280,600 acres in the Arkansas Valley. Total project supplies may be further increased through use and reuse of project water.

The project also includes one powerplant with a generating capacity of 200 megawatts.

Plan

There are two distinct areas of the project: the western slope, located within the Hunter Creek and Fryingpan River watersheds in the White River National Forests at elevations above 10,000 feet; and, the eastern slope in the Arkansas Valley. The project consists of facilities designed primarily to divert water from the western slope to the water-short areas of the eastern slope.

There are five dams and reservoirs in the project. Ruedi Dam and Reservoir, on the Fryingpan River, is the only facility on the western slope. Four dams and reservoirs exist on the eastern slope. Sugar Loaf Dam and Turquoise Lake, Mt. Elbert Forebay Dam and Reservoir, and Twin Lakes Dam and Reservoir are in the upper Arkansas watershed. Pueblo Dam and Reservoir, the largest reservoir in the project, is on the Arkansas River.

Reservoir	Active Conservation (acre-feet)	Total capacity storage (acre-feet)
Ruedi	101,278	102,373
Turquoise	120,478	129,398
Mt. Elbert Forebay	7,318	11,143
Twin Lakes	67,917	140,855
Pueblo	234,347	357,678

[1] Area Office Revision 12/1999. Replaces project description text from 7/1982 revision to Reclamation's Project Data Book. Revision includes the text in all sections from the introduction through "Recreation and Fish and Wildlife," only. All Project Data, Engineering Data, charts, maps, graphs and photos remain unchanged.

The Western Slope

Ruedi Dam and Reservoir provide storage for replacement and regulation of approximately 100,000 acre-feet of water for the western slope users. This water is used for irrigation, municipal benefits, recreation, and fish and wildlife enhancement.

Seventeen diversion structures on the western slope are used to divert water into the Fryingpan-Arkansas collection system. The project includes nine tunnels with a combined length of 26.7 miles. The collection system is divided into two parts: North and South.

The North and South Side Collection Systems on the western slope collect the melting snow and runoff from the high mountains. The diverted waters of the Fryingpan and Roaring Fork River Basins flow into the inlet portal of the Charles H. Boustead Tunnel. Boustead has a decreed diversion capacity of 1000 cubic feet per second (cfs) and conveys all the water from the North and South Collection Systems through the Continental Divide to Turquoise Lake.

The Eastern Slope

Turquoise Lake and Sugar Loaf Dam are located just east of the Continental Divide, approximately 5 miles west of Leadville, Colorado. The lake provides storage capacity for the regulation of project water flowing from the Boustead Tunnel.

Mt. Elbert Conduit conveys water from Turquoise Lake to the Mt. Elbert Forebay. The Halfmoon Diversion Dam intercepts the excess flows of Halfmoon Creek for diversion to the Mt. Elbert Conduit. Water delivered to the forebay is used for generation of power in the Mt. Elbert Pumped-Storage Powerplant. Water exits the powerplant into Twin Lakes.

Twin Lakes Dam is approximately 2,500 feet downstream from the original Twin Lakes. From Twin Lakes, project water is released to Lake Creek and the Arkansas River for delivery to project water users upstream of Pueblo Reservoir, or for storage in Pueblo Reservoir.

Project water is released from Pueblo Reservoir to the Arkansas River for irrigation and municipal purposes, to the Fountain Valley Conduit for municipal purposes, to the Bessemer Ditch for irrigation, and to the Pueblo Fish Hatchery for the fishery.

Construction is complete on all of the project features that were initially designed. Features that were authorized, but have not been built include: parts of the western slope collection system; the Clear Creek Dam, Reservoir, and Canal; and the Arkansas Valley Conduit.

Facility Descriptions

Ruedi Dam and Reservoir

Ruedi Dam, on the Fryingpan River is about 15 miles east of Basalt, Colorado. It creates a reservoir with a total capacity of 102,373 acre-feet. Ruedi is a rock and earthfill structure that stands about 285 feet high above streambed, has a crest length of 1,042 feet, and contains approximately 3,745,200 cubic yards of material.

The concrete spillway structure has an uncontrolled Ogee crest, a chute section, a stilling basin, and a bridge over the spillway. The spillway has a capacity of 5,540 cubic feet per second. The outlet works, located under the right abutment of the dam, consist of: a hexagonal intake structure with trashracks; a 10-foot-diameter concrete-lined circular tunnel to a gate chamber housing a 5-by-6-foot high-pressure gate; an 11 foot-diameter concrete-lined horseshoe tunnel with a 76-inch-diameter steel pipe; a control house with two sets of 3.5-by 4-foot tandem gates and wye (or "Y") to a 76-inch-diameter steel pipe that provides water to the FERC licensed Ruedi Water Power Authority powerplant. A shaft house and adit give access to the gate chamber of the outlet works and auxiliary works. The capacity of the outlet works is 1,810 cfs.

The auxiliary outlet works consist of an intake structure with trashracks, a 6-foot-diameter concrete-lined circular tunnel to a gate-chamber housing a set of 2.5-by-3-foot tandem gates, and a concrete-lined 5-by-6-foot flatbottom tunnel. The capacity is 600 cfs.

A concrete bypass, consisting of a concrete chute and stilling basin, bypasses flows of Rocky Fork Creek past the discharge of the spillway and auxiliary outlet.

The Collection System

The North and South Side Collection Systems are located at elevations of approximately 10,000 feet. The facilities divert and carry water from the Fryingpan and Roaring Fork River Basins to the inlet portal of the Boustead Tunnel, the tunnel that transports water from the collection system through the Continental Divide to the Arkansas River Basin.

The North Side Collection System diverts, collects, and transports an average of 18,400 acre-feet of water annually through the Mormon, Carter, Ivanhoe, Granite, Lily Pad, North Cunningham, Middle Cunningham, and South Cunningham Creeks facilities.

The South Side Collection System transports an average of 50,800 acre-feet of project water annually from the Fryingpan and Roaring Fork River Basins. Facilities located on Hunter, Midway, and No Name Creeks collect and divert water from Sawyer and Chapman Creeks, the South Fork of the Fryingpan River, and the main stem of the Fryingpan River downstream of Marten Creek.

North Side Collection System

Carter Tunnel is the first collection tunnel on the North Side Collection System. Water is diverted into the tunnel by Carter Diversion Dam through the 300-foot, 42-inch Carter Feeder Conduit to the inlet of the Carter Tunnel. The North Fork Diversion Dam is a drop-inlet structure that diverts North Fork Creek water into the Carter Tunnel by the 280-foot-long North Fork Feeder Conduit. Carter Tunnel is 0.54 mile long and has an 8-foot horseshoe cross-section with a capacity of 130 cfs. Water from Carter Tunnel flows to the Mormon Conduit.

Mormon Tunnel exists on Mormon Creek. The Mormon Feeder Conduit connects the Mormon Creek diversion structure to the intake portal of Mormon Tunnel. The conduit is a 250-foot-long structure, including a Parshall flume-measuring device. The tunnel is 1.4 miles long, with an 8.25-foot horseshoe-shaped section having a capacity of 190 cfs. The water from Mormon Tunnel flows to the Cunningham Tunnel.

The North Cunningham, Middle Cunningham, and South Cunningham diversion structures are connected to the Cunningham Conduit by feeder conduits which extend to Cunningham Tunnel. The length of the

three feeder conduits is 2,700 feet, and the Cunningham Conduit is 4,170 feet long. Cunningham Tunnel is 2.86 miles long and has a horseshoe shape of two sizes: 8.75 and 7.5 feet. The capacity is 270 cfs. The Cunningham Tunnel flows into the Nast Tunnel.

Ivanhoe Diversion Dam diverts water from Ivanhoe Creek and the Cunningham Tunnel through the Ivanhoe Creek crossing into the inlet of Nast Tunnel. Granite Diversion Dam diverts water through the Granite Siphon to the Granite Adit, which drops the flow into the Nast Tunnel. Lily Pad Diversion Dam drops the flow into Nast Tunnel. Nast Tunnel is 3 miles long, with a circular-shaped section with two diameters: 7.67 and 9.33 feet. The capacity of the tunnel is 360 cfs. The Fryingpan Conduit, which is 2,481 feet long and 84 inches in diameter conveys flows to the Boustead Tunnel.

South Side Collection System
Hunter Tunnel is 7.6 miles long. It transports the flows diverted at No Name, Midway, and Hunter Creeks to Chapman Gulch at the Chapman Diversion Dam. The capacity ranges from 90 cfs at No Name Creek--the point of the beginning of the South Side Collection System--to Midway Creek with 270 cfs at Chapman Gulch on the Chapman diversion site.

No Name, Midway, and the Hunter Creek diversion structures are all similar. Each has a sluicegate for bypassing all streamflow when water is not being diverted. When diversions are being made, minimum flow is released through a bypass to maintain the stream. A side overflow section provides for passing floodflows. Flows are diverted through a short flume section to a shaft that drops the water into the Hunter Tunnel. Hunter Tunnel is a semi-horseshoe-shaped structure with two sizes: 8.5 and 7.33 feet.

The Sawyer diversion drop inlet diverts water from Sawyer Lake into Sawyer Feeder Conduit (3,098 feet in length), and drops the water at Chapman Gulch. The water then flows to Chapman Diversion Dam, with the flow from Hunter Tunnel, to be diverted into Chapman Tunnel. Chapman Tunnel is a 2.8-mile long, 7-foot horseshoe-shaped structure, with a capacity of 300 cfs.

The South Fork Diversion Dam diverts water from South Fork Creek to the South Fork Siphon, where it combines with the flow from South Fork Creek and is conveyed by the South Fork Feeder Conduit to the inlet of the South Fork Tunnel. South Fork Tunnel is a 3.1-mile long, 8-foot horseshoe-shaped section, and has a capacity of 450 cfs. The tunnel discharges water into the Boustead Tunnel. Fryingpan Diversion Dam diverts water into the Fryingpan Siphon, under the Fryingpan River, to the inlet structure at the Boustead Tunnel.

Charles H. Boustead Tunnel
The Charles H. Boustead Tunnel conveys all the water collected at the Fryingpan diversion and in the North and South Side Collection Systems under the Continental Divide to Turquoise Lake. The 10.5-foot-diameter, horseshoe-shaped tunnel is approximately 5.4 miles long. The decreed capacity of the tunnel is cfs. The Fryingpan Valley control structure at the inlet portal of the tunnel will regulate flows entering the Boustead Tunnel. It is a concrete junction structure which contains two overflow weirs--one for each of the collection systems, a baffled-apron wasteway drop structure to return the excess flows to the Fryingpan River, a connection and access hatchway structure to receive the flows from the Fryingpan Feeder Conduit, and a control structure housing a 10.5-by-12-foot radial gate. The entire structure is underground.

Sugar Loaf Dam and Turquoise Lake
Sugar Loaf Dam and Turquoise Lake are east of the Continental Divide on the Lake Fork of the

Arkansas River in Lake County, approximately 5 miles west of Leadville. The reservoir storage capacity is 129,440 acre-feet. Sugar Loaf Dam is an earthfill structure. It has a length of 2,020 feet, a height above riverbed of 135 feet, and contains approximately 1,833,700 cubic yards of material.

In addition to the main earthfill section of the dam, there is a dike approximately 6,000 feet to the northeast. This dike is 475 feet long and 11 feet high. The spillway has a capacity of 2,920 cfs and consists of a morning-glory intake structure, a 16.5-foot-diameter monolithic concrete conduit, a chute, and a stilling basin. The outlet works consists of: an intake structure with trashracks; a 7-foot-diameter concrete conduit with a steel liner; a gate chamber housing a 5-by 6-foot high-pressure gate; an 11-foot-diameter concrete conduit with a steel liner; a 72-inch-diameter steel outlet pipe which bifurcates into two parallel branches just ahead of the control house for the river outlet; a river outlet control house with two 3.5-foot-square high-pressure gates for each branch; and a chute and stilling basin discharging to Lake Fork.

A short 72-inch-diameter steel branch outlet pipe with a bulkhead is provided upstream from the bifurcation for future use, and as an outlet to the Mt. Elbert Conduit. The capacity of the river outlet is 1,120 cfs, and the capacity of the outlet to the Mt. Elbert Conduit is 370 cfs.

Mt. Elbert Conduit
The Mt. Elbert Conduit conveys project water from Turquoise Lake to the Mt. Elbert Forebay. Water delivered to the forebay is used for the generation of power in the Mt. Elbert Pumped Storage Powerplant. At Halfmoon Creek, additional water is diverted into the conduit for delivery to the Mt. Elbert Forebay. A pipe turnout and conduit deliver supplemental water from the conduit to the Leadville National Fish Hatchery. The conduit is a 90-inch-diameter pipe, 10.7 miles long, and is designed for a flow of 370 cfs from Sugar Loaf Dam to the forebay. It consists of a series of siphon and free-flow conduit reaches.

Halfmoon Diversion Dam
The Halfmoon Diversion Dam intercepts the excess flows of Halfmoon Creek for diversion to Mt. Elbert Conduit. The diversion dam consists of a concrete spillway overflow structure, earth-wing dike structures, a gated concrete structure to bypass irrigation flows for downstream use, and a heading for a feeder conduit. The Halfmoon Feeder Conduit is a 60-inch-diameter pipe, 3,202 feet long, and delivers the flow diverted at Halfmoon Creek to the Mt. Elbert Conduit. Flow capacity of the feeder conduit is 150 cfs.

Mt. Elbert Forebay Dam and Reservoir
Mt. Elbert Forebay occupies a saddle on a ridge above Twin Lakes Reservoir. An outlet channel from the southeast corner of the reservoir connects to the inlet-outlet structure for the powerplant penstock.

The rolled earthfill forebay dam is about 2,600 feet long and 92 feet high. A 130-foot-long earth dike closes a low saddle at the southwest end of the reservoir. In 1980, the forebay was lined with a 45-mil reinforced chlorinated polyethylene flexible membrane lining material for seepage control. There is no spillway in the forebay dam. There are also no outlet works other than the penstock inlet-outlet structure. Natural flow into the reservoir is negligible.

Mt. Elbert Powerplant
The Mt. Elbert Pumped-Storage Powerplant is on the north shore of picturesque Twin Lakes, approximately 13 miles southwest of Leadville, Colorado at the foot of 14,433-foot Mt. Elbert, Colorado's highest mountain peak. The powerplant was designed with modern architectural lines and is an all-concrete structure equivalent to a 14-story building, although most of the structure is below ground.

Power is generated from water stored in the Mt. Elbert Forebay. The water drops through the penstocks 447 feet, spinning each of two 138,000 horsepower hydroelectric turbine-generators and developing 200,000 kilowatts of electrical power.

To supplement the flow-through water received from Turquoise Lake through the Mt. Elbert Conduit, these generators have been designed to operate as a 170,000-horsepower electric motor that drives the turbines in reverse, pumping the same water back up to refill the forebay. This pumping mode normally will be used during the very early morning hours, when power demands are low and surplus low-rate power is received from other generating stations. This pump-back storage principle is advantageous since the generating units can be started quickly and adjustments of power output can be made rapidly to respond to varying patterns of daily and seasonal power demands.

Twin Lakes Dam and Reservoir
Twin Lakes Dam and Reservoir is located approximately 13 miles south of Leadville, in Lake County. The reservoir has a total capacity of 141,000 acre-feet. The dam is a zoned, rolled earthfill structure with a height above streambed of 53 feet. The crest of the dam is 30 feet wide and 3,150 feet long.

The spillway is on the left abutment of the dam, and has a capacity of 1,400 cfs. The spillway is an uncontrolled concrete morning-glory inlet structure with a 9-foot-diameter concrete conduit under the dam embankment and a concrete stilling basin. A channel downstream from the stilling basin carries the water to Lake Creek. The outlet works located in the right abutment delivers 3,465 cfs to the river. The outlet works has an inlet structure with a trashrack, a 12-foot-diameter concrete conduit with steel liner, and a gate-chamber housing a 9-by-12-foot high-pressure gate. A 16.75-foot-diameter horseshoe-shaped concrete conduit containing a 12.0-foot-diameter steel outlet pipe leads from the gate chamber to the river outlet control house where two 6.5-by-8.0-foot high-pressure gates are located. A chute, stilling basin, and a 400-foot-long outlet channel lead to Lake Creek.

Pueblo Dam and Reservoir
The terminal storage facility, Pueblo Dam and Reservoir, is located on the Arkansas River in Pueblo County about 6 miles upstream and west of the city of Pueblo. The reservoir has a total storage capacity of 357,678 acre-feet: 30,355 acre-feet of dead and inactive capacity; 234,347 acre-feet of conservation capacity; 65,952 acre-feet of joint-use capacity; and 27,024 acre-feet of exclusive flood-control capacity.

The concrete dam and massive-head buttress-type spillway structure is the principal control structure for the reservoir. The concrete section is 1,750 feet wide with a maximum structural height of 250 feet. The spillway has a crest width of 550 feet and was designed for a maximum spill discharge of 191,500 cubic feet per second. The river outlet works is controlled by two 4-foot-square high-pressure gates and regulate normal water releases into the river. Additional releases may be made to the river through three separate spillway outlet works. Two 6-by-6.5-foot high-pressure gates control each outlet work.

The south outlet works was designed and constructed to deliver water for municipal and industrial use is made from the south outlet works, a multilevel intake structure capable of taking water from the reservoir at different levels, thus providing a degree of control over water temperature and quality. Water deliveries from the fish hatchery outlet works have similar controls. Included in the outlet works are the outlet channel, a concrete river plug in the river channel, and the Bessemer Ditch headworks.

Fountain Valley Conduit
The Fountain Valley Conduit begins at Pueblo Dam and ends near Academy Boulevard about 2 miles

south of Colorado Springs. The conduit conveys approximately 20,100 acre-feet of project water annually to the communities of Stratmoore Hills, Widefield, Security, and Fountain. The Fountain Valley Conduit is 45 miles long and ranges from a 42-inch to a 14-inch-diameter conduit. It has five pumping plants, two regulating tanks, two surge tanks, and four terminal tanks. The capacity is 31 cfs.

Operating agencies

The Bureau of Reclamation operates and maintains the dams and reservoirs. The U.S. Forest Service manages the recreation, fish and wildlife facilities, and resources at Ruedi Reservoir, Turquoise Lake, and Twin Lakes. At Pueblo Dam and Reservoir, fish and wildlife and recreation resources are under the management of the Colorado Department of Natural Resources.

Development History

The eastern slope area of the project north of the Arkansas River was a part of the Louisiana Purchase in 1803. Following the war with Mexico, Texas claimed the remainder of the basin. Mexican claims to the territory were relinquished in 1845 when Texas entered the Union.

Various Spanish explorers visited the project area during 1760-1780. Lieutenant Zebulon Pike made the first official exploration by the United States in 1806-1807. Captain John C. Fremont and Captain John W. Gunnison directed later explorations. The first permanent settlements were not established until after the discovery of gold in 1859-1861. With the mining boom came immigrants who turned to agriculture to supply foodstuffs for the expanding population. Large cattle ranches appeared as the result of cattle drives from Texas.

Investigations

Studies by the Bureau of Reclamation on a transmountain diversion project began in 1936. Intensive investigation started in 1941, resulting in a potential planning report in 1947 and 1948, followed by a special report in 1949 and official recommendations in 1951.

A revised planning report under the name “Fryingpan-Arkansas Project” in 1953 led to congressional approval of the project. In September 1959, a report that supplemented House Document No. 187. 83d Congress, 1st session, recommended Ruedi Dam and Reservoir instead of the previously recommended Aspen Dam and Reservoir.

Authorization

The Fryingpan-Arkansas Project was authorized for construction in 1962, Public Law 87-590 (77 Stat. 393), which was amended by Public Law 95-586 (92 Stat. 2485) in 1978. Operation of the project is governed by a set of operating principles originally approved by Congress. The State of Colorado and others adopted the operating principles in April 1959, amended December 30, 1959 and amended again December 9, 1960.

Construction

Construction of the project began with Ruedi Dam and Reservoir in 1964. Project water for irrigation and municipal and industrial purposes was available in September, 1975. Power was first delivered from Mt.

Elbert powerplant in 1981. Initial deliveries of project water to the Fountain Valley Conduit occurred in the mid-1980s.

Benefits

Irrigation
Water diverted from the western slope and regulation of the Arkansas River flows provides supplemental irrigation supplies for 280,600 irrigable acres in the Arkansas Valley. Project water, first delivered in 1975 has enabled farms to sustain and increase the level of agricultural productivity per acre. It permits farmers to diversify the crops produced and be more responsive to market demands for food and fiber.

Because of the ability to diversify crops and meet peak demands, the value of total crop production of the Arkansas Valley has increased. Major crops grown are alfalfa, corn, sorghum, and sugar beets. Specialty crops such as onions, beans, various nuts, tomatoes, and melons are also grown extensively in the valley.

Municipal and Industrial Water
Water for municipal and industrial use was developed by the project to supplement existing supplies and was first delivered in 1975. A separate water delivery pipeline system, the Fountain Valley Conduit, begins at Pueblo Dam and conveys water to organizations and communities in the Fountain Creek watershed on the eastern slope.

The cities of Colorado Springs and Aurora have contracted to use the conveyance system of the Fryingpan-Arkansas Project from Turquoise Lake for transportation of municipal water supplies owned by the two cities. Homestake Project water is pumped from Twin Lakes into the Upper South Platte River Basin for delivery to the city water systems.

Power
The Mt. Elbert power generation and transmission system is connected to the Public Service Company of Colorado transmission system at the Malta substation near Leadville. This interconnection with Public Service Company enables Fryingpan-Arkansas Project power to be marketed to Colorado customers through the Western Area Power Administration.

Recreation and Fish and Wildlife
The Bureau of Reclamation has developed recreation facilities throughout the Fryingpan-Arkansas Project in cooperation with the National Park Service, Forest Service, and State and local agencies.

The location of Ruedi Reservoir on the western slope provides an exceptionally beautiful background for swimming, boating, water skiing, fishing, picnicking, camping, and general relaxation. The Forest Service has developed and is managing these recreation activities at Ruedi.

Dominant game fish found in the rivers on the western slope include rainbow, brown, cutthroat, and brook trout. Development of Ruedi Dam and Reservoir has increased the available fish habitat in the area and the Fryingpan River immediately downstream from Ruedi is known as a gold medal fishery. Operation of the dam has exposed about six acres of gravel, which now serve as a brown trout spawning ground, immediately downstream from the dam. The gravel areas and regulated streamflow have improved the fishery through increased natural reproduction and increased recreation opportunities in the immediate area. The most common big game species are deer and elk; black bears are seen occasionally.

Recreation activities at Turquoise Lake include sightseeing, camping, swimming, water skiing, boating, and hunting. Development of the lake has increased the aquatic habitat and surface acreage available for fish. Species in this area include kokanee salmon and rainbow, brown, and lake trout. The Forest Service administers recreation facilities.

The Mt. Elbert Conduit permits delivery of up to 3,000 gallons per minute of high quality water to the Leadville National Fish Hatchery. Dominant big game species are deer and elk, which migrate into the Twin Lakes area each winter and scatter throughout the area during the summer. Elk range north of the lakes in winter. Big and small game hunting in season is allowed in the areas adjacent to Twin Lakes.

Recreation at Twin Lakes and the Mt. Elbert Forebay and Powerplant complex is water-oriented; fishing and boating are the major activities. Facilities consist of a boat ramp, boat and trailer parking lot, and two car-parking lots with minimum sanitary facilities.

Pueblo Reservoir provides water-oriented recreation in the Arkansas Valley. The Colorado Department of Natural Resources and Colorado State Parks manage facilities constructed by the Bureau of Reclamation including the north and south shore boat ramp, marina, parking, and the harbor.

A combination warm water fish hatchery and cold water rearing unit, managed and administered by the Colorado Department of Natural Resources, exists downstream from Pueblo Dam. This hatchery provides most of the fingerlings for stocking Pueblo Reservoir and other project reservoirs, streams, and lakes.