ArkDSS Memorandum
Final

To: Bill Tyner, John van Oort, and Kelley Thompson, Colorado Division of Water Resources

From: ParsonsWater Consulting

Subject: Task 2.1 – Holbrook Canal Company

Date: April 2010

INTRODUCTION

One of the Task 2 objectives is to:

> *Develop and document an understanding of the operations of key water use facilities in the basin in order to facilitate consumptive use modeling and to support selected data needs for the ArkDSS effort. This understanding will be developed through interviews with DWR personnel, major water users, including operators of large canal and reservoir systems and representatives of federal facilities.*

Key water use facilities include diversion structures, transmountain diversions, reservoirs, and reservoir systems. A number of components in the Holbrook Canal system have been identified as key structures for the Arkansas Decision Support System (ArkDSS) consumptive use and surface water modeling efforts. The purpose of this Task 2 memorandum is to document physical, legal, and operational aspects of those key structures.

The information provided in this memorandum was developed from publicly accessible sources, meetings and discussions with Division 2 personnel, DWR Modeling Group personnel, Canal Company Superintendent Bob Barnhart, and District 17 Commissioner, Lonnie Spady. Information in this memorandum is believed to be accurate. However, this information should not be relied upon in any legal proceeding.

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SYSTEM OVERVIEW

The Holbrook Canal, Holbrook Creek Reservoir and Dye Reservoir are owned by the Holbrook Mutual Irrigating Company. These canals and reservoirs are operated together to provide irrigation supplies to lands located north of the Arkansas River in Otero County. Share ownership was originally established based on land ownership at a ratio of approximately one share per acre of irrigated land. There are currently 16,244 outstanding shares of stock issued in the company.

The Holbrook Canal headgate is located on the Arkansas River approximately 1.5 miles northeast of Manzanola, Colorado. The canal runs along the north bank of the Arkansas River for

approximately 25 miles until it terminates near Horse Creek, north of the Town of Cheraw. Direct flow and storage water is delivered to shareholders on a rotational basis in the Jackson Lateral, Little Ditch Lateral, and the up-gradient Holbrook Canal.

The system has been used consistently for irrigation since the water rights were originally appropriated. There has been limited use for augmentation of well depletions under Rule 14 Plans in recent years. Augmentation use under the ditch is anticipated to increase in the future, in part due to the Town of La Junta's recently-adjudicated change case of its 5.44 percent ownership of the ditch company (Case No. 11CW13).

Key facilities identified in the Holbrook Canal, Lake Meredith and Lake Henry Reservoir system are as follows.

1) Holbrook Canal
2) Holbrook Reservoir
3) Dye Reservoir

The contact information for the Holbrook Canal Company is:

Bob Barnhart, Superintendent
26334 Hwy 266
Rocky Ford, Colorado 81067
719-469-1225

The general locations of the Holbrook Canal, Holbrook Reservoir and Dye Reservoir system and associated structures are shown on Figure 1.

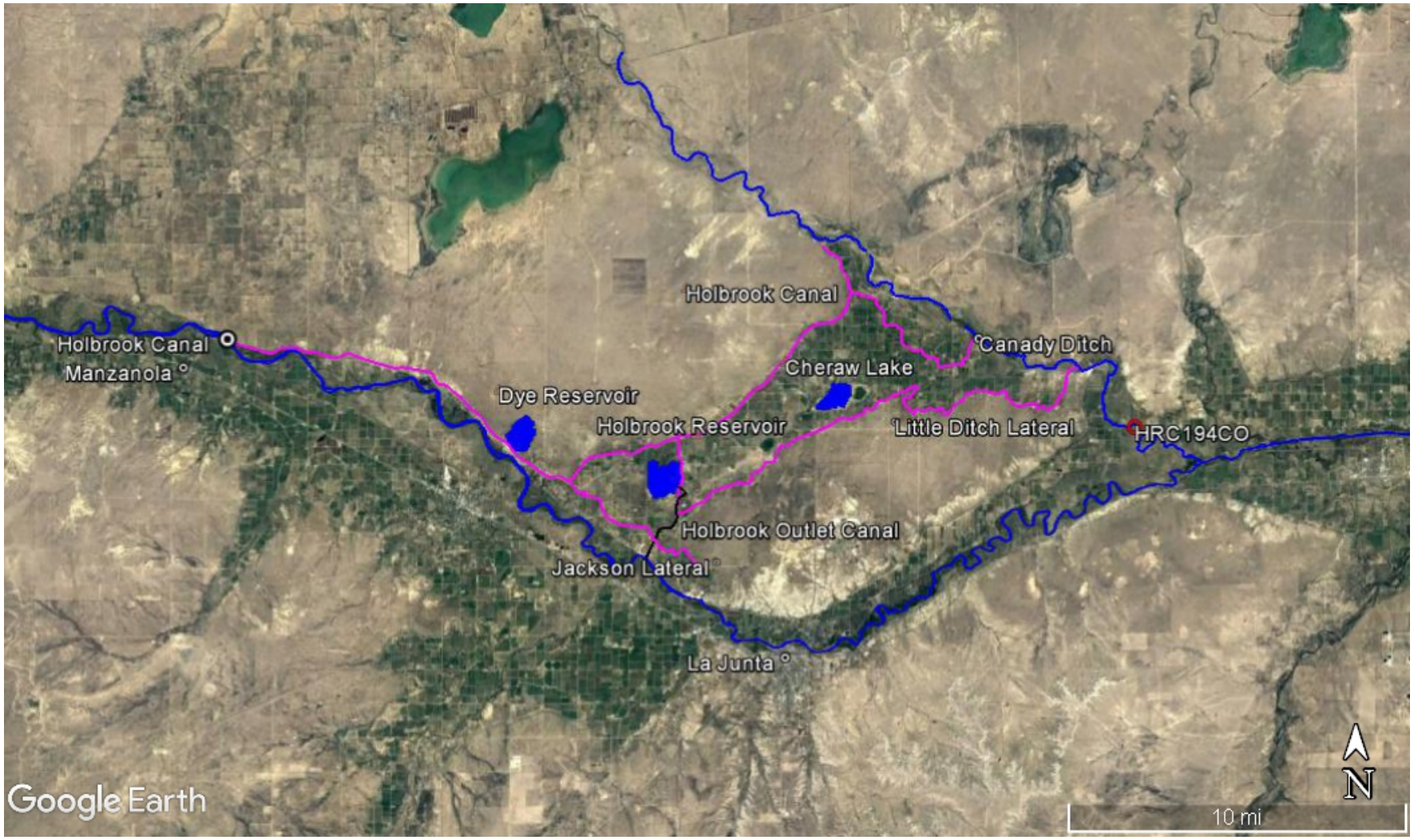

Figure 1: Holbrook Canal, Holbrook Reservoir, and Dye Reservoir System

PHYSICAL INFORMATION

The major structural elements in the Holbrook Canal Company's water resources system include the Holbrook Canal, Holbrook Reservoir, and Dye Reservoir.

The operations and current specifications of the elements of the Holbrook Canal's water resources infrastructure are summarized below. The primary source for this information is the water resources data and GIS coverages available on the State of Colorado Decision Support System website (http://cdss.state.co.us/). A basin model was previously developed to support the Colorado Springs Utilities Southern Delivery System Environmental Impact Statement (EIS) analysis. This model is also being used for the Arkansas Valley Conduit EIS. The data from these models were not made available for this effort.

Additional information related to a number of the structural elements and operations In Water District 17 and nearby water districts is listed in the *Where to find more information* section at the end of this memorandum.

1. Holbrook Canal (1700554)

The Holbrook Canal runs along the north side of the Arkansas River generally parallel to the river. The Jackson Lateral, which serves approximately 20 percent of the land under the system, continues along the Arkansas River at a point near Rocky Ford where the canal turns north from the river.

Length: The length of the Holbrook Canal is approximately 24 miles and it terminates just below the Canady Ditch (1700587) on Horse Creek.

Capacity: The capacity of the Holbrook Canal is approximately 1,000 cfs. A wasteway is located above the measurement device to control diversions since the river headgate can sweep the whole river. The capacity of the canal below the wasteway is about 600 to 610 cfs.

Conveyance Efficiency: Holbrook Canal Company personnel indicate ditch losses average approximately 24 percent in the Holbrook Canal system. The conveyance losses are split evenly above and below Holbrook Reservoir. Conveyance losses up-ditch of Holbrook Reservoir accrue to the Arkansas River system. Conveyance losses below Holbrook Reservoir and from the Little Ditch Lateral accrue to the natural depression in between the two ditches, which ultimately drains into Cheraw Lake. The H-I Model uses a main canal loss of 11.9 percent for the Holbrook Canal plus additional off-farm and on-farm lateral losses of 3.5 percent and 2.96 percent, respectively, as a proportion of headgate diversion (resulting in a 15.4 and 18.4 percent loss at the farm headgate and parcel, respectively).

Irrigated Acreage and Crop Types: GIS coverages from the State of Colorado's Decision Support System (CDSS) list approximately 12,500 to 13,000 irrigated acres under the Holbrook Canal over the past 10 years. Additional acreage under the canal system is shown as fallowed. The primary crop under the Holbrook Canal is alfalfa. Additional GIS coverages are being developed as part of the ArkDSS project to provide additional snapshots of irrigated acreage over time during the 1950

to 2017 period. The Division 2 office maintains more detailed coverages of total acreage, field verification of dry up acreage, well associations, and augmentation plan assignments.

Ground Water Use: GIS estimates for the irrigated lands indicate approximately 2,100 acres (~17 percent of total irrigated acreage) are supplied by supplemental wells. There are also lands within the Holbrook Canal service area that only irrigate with ground water. The wells are augmented primarily by the Colorado Water Protective and Development Association (CWPDA).

Return Flow Locations: Return flows from irrigated lands under the ditch system accrue as discussed above for conveyance losses. Approximately 20 percent of the irrigated land is tributary to the Arkansas River. The remaining lands are tributary to Cheraw Lake and ultimately to Horse Creek above the Hwy 194 stream gage during average and wet years when water reaches a sufficient depth in Cheraw Lake and then overflows out of the lake toward the Horse Creek drainage.

Return flows from ditch seepage and irrigation application will be accounted for separately in the ArkDSS Surface Water Model. The spatial distribution of losses shown in Table 1 are based on approximate canal length and layout of irrigated lands in relation to locations of gages, reservoirs and ditch headgates included in Water District 17. The H-I Model includes response functions used for timing and location of return flows and estimates that 65 percent of return flows accrue solely to Cheraw Lake. Note Cheraw Lake is not included in the table below. The return flows will be revisited during development of the ArkDSS Surface Water Model.

Table 1: Holbrook Canal Return Flow Locations

Model Node	Structure ID	Canal Loss Return Percentage	Irrigated Lands Return Percentage
Arkansas River at Rocky Ford gage	ARKROCCO	25%	4%
Lake Meredith	1703525	---	2%
Fort Lyon Canal	1700553	25%	54%
Horse Ck nr Hwy 194 gage	HRC194CO	50%	40%
TOTAL		100%	100%

HydroBase Data: Diversion data are available in HydroBase from the early-1910s to present. Total diversions, shown in Figure 2, and diversions to irrigation (Use 1) are complete from 1950 to the current year. Total annual diversions averaged about 44,000 ac-ft from 1950 to 2017.

- Releases to irrigation from storage (Source 2) are available sporadically for Dye Reservoir from 1960 through 1985, and more consistently from 2015.
- Releases to irrigation from storage (Source 2) are available for Holbrook Reservoir from 1950 to the current year, with about 20 percent of years missing. They are recorded as releases under both Holbrook Canal and Holbrook Reservoir WDIDs, depending on the year.
- Reported Winter Water deliveries and Fry-Ark Project deliveries from Pueblo Reservoir have significant missing data for the 1975 through 2015 period

The recording device is located below the Lake Meredith Outlet Canal; therefore releases from the Colorado Canal system reservoirs may be included in the total diversions if water is being delivered from Lake Meredith for use by the Holbrook. Deliveries from Lake Meredith Outlet Canal can be discharged out the wasteway prior to the recording device and not included in the Holbrook Canal total diversion record. Dye Reservoir is filled from the ditch. According to the water commissioner, although this is not measured; anything above 155 cfs in the daily record is basically going to storage in either Dye or Holbrook Reservoirs up to the point when the junior direct flow right comes into priority.

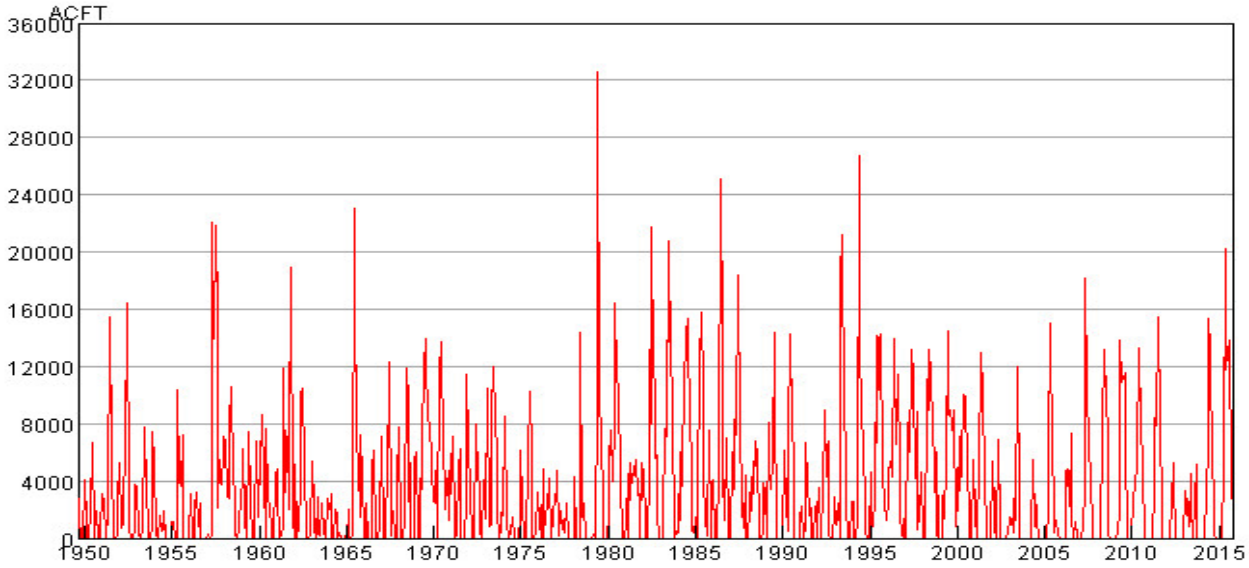

Figure 2: Holbrook Canal River Headgate Diversions

2. Holbrook Reservoir (1703511)

Holbrook Reservoir is filled by the Holbrook Canal. Water stored under the Holbrook Reservoir storage rights is available to Holbrook Canal Company shareholders. In addition to storing the reservoir storage right, Holbrook Reservoir is one of the off-channel reservoirs used to store water as part of the Winter Water storage program.

Holbrook Reservoir releases can go to the lower ditch (Little Ditch Lateral) and can also release to the river. The Holbrook augmentation station (1700806) is located below the Jackson Lateral and is used for CWPDA replacement plan (ID 7151, various water districts) and the recently adjudicated La Junta augmentation plan (1707016).

Capacity:

- Total Storage: Approximately 6,300 ac-ft
- Active Storage: 6,300 ac-ft
- Dead Storage: Unknown

Area/Capacity Data: Table 2 shows the most recent elevation-area-capacity table.

Table 2: Holbrook Reservoir Current Elevation-Area-Capacity Table

Gage Height (ft)	Surface Area (acres)	Cumulative Capacity (ac-ft)
2.0	0	0
3.8	13.4	156
5.5	37.5	437
7.3	68.6	799
9.0	114	1,327
10.8	154	1,795
12.6	211	2,457
14.3	278	3,237
16.1	355	4,133
17.8	441	5,138
19.6	537	6,258

Source: http://www.dwr.state.co.us/Surfacewater/data/division.aspx?div=2

Reservoir Storage Measurement: Storage levels in Holbrook Reservoir are not consistently measured.

Reservoir Seepage Information: Seepage from Holbrook Reservoir is not routinely monitored. Seepage from the reservoir accrues mostly to the Holbrook Reservoir Outlet Canal (see Figure 1). The Holbrook Reservoir Outlet Canal is used to deliver water to Adobe Creek to be picked up by the Holbrook Canal for delivery to shareholders. The capacity of the outlet canal is unknown.

HydroBase Data: Historical storage contents data are available for about two-thirds of the 1950 to 2015 period (see Figure 3). The Holbrook Canal Company indicated they do not maintain storage contents data. These data were also not available from DWR.

During development of the ArkDSS Surface Water Model, the remaining missing storage contents data will be estimated based on review of available daily storage contents data for Dye Reservoir and Holbrook Reservoir, review of diversion data for the Holbrook Canal discussed above, water commissioner records and comments.

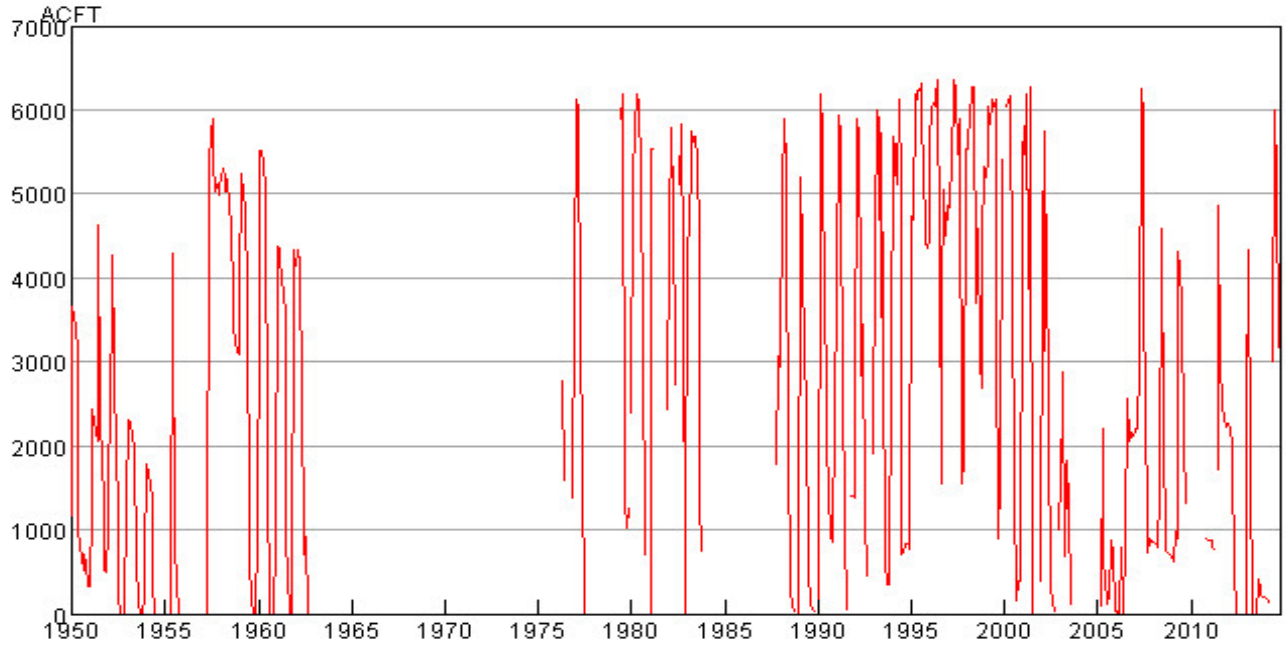

Figure 3: Holbrook Reservoir Storage Contents

3. Dye Reservoir (1703510)

The Dye Reservoir is filled by the Holbrook Storage Canal. Water stored under the Dye Reservoir storage rights is available to Holbrook Canal Company shareholders.

Capacity:

- Total Storage: 2,500 ac-ft
- Active Storage: 2,500 ac-ft
- Dead Storage: Unknown

Area/Capacity Data: The area/capacity data in Table 3 were obtained from the Map of Dye Reservoir and Dye Reservoir Outlet Ditch (approved by State Engineer 11/1/1909). The Filing Map included in the Statement of Claim Canal Company representatives indicated they had an area-capacity table but it was not provided for this effort; however the values are appropriate for use in the model as they correspond with the historical storage contents measurements. A new survey was recently completed, but has yet to be obtained.

Table 3: Dye Reservoir Historical Elevation-Area-Capacity Table

Gage Height (ft)	Surface Area (acres)	Cumulative Capacity (ac-ft)
0	29	-
4	43	143
8	86	413
12	148	899
16	211	1,616
20	271	2,566
24*	333	3,743
28*	404	5,233
32	481	7,044
36	695	9,464
40	997	12,736
44	1,153	16,956

* The Filing Map for the Statement of Claim for Dye Reservoir includes a figure on Sheet 1 that indicates a Capacity of 5,052 ac-ft and Surface Area of 371.2 acres

Reservoir Storage Measurement: Dye Reservoir storage levels are not typically measured.

Reservoir Seepage Information: Seepage from Dye Reservoir is not routinely monitored. Seepage from the reservoir accrues mostly to the Dye Reservoir Outlet Canal. The Dye Reservoir Outlet Canal is used to deliver water to the Arkansas River to be diverted by exchange at the Holbrook Canal for subsequent delivery to shareholders. The capacity of the outlet canal is unknown, although the Filing Map for the Statement of Claim for Dye Reservoir noted an outlet capacity of 100 cfs.

HydroBase Data: A significant amount of historical end-of-month contents are missing in HydroBase (red line) over the 1950 to 2015 period, as shown in Figure 4. Missing data were not available from the Holbrook Canal Company or the DWR.

During development of the ArkDSS Surface Water Model, the remaining missing storage contents data will be estimated based on review of available daily storage contents data for Dye Reservoir and Holbrook Reservoir, review of diversion data for the Holbrook Canal discussed above, water commissioner records and comments.

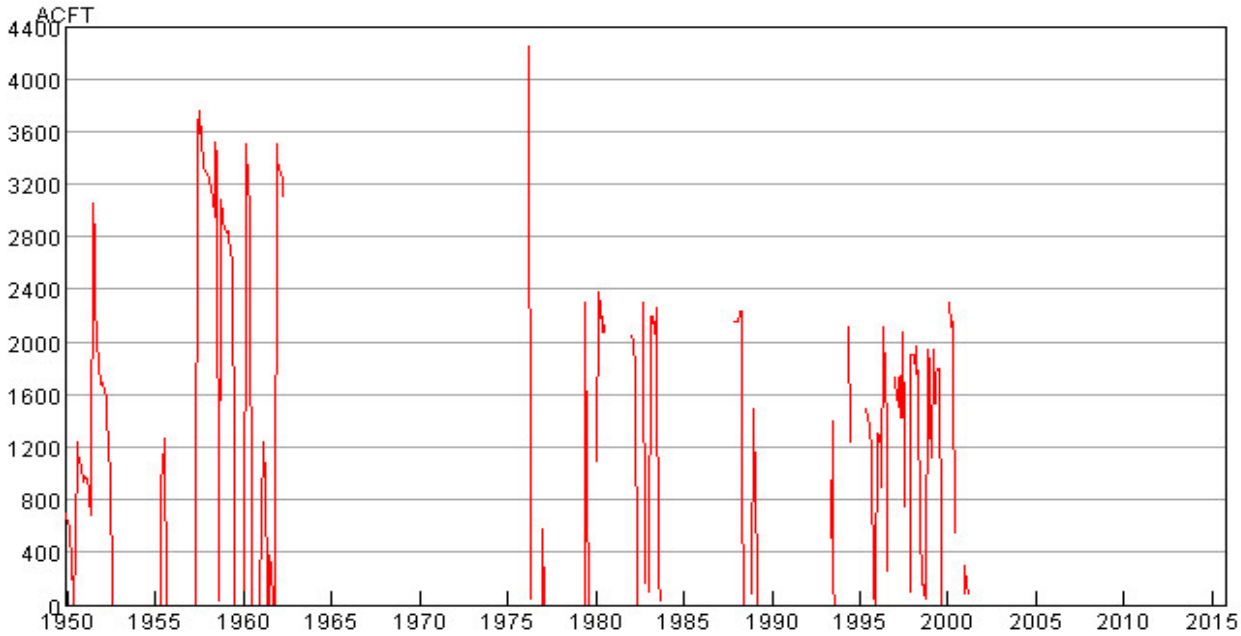

Figure 4: Dye Reservoir Storage Contents

WATER RIGHTS

Direct Flow Rights

The Holbrook Canal Diversion System has a total decreed flow rate of 600 cfs for irrigation uses, as summarized in Table 5. Also listed in Table 4 are the filling rates for the Holbrook Reservoir and Dye Reservoir storage decrees.

Table 4: Direct Flow Rights

Structure	Appropriation Date	Adjudication Date	Admin. No.	Decreed Amount (cfs)	Case No.	Notes
Holbrook Canal	9/25/1889	4/8/1905	14513.0	155	4/8/1905	Irrigation Use
	8/30/1893		15948.0	445		
			Total	600		
	10/10/1903	2/3/1927	19640.0	595	2/3/1927	Exchange from Dye Reservoir
	9/15/1909		21807.0	230		Exchange from Holbrook Reservoir
	3/2/1892	4/8/1905	15402.0	600	4/8/1905	Storage in Holbrook Reservoir
	10/10/1903	2/3/1927	20186.19640	600	2/3/1927	Storage in Dye Reservoir
	9/3/1909		21795.0	400		Storage in Dye Reservoir
	9/15/1909		21807.0	600		Storage in Holbrook Reservoir

Source: Colorado Water Rights Tabulation

Storage Rights

The storage rights for Holbrook Reservoir and Dye Reservoir are summarized in Table 5. Holbrook Reservoir has undergone one enlargement from its initial decreed capacity of 4,247.06 ac-ft; the enlargement increased the decreed storage capacity by 3,196 ac-ft, of which 2,000 ac-ft was transferred to Dye Reservoir. In addition, 2,000 ac-ft of the senior storage right in Dye Reservoir was transferred to Holbrook Reservoir, bringing Holbrook Reservoir to its current decreed capacity of 7,443.06 acre-feet.

Dye Reservoir had an initial decreed capacity of 4,500 ac-ft, of which 2,000 ac-ft was transferred to Holbrook Reservoir. Dye Reservoir has undergone one enlargement from its original decreed capacity; the enlargement increased the decreed storage capacity by 3,486 ac-ft. In addition, 2,000 ac-ft of the second storage right in Holbrook Reservoir was transferred to Dye Reservoir, bringing Dye Reservoir to its current decreed capacity of 7,986 acre-feet.

Note that both Holbrook and Dye Reservoirs were included as exchange to and from points in the Super Ditch Decree in Case No. 10CW004.

Table 6
Storage Rights

Storage Unit	Appropriation Date	Adjudication Date	Admin. No.	Decreed Amount (ac-ft)	Case No.	Notes
Holbrook Reservoir	3/2/1892	4/8/1905	15402.0	4,247.06	4/8/1905	
	10/10/1903	2/3/1927	20186.19640	2,000	W-3905	Transferred from Dye Reservoir
	9/15/1909		21807.0	1,196	2/3/1927	Portion of original 3,396 ac-ft right transferred to Dye Reservoir
			Total	7,443.06		
Dye Reservoir	10/10/1903	2/3/1927	20186.19640	2,500	2/3/1927	Portion of original 4,500 ac-ft right transferred to Holbrook Reservoir
	9/3/1909		21795.0	3,486		
	9/15/1909		21807.0	2,000	W-3905	Transferred from Holbrook Reservoir
			Total	7,986		

Source: Colorado Water Rights Tabulation

Administration

Administration of the water rights associated with the Holbrook Canal Company involves interaction with the Commissioner for Water Districts 17 and 67 and the Division 2 Engineer. The Superintendent of the canal company is more often in contact with these individuals during periods of storage and during periods when direct flow calls have been placed downstream on the Arkansas River.

OPERATIONAL INFORMATION

The general operating strategy for the Holbrook Canal and Reservoir System in a typical year is as follows:

Non-Irrigation Season

The Holbrook Canal typically shuts off by November 15, once the Winter Water season begins. Winter Water is stored in multiple locations, which may include Pueblo Reservoir, John Martin Reservoir, Lake Meredith, Dye Reservoir, Holbrook Reservoir, and Adobe Creek and Horse Creek Reservoirs. The amount of water available to the Winter Water program participants is dependent on river flows, as outlined in the 84CW179 decree that officially recognized the Winter Water Storage Program. The Holbrook Canal company is entitled to 38.16 percent of the first 100,000 ac-ft yield and a similar percentage of any water stored beyond 103,106 ac-ft. The Holbrook Canal Company is also entitled to 356 ac-ft of the first 3,106 ac-ft of Winter Water accounted for above 100,000 ac-ft. Total yields for the Winter Water Program have ranged from about 75,000 ac-ft in 2003 to almost 180,000 ac-ft in 2000. The Holbrook Canal Company's portion of the 2000 yield amounts to about 67,500 ac-ft. The Holbrook Canal Company's Winter Water yield was historically stored under the Holbrook Canal system, but the canal company stored its pro-rata share in Lake Meredith for most of the early-2000s.

The Holbrook Canal Company entered into an operating agreement with the City of Aurora in 2006 that prompted storage of the Holbrook Winter Water in Pueblo Reservoir. Under the agreement, Aurora may request that the City's transferable yield in the Rocky Ford Ditch be stored in Holbrook Reservoir. In the winter before the year this operation is anticipated to occur, the Holbrook Canal Company will store its Winter Water in Pueblo Reservoir and then book that water over to the City of Aurora for a like amount of Rocky Ford Ditch consumptive use credits stored in Holbrook Reservoir. This has apparently occurred a few times in recent years and may occur into the future, depending on various circumstances.

Irrigation Season

The Holbrook Canal has a relatively junior direct flow right that is typically only in priority to divert during spring runoff and later in the summer in above average and wet years.

Currently, unless operating under the agreement with the City of Aurora, the Holbrook Canal Company generally takes delivery of its Winter Water stored in Lake Meredith early in the irrigation season, since its water will be booked out if the Lake Henry or Lake Meredith storage rights come into priority during the spring runoff. Water stored in Lake Meredith can be released to the river via the Meredith Outlet Canal and re-diverted at the Holbrook Canal headgate. Alternately, water released from Lake Meredith can be picked up in the Holbrook Canal directly prior to Meredith Outlet Canal releases reaching the Arkansas River. These releases from Lake Meredith are then typically stored in Holbrook Reservoir and later released to the Holbrook Canal.

Historically, irrigators under the ditch benefitted from river diversions to storage or Winter Water stored in Holbrook Reservoir and Dye Reservoir and took late-season delivery of water from storage. Fryingpan-Arkansas Project (Fry-Ark) water released from Pueblo Reservoir is also diverted

into the Holbrook Canal later in the season.

Although the sequence of delivery each year varies based on hydrologic conditions, ditch operational issues and locations of storage of its Winter Water and other supplies, a general order of operations for water supplies into the Holbrook Canal is as follows:

- Direct Flow Water
- Holbrook Reservoir Storage Right
- Dye Reservoir Storage Right
- Winter Water from Lake Meredith (may involve trade with City of Aurora for water in Pueblo Reservoir)
- Winter Water and Storage Rights from Holbrook Reservoir and Dye Reservoir
- Fry-Ark Project Water from Pueblo Reservoir

Where to find more information

- Additional information on ditch and reservoir operations in and around the Holbrook Canal is presented in the ArkDSS Water District 17 memorandum.
- Additional information on Pueblo Reservoir and the Winter Water Storage Program is presented in the ArkDSS Fryingpan-Arkansas Facilities and Related Operations memorandum.
- Additional information on Colorado Canal Company operations is presented in the ArkDSS Colorado Canal memorandum.

REFERENCES

- Meeting with Water Division 2, Water District 17 Commissioner Lonnie Spady (lonnie.spady@state.co.us).
- Communication with City of La Junta water resources engineer, Ivan Walter (walterivana@iengrng.com).
- Meeting with Bob Barnhart, Superintendent, Holbrook Canal Company (bbarnhart76@yahoo.com).
- Meeting with Tom Simpson, Senior Water Resources Engineer, City of Aurora Lower Arkansas Valley team. (ktsimpson@rural-com.com).
- Abbott, P.O., Description of Water-Systems Operations in the Arkansas River Basin, Colorado. USGS Water Resources Investigations Report 85-4092. Lakewood, Colorado. 1985.
- Aqua Engineer, Inc. Super Ditch Rotational Fallowing – Water Leasing Program Report. Prepared for Lower Arkansas Valley Super Ditch Company as part of Task C of Colorado Water Conservation Board Water Supply Reserve Account Grant. December 30, 2010 (Revised).
- Decrees, engineering reports, and associated water court material available at http://dwrweblink.state.co.us/
- State of Colorado, Division of Water Resources, HydroBase database.
- State Engineer's Office. Straightline Diagrams and Maps and Filing Statements.