EL PASO COUNTY

WATER LOOP STUDY

May 2022

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ACRONYMS

AF, AC-FT	acre-feet
AFY	acre-feet per year
ALT	alternative
BJR	Big Johnson Reservoir
BWTP	Bailey Water Treatment Plant
CCF	hundred cubic feet
CFS	cubic feet per second
CMD	Cherokee Metropolitan District
CWCB	Colorado Water Conservation Board
DBGW	Denver Basin Groundwater
DWSD	Donala Water and Sanitation District
FLMD	Forest Lakes Metropolitan District
FMIC	Fountain Mutual Irrigation Company
FT-MSL	feet, mean sea level
GAL	gallons
GPCD	gallons per capita per day
GPD	gallons per day
GPM	gallons per minute
HP	horsepower
IPR	indirect potable reuse
JDPWRRF	JD Phillips Water Resource Recovery Facility
KGAL	one thousand gallons
LVWRRF	Las Vegas Water Resource Recovery Facility
MCL	maximum contaminant level
MGAL	one million gallons
MGD	million gallons per day
NMCI	Northern Monument Creek Interceptor
PPRWA	Pikes Peak Regional Water Authority
PS	Pump Station
UBSC	Upper Black Squirrel Creek
SAFB	Schriever Air Force Base
SDS	Southern Delivery System
SFE	single family equivalent
SWSD	Security Water and Sanitation District
TMD	Triview Metropolitan District
WRF	water reclamation facility
WRRF	water resource recovery facility
WSMP	water supply master plan
WTP	water treatment plant
WWSD	Woodmoor Water and Sanitation District
WWTF	wastewater treatment facility

EXECUTIVE SUMMARY

The El Paso County Loop project would integrate some existing assets with the additional infrastructure necessary to divert, store, treat and transport reusable and renewable water supplies from Fountain Creek, near the City of Fountain to water providers throughout the region east and north of Colorado Springs.

Water diverted from Fountain Creek would be conveyed by Chilcott Ditch to an expanded Callahan Reservoir for storage. From the reservoir, the water would undergo full or partial treatment and then be conveyed through approximately 20.7 miles of new 24-inch pipeline, aided by two new pump stations along the route, to the southern terminus of the existing 24-inch Sundance pipeline at Marksheffel and Tamlin Roads.

The Sundance line, with two new pump stations along the way, would convey water to its northern terminus near Hodgen and Black Forest Roads. From there, a new pump station and 24-inch pipeline approximately 11 miles long will convey water west along Hodgen and Higby Roads to Monument-area water providers. A potential 3-mile segment could later be added from Springs Utilities' system at CO Highway 83 and Old North Gate Road to a connection at Higby Road for delivery of finished water via the Springs system.

This project would regionalize northern El Paso County water providers through a sustainable system of water supply conveyance. In addition, the project can provide this same opportunity for water transport to eastern El Paso County communities who participate. Many northern and eastern water providers rely heavily on Denver Basin groundwater supplies, but those supplies are diminishing and becoming more costly to use. Continued reliance on Denver Basin supplies is not sustainable; the Loop project can provide the means to maximize use of existing supplies and possibly position several El Paso County water providers to secure additional surface water supplies.

An analysis of preferred alignments for the new northern and southern transmission pipelines, along with regional water treatment near Callahan Reservoir to meet full drinking water standards, results in the costs shown in the table below, including capital costs, O&M and total present worth. The cost opinion to build the system ranges from $162.3-191.9 M, depending on the how the reservoir is expanded. Adding the costs to operate the system for 20 years with flows growing steadily from 3.0 MGD to 6.0 MGD over that period, the total present worth in 2022 dollars is approximately $225-255M.

DESCRIPTION	CAPITAL COST	O&M PRESENT WORTH	TOTAL PRESENT WORTH
Reservoir Expansion, Full Regional Treatment, Transmission Loop	$162.3-191.9 M	$63.1 M	**$225-255M**

CHAPTER 1
INTRODUCTION

Four El Paso County water providers with shared interests in water supply planning and water quality initiated this El Paso County Water Loop Study. They all want to ensure that sufficient water supplies are cost effective and sustainable throughout the county given long term projections and ongoing growth. All have some level of reliance on nonrenewable Denver Basin water supplies, which will not be economically viable over time given declining water levels. The water providers recognize the need to make full use of their water supplies to the extent practicable and anticipate that other water providers could also join in this regional effort.

This study serves to evaluate the feasibility of capturing and reusing return flows that accrue to Monument and Fountain Creeks within El Paso County. The specific water providers participating in this study are:

- Cherokee Metropolitan District (CMD)
- Donala Water and Sanitation District (DWSD)
- Town of Monument
- Woodmoor Water and Sanitation District (WWSD)

All are members of the Pikes Peak Regional Water Authority (PPRWA), and this study builds upon concepts developed in prior PPRWA studies. The first of those was the Water Infrastructure Planning Study (WIPS). The WIPS provided a broad view of alternatives to use Denver Basin supplies more efficiently, and acquire and deliver new, renewable water supplies to the Monument area. PPRWA's Regional Infrastructure Study (RIS) in 2015 developed the concept of connecting Springs Utilities' Southern Delivery System (SDS) to CMD's Sundance Pipeline to provide a regional backbone for water deliveries from the Fountain to Monument areas, along with reservoir storage, treatment, and pumping facilities. PPRWA's Area 3 Preliminary Engineering Report provided greater detail on the northernmost of the three RIS project areas.

The Water Loop Study participants also joined Colorado Springs Utilities and other PPRWA members recently to complete the PPRWA Regional Reuse Study. That study similarly evaluates the feasibility of capturing and reusing return flows from Fountain Creek, but then treating and delivering those flows to participants as finished water via the Springs Utilities water distribution network.

1.1 Purpose

In this study, we evaluate the physical facilities needed to capture return flows available from Fountain Creek and deliver them to the respective service areas as either partially treated or finished water via a combination of new and existing infrastructure. Additionally, some of the service providers have existing local water rights that may be delivered using that same infrastructure. We also consider what additional facilities or upsizing would be needed to make use of those supplies as well.

This study identifies alternatives to divert, store, and treat water from Fountain Creek and cost effectively deliver it to participating members' service areas east and north of Colorado Springs. The Water Loop Study facilitates a collaborative effort between participating entities in achieving a common goal to most efficiently use their existing water supplies, while also optimizing the reuse of any additional supplies that participants may develop in the Arkansas River basin.

1.2 Concept

The loop concept entails capturing reuse return flows, and other locally available water rights owned by the participants, from Fountain Creek and conveying those flows via Chilcott Ditch for storage in Callahan Reservoir. The water would then be pumped through a transmission line around the east side of Colorado Springs and north to the Monument area. Water could either be fully treated to meet primary drinking water standards at a single regional facility prior to distribution to member entities, or be partially treated at a single facility with polishing provided at each entity's individual system to include filtration, advanced oxidation and disinfection.

The concept makes use of existing assets including the ditch and reservoir in which WWSD holds majority interest, and CMD's Sundance waterline which comprises approximately one-third of the entire transmission loop (see Figure 1-1).

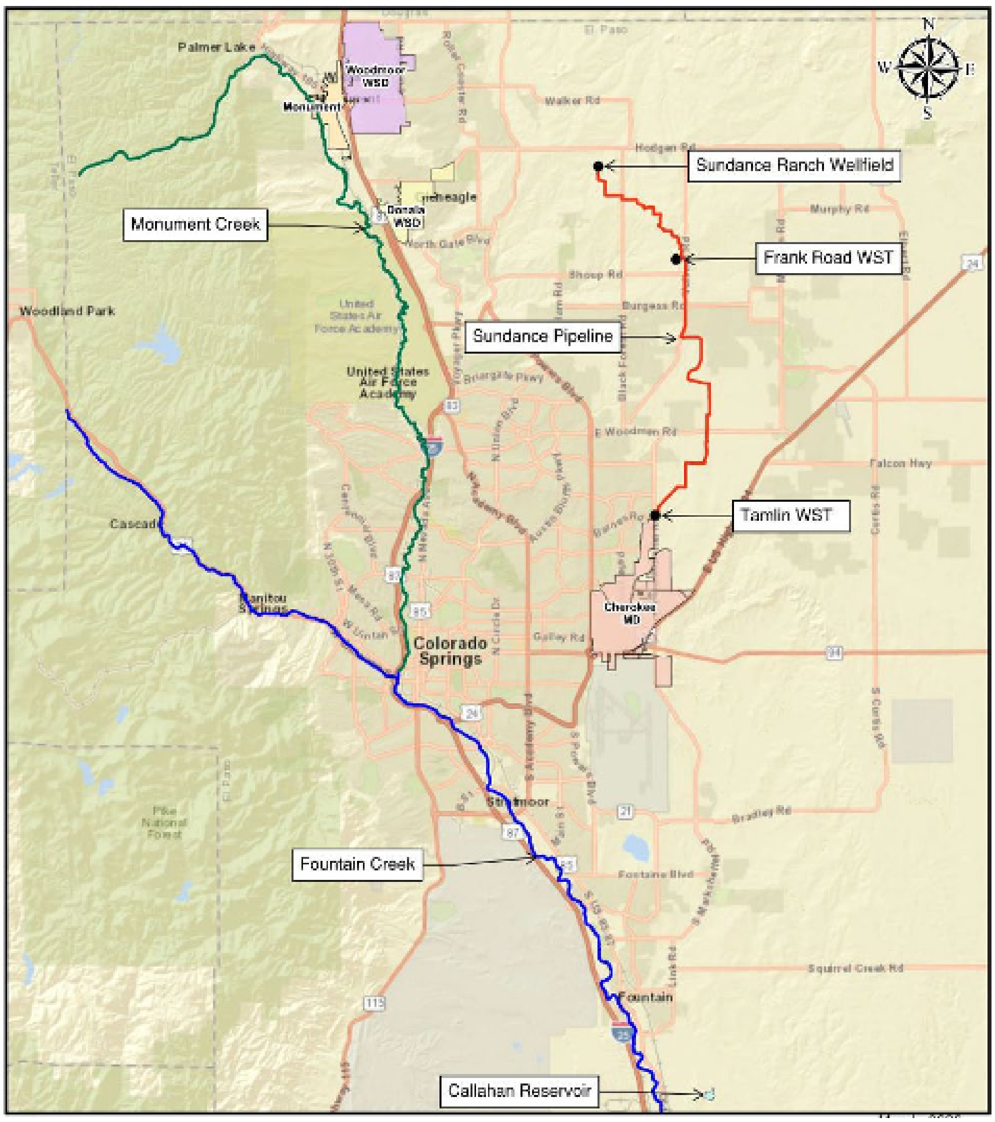

Figure 1-1: Existing System

1.3 Scoping and Objectives

The work of this study was completed in two phases. Phase I consisted of identifying conceptual system alternatives for raw water storage and conveyance, loop conveyance, pumping, and water treatment; and preparing cost opinions for the alternatives. Phase II consisted of developing opinions of probable construction costs for refined and preferred alternatives, as well as annual O&M costs and total present worth costs.

CHAPTER 2
SYSTEM CAPACITY NEEDS

Planning for the Loop system must, at a minimum, accommodate the projected water delivery needs of the participating water providers through 2050. But the participants plan to offer a participation interest to other entities. Therefore, the system will be planned for additional capacity available to serve other regional needs yet to be specified. This chapter identifies the criteria used to size the system.

2.1 Initial Sizing Assumptions

The participants asked that the following assumptions be used to plan the water loop system, subject to revision during the study's technical refinement phase:

1. ***24-inch pipeline diameter for all loop alignments***
   This sizing was confirmed during the technical refinement phase as it matches that of CMD's existing Sundance Ranch transmission pipeline which comprises approximately one-third the length of the loop pipeline.
2. ***10.0 MGD maximum daily water treatment plant (WTP) throughput***
   The WTP capacity was changed to 6.0 MGD to match the flow used for planning the loop pipeline.
3. ***10.0 MGD maximum daily loop pipeline transport***
   The loop pipeline capacity was reduced to a maximum flow of 6.0 MGD. This change reduced the pipeline velocity from 4.93 fps to 2.96 fps in the 24-inch pipeline, requiring fewer pump stations and reduced power costs to operate the system.
4. ***6,000 AF of active usable storage required in Callahan Reservoir***
   Consistent with the *PPRWA Regional Reuse Study*, local water rights available from Fountain Creek would require an additional 1,500 to 1,600 AF of storage capacity at Callahan Reservoir; a total of up to 2,200 AF rather than 6,000 AF.
5. ***60 cfs current Chilcott Ditch flow capacity***
   WWSD, a Chilcott Ditch shareholder, confirms that the ditch has sufficient capacity to match delivery of up to 6.0 MGD through the loop system.

2.2 Reusable Return Flows

In El Paso County, reusable return flows are primarily derived from nontributary groundwater, transmountain diversions, and the consumptive share of water rights converted from agriculture. As those water supplies are used, a significant portion of them are recaptured in the wastewater collection systems, treated and then discharged from WWTPs. These flows are commonly referred to as "reusable return flows" or "sewered return flows" and tend to be consistent on a year-round basis. A smaller share of reuse returns can be attributed to lawn irrigation return flows (LIRFs) during the irrigation season, but they are not consistent year-round and lag in accrual to the creek. For purposes of this study, we will consider only the reusable return flows generated from wastewater treatment.

Treated wastewater return flows from three of the four participants are currently discharged into Monument Creek from one of two treatment facilities. The Tri-Lakes WWTF in southwest Monument treats flows from Monument and WWSD (in addition to Palmer Lake, see Figure 2-1). The Upper

Monument Creek WWTF treats flows from DWSD (in addition to Triview and Forest Lakes Metropolitan Districts.)

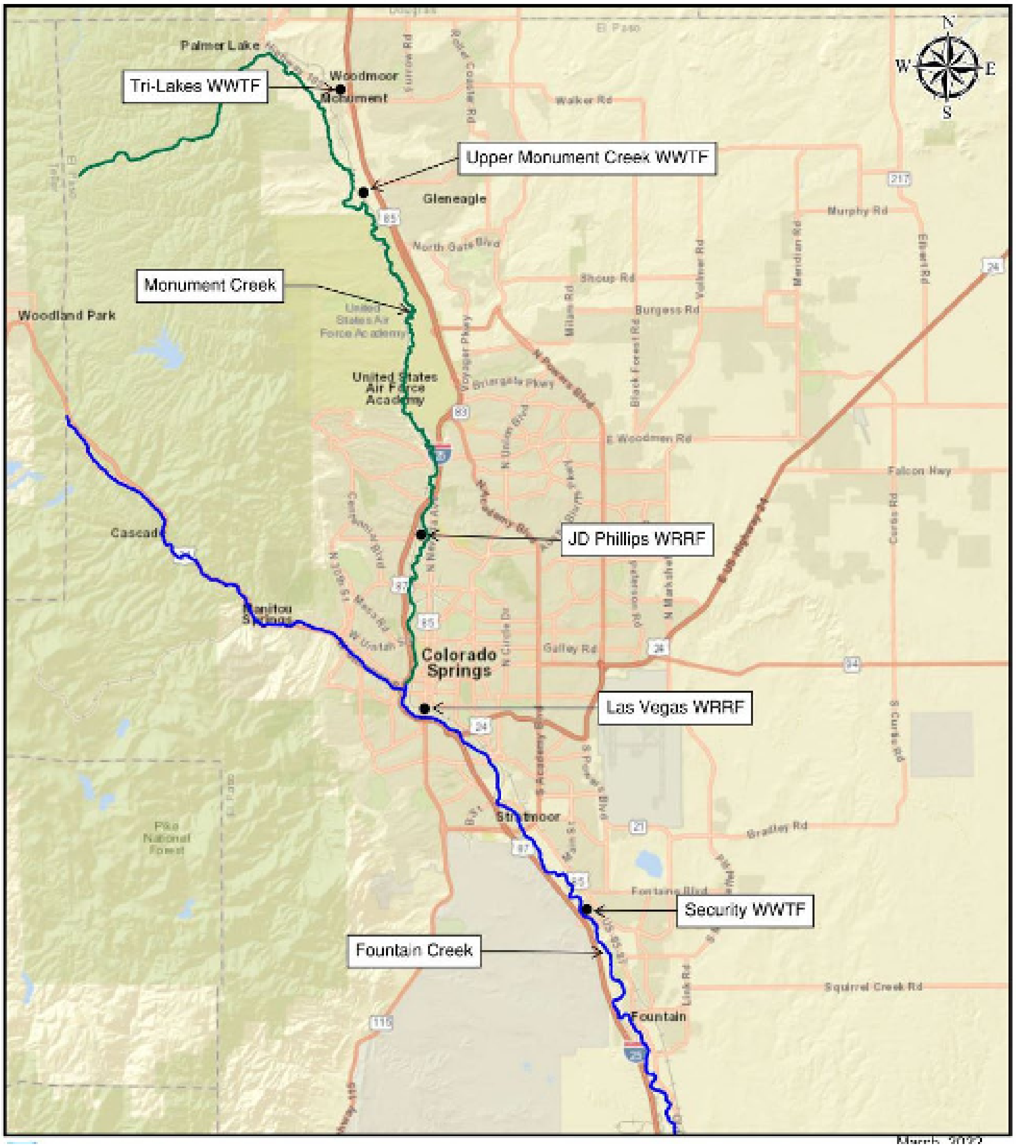

Figure 2-1: Area WWTFs on Monument and Fountain Creek

Springs Utilities has proposed a regional wastewater project that would collect and treat wastewater flows from both the Tri-Lakes and Upper Monument Creek WWTFs. The Northern Monument Creek Interceptor (NMCI) project would allow those two WWTFs be decommissioned. The NMCI would convey flows to Springs Utilities' J.D. Phillips Water Resource Recovery Facility (JDPWRRF), which has sufficient capacity available for consolidation of treatment. One noted benefit of the NMCI project is that it would reduce stream losses suffered on the return flows between discharge to the stream and recapture further down. Whether the six Monument-area participants join Springs Utilities in developing NMCI or not, their return flows will still be discharged into Monument Creek and available for recovery downstream of its confluence with Fountain Creek.

CMD has no current return flows discharged into the Fountain Creek basin. All treated wastewater flows from their Upper Black Squirrel Creek (UBSC) WWTF are conveyed to recharge basins in the UBSC Basin aquifer east of Colorado Springs. A portion of that flow is pumped from a downgradient well field for indirect potable reuse within CMD's service area. CMD may consider future scenarios that would result in having return flows or water rights available from Fountain Creek.

Based on the background documents review and participant interviews, Table 2-1 summarizes the expected reusable return flow rates for participants currently and projected for 2050. The storage volumes needed for reuse should be understood as narrative or qualitative in nature based on existing studies or participant estimates. A subsequent phase of this study would be needed to develop conceptual plans for operation considering the dynamics of diversion and conveyance rates, necessary storage volume, and forecast treatment capacity.

Entity	Location / Notes	Current Wastewater Effluent Flows		2050 Wastewater Effluent Flows	
		[AFY]	[cfs]	[AFY]	[cfs]
CMD	Not currently a discharger to the Fountain Creek system.	n/a	n/a	n/a	n/a
DWSD	Return flows from DBGW & Willow Creek discharged from UMCWWTF	507	0.700	507	0.700
Town of Monument	Return flows from DBGW discharged from TLWWTF	145	0.200	574	0.793
Woodmoor Water and Sanitation District	Return flows from DBGW & transferred ag water rights (under development) discharged from TLWWTF	652	0.900	1,160	1.60
Total		**1,304**	**1.81**	**2,241**	**3.1**

Table 2-1: Expected Reusable Return Flow Rates

2.3 Local Water Rights Flows

As previously noted, local water rights flows owned by two of the participants and available on Fountain Creek could be accessed through some upsizing of the infrastructure needed to recover and return their reuse flows. Those water rights are listed in Table 2-2. Local water rights are generally available for diversion during the irrigation season, April through October.

Entity	Location/Notes	Water Rights (AFY)
DWSD	Laughlin Ditch	300
WWSD	Woodmoor Ranch	2,630
TOTAL		2,930

Table 2-2: Local Water Rights

Based on projected average-year return flows of approximately 2,240 AFY in 2050 and additional water rights flows of 2,930 AFY, the planned system would need to deliver a total of 5,170 AFY to fully meet participants' water delivery requirements. Averaging that flow throughout the year, the system would need to be able to deliver 4.63 MGD to meet participants' 2050 needs. Therefore, planning the system for delivery of 6.0 MGD allows some additional capacity for the participating entities to either acquire more water rights, bring additional participants into the Water Loop project at a future date, or deliver peak season demands.

CHAPTER 3
RAW WATER CONVEYANCE & STORAGE

This chapter provides a review of how existing raw water conveyance from Fountain Creek and reservoir storage could be incorporated into the Loop project. The water would be diverted into Chilcott Ditch for transport to Callahan Reservoir.

3.1 Chilcott Ditch

Chilcott Ditch is used for all flow scenarios considered in this study. WWSD has a majority interest in this ditch, approximately 9.6 miles from the Fountain Creek headgate to Callahan Reservoir (Fig. 3-1). The ditch is expected to have ample capacity available for the anticipated Loop project flows. No improvements are necessary to serve this project's needs, although there is opportunity to improve some sections of the ditch for even greater capacity should the need arise.

For purposes of this study, a ditch loss of 10 percent was used to determine the reduced flow volume delivered to Callahan Reservoir, but the ditch company typically requires a 15 percent loss calculation for administrative purposes. A possible variation considered in this study would be to pump reuse return flows from alluvial wells via a transmission pipeline to Callahan Reservoir, essentially eliminating ditch losses for that portion of the flow.

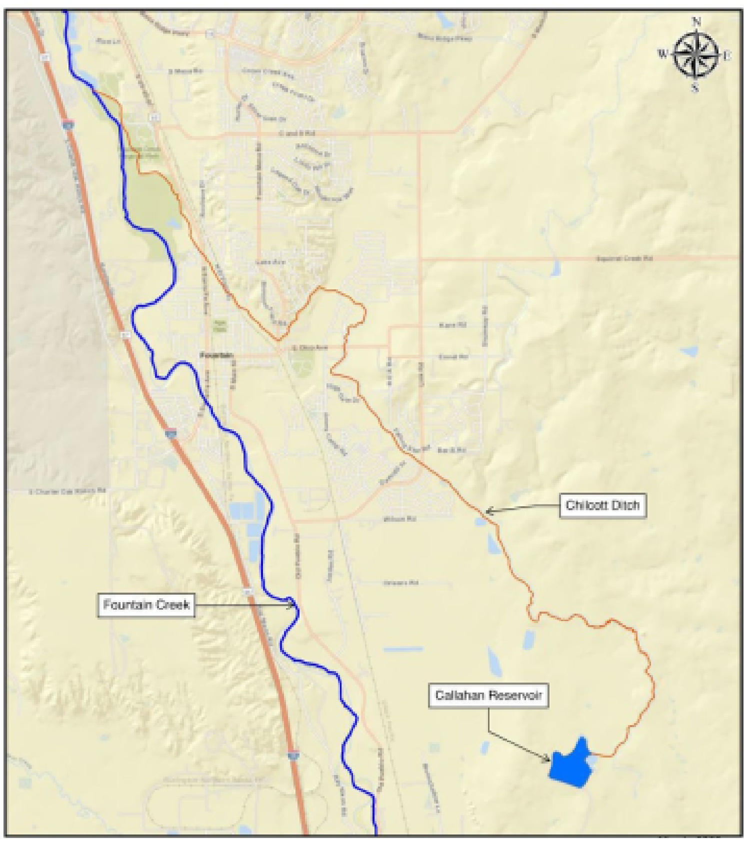

Figure 3-1: Chilcott Ditch

3.2 Callahan Reservoir

Because reuse flows will be diverted and returned at fairly constant rates year-round, no storage is theoretically needed to facilitate those flows. Return flows diverted from Fountain Creek can be delivered to the participants at those same constant rates (not accounting for system losses). Some minimal storage may be needed only to maintain operations in the event of a water transmission line break, pump station failure or some other system upset. The storage that accommodates diversion of local water rights can also fulfill this need for operational storage.

Callahan Reservoir in southern El Paso County (Fig. 3-2) is owned and operated by WWSD. The reservoir is operated for summer storage, filling seasonally at the same time as needed for diversion of the participants' local water rights. Therefore, Callahan's existing capacity of 660 AF is not available to accommodate those water rights. The *PPRWA Regional Reuse Study* identified the need for 1,500 to 1,600 AF of added storage capacity to accommodate year-round delivery of 4,670 AFY in local water rights to current and potential participants in the Loop project. To be consistent, this study relies on that same conclusion and assumes an increase in Callahan Reservoir storage capacity is needed to bring total forebay system storage to 2,200 AF of capacity.

Expansion can be achieved via two possible options representing a range of costs. The first option would require demolition of the existing dam structure as it does not meet modern dam safety requirements set forth by the State Engineer's Office (SEO) and is currently not authorized to store water at normal operation levels. Therefore, a new dam would be constructed further south to 10 feet higher than the existing dam crest for a total storage volume of 2,200 AF.

The second, less costly expansion option would involve dredging material from the reservoir and upgrading the existing dam structure for compliance with SEO standards. The dam upgrade would consist of reconstructing the outlet works and toe drains. Expansion would be achieved by dredging material to increase capacity by approximately 1,500 AF (from 660 AF to 2,200 AF) and spreading it on open land north of the reservoir.

Figure 3-2: Callahan Reservoir

CHAPTER 4
WATER LOOP CONVEYANCE

This chapter describes the 24-inch Loop transmission pipeline and pump stations needed to deliver water from Callahan Reservoir to the water systems of each participant. The transmission line would consist of two separate pipelines, the southern and northern alignments, and repurposing the existing Sundance Pipeline in between, to deliver water east of Colorado Springs and to northern El Paso County. The southern segment of pipeline would run from Callahan Reservoir to the southern terminus of the Sundance Pipeline for possible delivery to CMD's Tamlin Water Storage Tank (WST). From that point, water would be pumped north through the Sundance Pipeline to the Sundance Ranch and then west to each of the three Monument-area participants.

4.1 Southern Alignment

Some level of regional water treatment would be provided along the southern alignment, possibly near Callahan Reservoir, and prior to any deliveries to individual water systems as described in Chapter 5. The southern alignment of the water loop would extend approximately 20.7 miles north from the reservoir to the Tamlin WST near the intersection of Tamlin and Marksheffel Roads. Two alignments were evaluated that differ for the segments between Callahan Reservoir and Marksheffel Road (see Fig. 4-1).

The primary alternative for the southern alignment would traverse the west side of Callahan Reservoir, following the Chilcott Ditch service road for 3.2 miles. This portion of the alignment would cross four separate private properties, requiring approximately 1.5 miles of easement acquisition. Continuing northwest along the ditch service road, the alignment would intersect Link Road and turn north along that road for 1.7 miles before intersecting Marksheffel. The waterline would proceed along Marksheffel for 15.9 miles before terminating at the Tamlin WST. Two pump stations will be required along this route: one at the south end, and one more along Markscheffel Rd.

The second alternative alignment was evaluated and determined to be less favorable due to additional length and possible difficulty in obtaining an easement from Springs Utilities. Therefore, the primary alignment is preferred, and cost evaluations shown in Chapter 6 are provided only for the primary alignment.

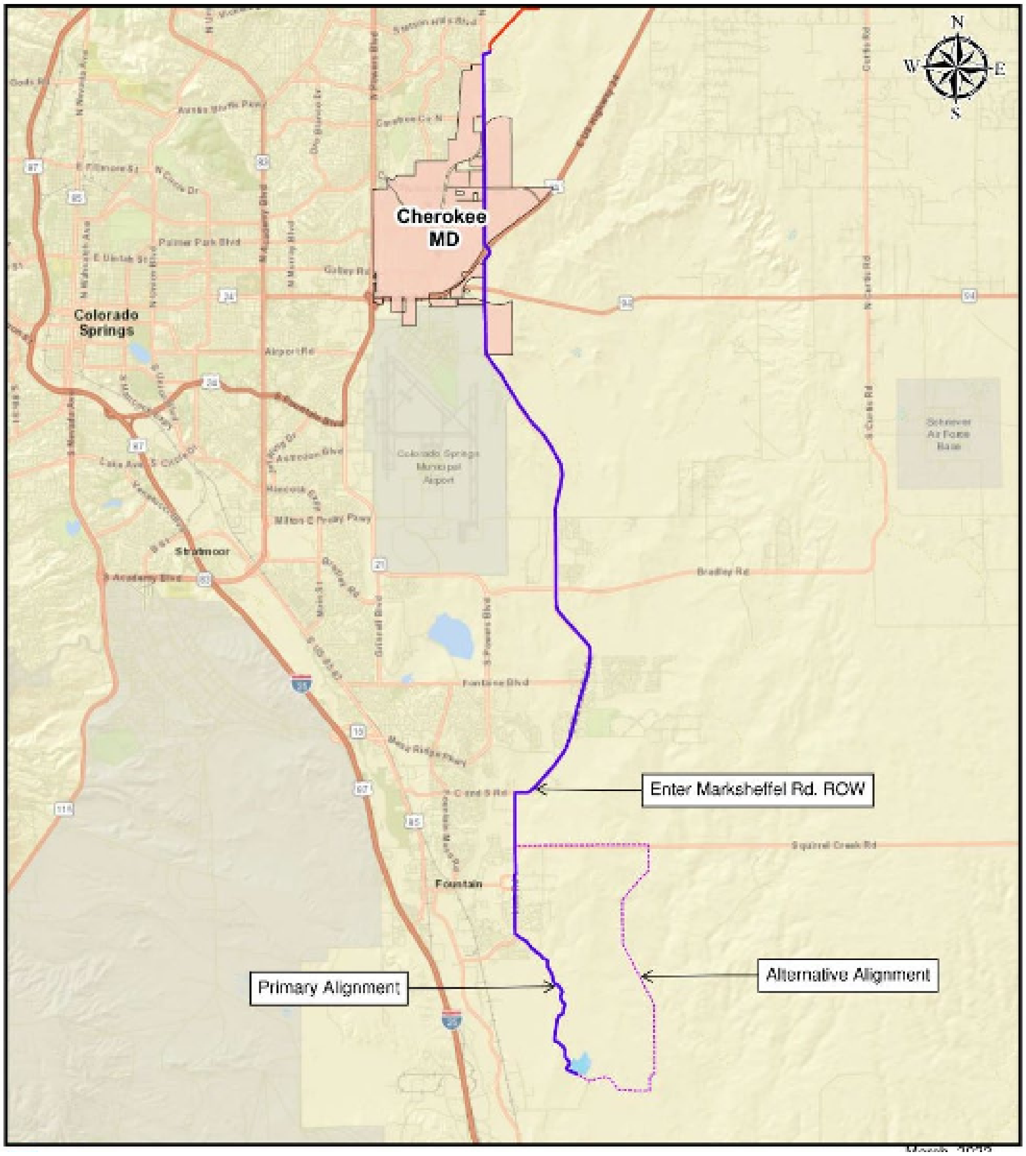

Figure 4-1: Southern Alignment

4.2 Sundance Pipeline

Connecting the southern and northern portions of the water loop system is CMD's existing 24-inch Sundance Pipeline. That line was constructed in 2013 to convey Denver Basin groundwater from CMD's Sundance Ranch well field. Water is pumped from there to a high point southeast of the well field, for gravity flow from there to the Tamlin WST and CMD's distribution system. Some operational storage is also provided at the Frank Road WST between the well field and the Tamlin WST. Because the pipeline is existing, no construction costs are included for it in Chapter 6. However, some financial consideration will be required for other entities to use this CMD asset.

To integrate the pipeline into the Loop system, flow would be reversed with the aid of two new pump stations. Stretching approximately 16 miles from beginning at the Tamlin WST, it runs northeast along Tamlin Road for 2 miles before intersecting Dublin Blvd. From Dublin Blvd, the pipeline traverses east around the Banning Lewis development before crossing through open fields for approximately five miles. It then intersects Vollmer Road and follows it for 2.5 miles. At that point, the pipeline meanders northwest through Black Forest to its termination at the Sundance Ranch well field.

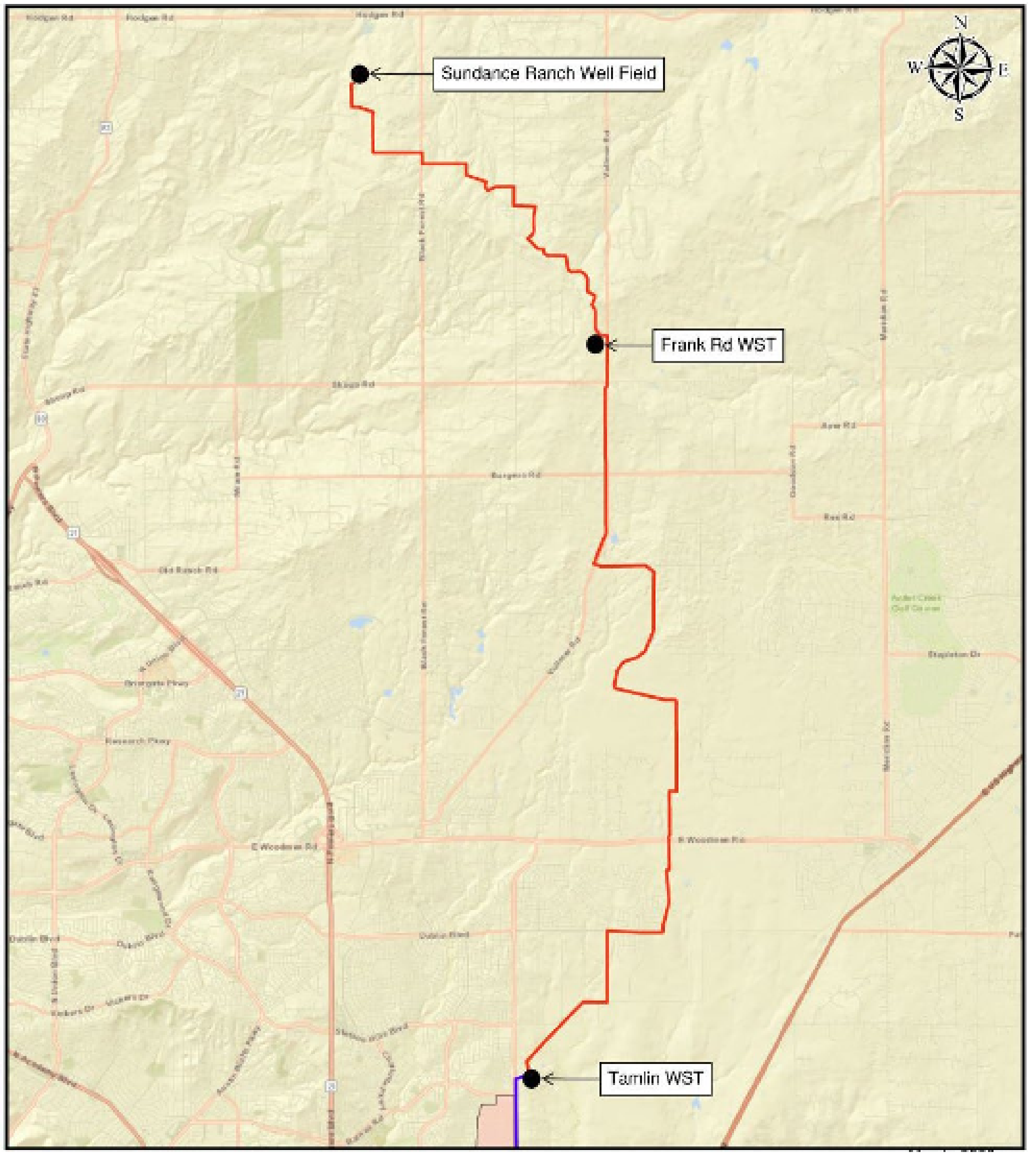

Figure 4-2: Sundance Pipeline

4.3 Northern Alignment

The northern alignment for the water loop system comprises approximately eight miles of 24-inch waterline, with the potential addition of another three-mile segment (Fig. 4-3). The waterline runs from the northern terminus of the Sundance pipeline at Sundance Ranch west to the Monument area. It follows Hodgen Road for approximately 3.5 miles before turning north on Roller Coaster Road for approximately 0.5 mile. Then it proceeds to intersect Higby Road and follow it approximately 4 miles west to Jackson Creek Parkway.

A new waterline would connect to the transmission line at Higby Road and run south to serve DWSD. At Jackson Creek Parkway, the northern transmission line could connect to WWSD's existing raw waterline running north along Jackson Creek Parkway to Lake Woodmoor and WWSD's South WTP. That raw waterline currently conveys flow to WWSD from Monument Creek, passing under Interstate I-25 at Higby Road. There may be an opportunity to repurpose that segment to instead deliver Loop water to the west to connect to Monument's system on the other side of I-25.

As contemplated for the Northern Delivery System, water providers in the Monument area may, at some point, receive some portion of their water supplies via the Springs Utilities water distribution system. If so, a 3-mile segment of waterline could be added from Springs Utilities' WST near CO Highway 83 and Old North Gate Road to the northern transmission line in Hodgen Road for possible delivery to DWSD, WWSD, the Town of Monument, and others. Water from Springs Utilities' system would be fully treated, so this option would be more compatible with the full treatment alternative for the Loop System. If the Loop system provides only partially treated water, water received from Springs Utilities and blended with Loop water would need to be treated again to some extent.

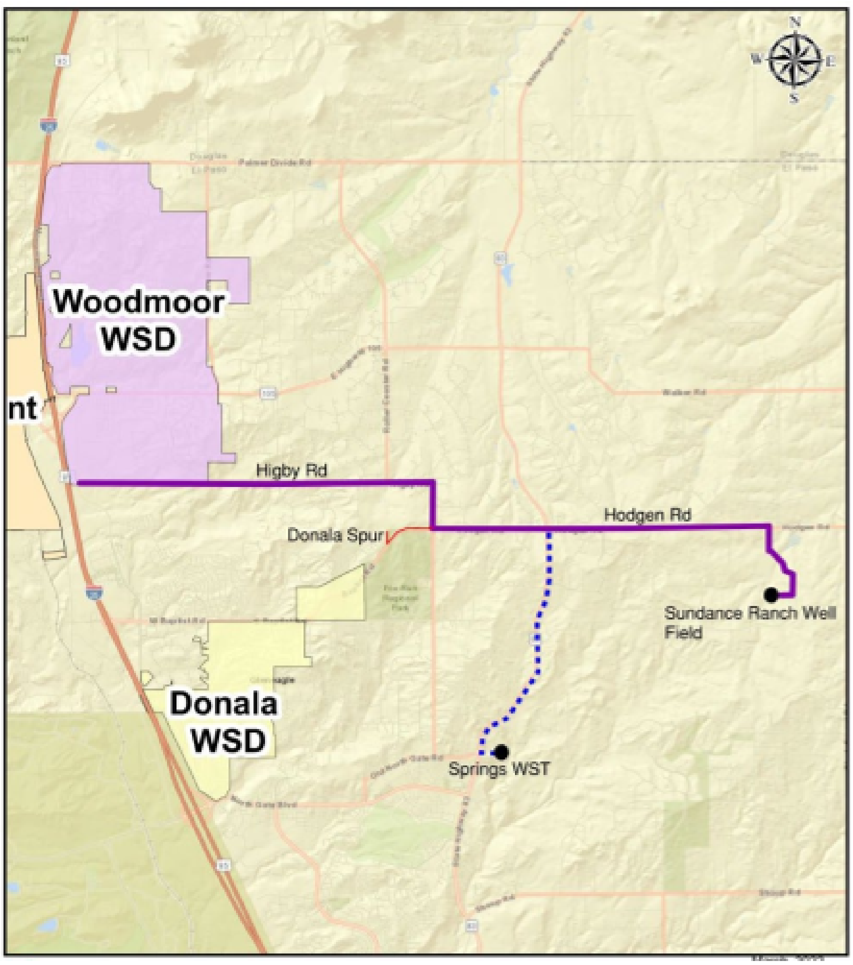

Figure 4-3: Northern Water Supply Delivery

CHAPTER 5
WATER TREATMENT

Water treatment will be an important component of the water loop system, and two alternatives are considered: full drinking water treatment at a single facility; or partial treatment at a single facility with polishing treatment to be provided within the water system of each participating entity. This chapter outlines what treatment is needed and provides an analysis of the two alternatives.

5.1 Water Quality

Raw water for the loop system would be drawn from Callahan Reservoir, supplied by Fountain Creek via the Chilcott Ditch. As described in Chapter 1, Fountain Creek receives treated wastewater effluent from several treatment facilities along Monument and Fountain Creeks upstream of the Chilcott Ditch headgate. Extensive USGS water quality data is available in the area of the headgate. For this study, additional sampling was performed for total organic carbon (TOC), dissolved organic carbon (DOC), and manganese in December 2021 and January 2022 at both the headgate and reservoir. The table below provides an average of the manganese data analyzed from each. Sampling also indicated TOC and DOC levels two to three times higher in the reservoir compared to the headgate area.

Constituent	Chilcott Headgate	Callahan Reservoir
Manganese (ug/l)	38.6	147.5

Table 5-1: Water Quality Data Summary

5.2 Regulatory Standards

Treatment requirements are prescribed by the Colorado Department of Public Health and Environment (CDPHE) through *Regulation 11 – Colorado Primary Drinking Water Regulations*, and the *Design Criteria for Potable Water Systems.* Based on the source water quality, treatment must be adequate to demonstrate that resulting water quality can meet CDPHE potable water requirements. That includes minimum treatment levels for virus and pathogen inactivation, turbidity, total coliform and e. coli, nitrate and nitrite, radionuclides, and inorganic and organic chemicals. Maximum contaminant levels (MCLs) for primary and secondary drinking water standards are listed in Regulation 11.

The primary drinking water standards are enforceable. The secondary drinking water standards are related to aesthetic effects such as color, taste and odor, but are not enforceable. Iron, manganese and total dissolved solids (TDS), however, are some secondary standards that are generally recommended to be controlled.

Based on the limited testing performed, it appears that the TOC and DOC levels in Callahan Reservoir are relatively high. For TOC concentrations greater than 8 mg/l, Regulation 11 requires 30 to 50 percent removal, depending on the alkalinity, to comply with the Disinfectant Byproduct Precursor Rule. Data for iron (Chilcott, from USGS) and manganese (Callahan Reservoir) are approximately three times their respective secondary MCLs. Therefore, the treatment facilities should include iron and manganese removal capabilities. Additional water quality testing is recommended to confirm the limited testing that was performed, and jar testing is recommended during development of the final treatment strategy.

By using Callahan Reservoir as an additional environmental buffer prior to treatment, this system would be considered an *indirect* potable reuse system. Current CDPHE regulations do not specifically address indirect potable reuse. However, a draft regulation for *direct* potable reuse (DPR) has been developed and is currently going through CDPHE's stakeholder process, with anticipated issuance in 2023.

5.3 Treatment Strategy

While the DPR draft regulations require a multi-barrier treatment approach, multi-barriers may not be required by CDPHE for the Loop's indirect potable reuse system. However, it may be prudent at this early planning stage to adopt a conservative approach that provides for multi-barrier treatment.

Based on a literature review and consideration of treatment technologies used in other facilities, the preliminary cost opinions in this report are based on microfiltration followed by ozone/biologically activated filtration (O_3/BAC). (Reverse-osmosis [RO] was not considered due to the creation of a brine stream that has significant disposal challenges for an inland state such as Colorado.)

Multi-barrier treatment can be achieved with the addition of either granular activated carbon (GAC) or conventional filtration. Ultraviolet (UV) advanced oxidation is also included for removal of chemicals, and additional virus, cryptosporidium, and giardia log removal credit. Chlorination would be provided for additional disinfection and to maintain a chlorine residual in the distribution system.

5.4 Treatment Alternatives

Two water treatment scenarios have been considered. Both scenarios include construction of a new 6.0 MGD capacity treatment facility near Callahan Reservoir, with raw water being supplied from the reservoir. The first scenario includes treatment to potable water quality at the Callahan Reservoir facility. In this scenario all of the treatment steps described would be performed at that facility. Booster chlorine stations would need to be provided along the transmission pipeline route, probably at the pump stations.

For the second scenario, partial treatment consisting of microfiltration and ozone/biologically activated filtration (O_3/BAC) would be provided at the Callahan facility. Polishing treatment consisting of conventional filtration and UV advanced oxidation would be provided at each end-user's treatment facility.

5.5 Riverbank Filtration

Along with the full and partial treatment options described, the source water quality could be improved for a portion of the flow with riverbank filtration. This would require pumping new alluvial wells on Fountain Creek and a new raw waterline to the treatment facility, bypassing storage. Use of alluvial wells may negate the need for some treatment processes for that portion of the flow. Some filtering would occur naturally in the alluvium, possibly reducing suspended solids, bacteria, viruses, micropollutants, and other organic and inorganic compounds.

Reservoir storage will generally be needed to balance the flows obtained from local water rights to maintain steady supply for year-round use (unless the Loop system is built with summer peaking capacity). That water would continue to be conveyed to Callahan Reservoir via the Chilcott Ditch and require surface water treatment. But some treatment processes could be downsized if the reuse return flows can benefit from riverbank filtration and bypass reservoir storage. There would be an added benefit in that pumping from an alluvial wellfield to the new water treatment plant would eliminate ditch losses, increasing net water production.

Capital and operating costs of the alluvial wells, pumping and transmission are likely to exceed the costs of somewhat larger treatment facilities. But this should be evaluated further once the participants are able to confirm what share of the water supplies require reservoir storage to balance flows vs. what portion could be produced at a consistent rate from alluvial wells.

CHAPTER 6
COST ANALYSIS

This chapter provides overall cost opinions for the Loop system, including further screening of the treatment alternatives identified in Chapter 5 for analysis and recommendations. The alternatives are compared on the bases of capital costs, operation and maintenance (O&M) costs, and total present worth.

6.1 Capital Costs

We developed opinions of project capital costs to include: the range of expansion costs for Callahan Reservoir as described in Chapter 3; a new regional WTP for either full or partial treatment (with localized polishing treatment); the northern and southern pipeline alignments; and five pump stations along the entire route. Project cost opinions are shown in Appendix II and summarized in Table 6-1. As previously noted, costs for the existing Sundance pipeline are not included, but there are potential added costs to those water providers that take deliveries from that line.

LOOP ALTERNATIVE	PROJECT COST
Reservoir Dredge/Rehab & Partial Regional Treatment	$155.1 M
Reservoir Dredge/Rehab & Full Regional Treatment	$162.3 M
Reservoir Reconstruction & Partial Regional Treatment	$184.7 M
Reservoir Reconstruction & Full Regional Treatment	$191.9 M

Table 6-1: Project Cost Opinions

6.2 O&M Costs

We also prepared opinions of annual O&M costs to include water treatment, pumping and transmission. Although the Loop system would be constructed to a 6.0 MGD capacity, it could be several years until that capacity is fully used year-round. As discussed in Chapter 2, reuse return flows available to the participants in this study are expected to grow from approximately 1.2 MGD currently to 2.0 MGD in 2050 (1,300 to 2,240 AFY). An additional supply of 2.6 MGD (2,930 AFY) in local water rights owned by participants could be added. For purposes of this study, we will assume that the Loop system flows will be delivered from Fountain Creek to the Monument area, growing steadily from 3.0 MGD in the first year of operation to 6.0 MGD in year 20. Annual O&M costs for both flows are shown in Table 6-2.

LOOP ALTERNATIVE	ANNUAL O&M for 3.0 MGD	ANNUAL O&M for 6.0 MGD
Partial Regional Treatment & Pumping	$3.27 M	$4.72 M
Full Regional Treatment & Pumping	$3.62 M	$5.07 M

Table 6-2: Annual O&M Costs

6.3 Total Present Worth Costs

For total present worth costs, we combined the capital project costs with the O&M costs needed to run the Loop system for 20 years, in 2022 dollars. The total O&M costs used over the 20-year period are based on having the Loop flow grow steadily from 3.0 MGD to 6.0 MGD over that period and using an annual discount rate of 3% over that period. Total present worth costs are shown in Table 6-3.

LOOP ALTERNATIVE	CAPITAL COST	O&M PRESENT WORTH	TOTAL PRESENT WORTH
Reservoir Dredge/Rehab & Partial Regional Treatment	$155.1 M	$57.85 M	**$213.0 M**
Reservoir Dredge/Rehab & Full Regional Treatment	$162.3 M	$63.06 M	**$225.4 M**
Reservoir Reconstruction & Partial Regional Treatment	$184.7 M	$57.85 M	**$242.5 M**
Reservoir Reconstruction & Full Regional Treatment	$191.9 M	$63.06 M	**$255.0 M**

Table 6-3: Total Present Worth Costs

CHAPTER 7
RECOMMENDATIONS

The Loop system as described in this study is feasible and could prove key to improving the sustainability of water supplies for several of the county's water service providers. Each participant can realize the cost benefits of sharing a single regional system versus independently developing their own reusable return flow systems. The regional system could also provide the means for delivery of local water rights. This chapter provides our system recommendations.

7.1 Reservoir Expansion

As shown in Chapter 6, constructing a new, larger dam for Callahan Reservoir and removing the old one is estimated to cost nearly $30 M more than rehabilitating the existing dam/dredging material from the reservoir. A closer analysis is recommended to confirm that the rehabilitation/dredging option can be performed for the necessary expansion.

7.2 Water Treatment

Full regional treatment is estimated at a $7.2 M higher capital cost and $5.2 M higher 20-year present worth O&M cost vs. partial regional treatment with local polishing treatment systems. These are relatively low-cost differences for a project of this scale. When considering the added complexity of upgrading local water treatment facilities and having each address future water quality standards, we recommend that full regional treatment be selected for further evaluation. Additionally, due to lack of state guidance on indirect reuse, the full treatment option likely provides less of a permit burden for the participating entities and readily allows for service to more entities.

7.3 Other Considerations

Two other considerations are noted as the participants continue their evaluation of the Loop system: point of diversion and storage need. Regarding point of diversion, it is assumed for this study that the participants can legally obtain their return flows at the Chilcott Ditch headgate. It is assumed that all local water rights flows can also be obtained at the headgate or could be transferred to that point of diversion. Each participant will need to review their water rights decrees and discuss with their water attorney to confirm.

Although allocation of costs is beyond the purposes of this study, it is helpful to again note that expanding reservoir storage would primarily accommodate the storage of local water rights flows. Some operational storage is helpful to manage reusable return flows, but existing storage capacity could reasonably fulfill that need. Therefore, reservoir expansion needs are primarily driven by the quantity of local water rights being fed into the Loop System from Fountain Creek over and above the quantity of reusable return flows routed through the Loop System.

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APPENDIX II: COST OPINIONS

II.1 Capital Costs

ITEM	COST	
Reservoir Expansion (Rehab & Dredge)	$	7,300,000
Water Treatment Facility (Partial Treatment)		55,000,000
Southern Pipeline Alignment		29,100,000
Pump Stations (5)		2,500,000
Northern Pipeline Alignment		13,800,000
Subtotal	**$**	**107,700,000**
20% Construction Contingency		21,540,000
Subtotal	**$**	**129,240,000**
20% Engineering Fee		25,850,000
Project Total	**$**	**155,090,000**

Loop System – Reservoir Expansion, Partial Regional Treatment

ITEM	COST	
Reservoir Expansion (Rehab & Dredge)	$	7,300,000
New Water Treatment Facility (Full Treatment)		60,000,000
Southern Pipeline Alignment		29,100,000
Pump Stations (5)		2,500,000
Northern Pipeline Alignment		13,800,000
Subtotal	**$**	**112,700,000**
Contingency		22,540,000
Subtotal	**$**	**135,240,000**
20% Engineering Fee		27,048,000
Project Total	**$**	**162,288,000**

Loop System – Reservoir Expansion, Full Regional Treatment

ITEM	COST	
Reservoir Expansion (Reconstruction)	$	27,872,000
New Water Treatment Facility (Partial Treatment)		55,000,000
Southern Pipeline Alignment		29,100,000
Pump Stations (5)		2,500,000
Northern Pipeline Alignment		13,800,000
Subtotal	**$**	**128,272,000**
Contingency		25,654,000
Subtotal	**$**	**153,926,000**
20% Engineering Fee		30,785,000
Project Total	**$**	**184,711,000**

Loop System – Reservoir Reconstruction, Partial Regional Treatment

ITEM	COST
Reservoir Expansion (Reconstruction)	$ 27,872,000
New Water Treatment Facility (Full Treatment)	60,000,000
Southern Pipeline Alignment	29,100,000
Pump Stations (5)	2,500,000
Northern Pipeline Alignment	13,800,000
Subtotal	**$ 133,272,000**
Contingency	26,654,000
Subtotal	**$ 159,926,000**
20% Engineering Fee	31,985,000
Project Total	**$ 191,911,000**

Loop System – Reservoir Reconstruction, Full Regional Treatment

II.2 O&M COSTS

Annual Operation & Maintenance Cost	COST
Water Transmission	$ 712,000
Pumping	$ 1,887,000
Regional Water Treatment	$ 1,623,000
Polishing Treatment	$ 500,000
Project Total	**$ 4,720,000**

6 MGD Partial Regional Treatment Annual O&M Costs Breakdown

Annual Operation & Maintenance Cost	COST
Water Transmission	$ 649,000
Pumping	$ 1,721,000
Regional Water Treatment	$ 2,708,000
Project Total	**$ 5,077,000**

6 MGD Full Regional Treatment Annual O&M Costs Breakdown