Storage Study Report—Task 1

Cucharas Basin
Collaborative Storage Study

Task 1 Storage Needs Assessment

Huerfano County, Colorado

June 2017

CWCB Contract No. CTGGI 2016-1053

***Prepared for*:**

Huerfano County

Huerfano County Water
Conservancy District
P.O. Box 442
La Veta, CO 80155

***Prepared by*:**

Parsons Water

1619 Minear Road
Medford, OR 97501
Phone: 303-667-5067
Fax: 303-309-0068
www.parsonswater.com

Applegate Group, Inc.

Water Resource Advisors for the West
1490 W. 121st Ave., Suite 100
Denver, CO 80234
Phone: 303-452-6611
Fax: 303-452-2759
www.applegategroup.com

TABLE OF CONTENTS

INTRODUCTION

The Storage Needs Assessment is comprised of two subtasks: the Demand-Supply Analysis (Task 1a) and Infrastructure Assessment (Task 1b). The objectives of these tasks are as follows:

Analyze sufficiency of water supply and associated infrastructure to meet the current and future demands of Collaborative stakeholders. Identify options for water conservation and rehabilitation and/or development of storage capacity that would provide additional yield to meet demands unsatisfied with existing infrastructure. Develop cost estimates associated with the different options recommended for enhancing the stakeholders' yields.

The efforts completed in Task 1a are intended to provide an overview of demands, supply, infrastructure, and operations in the Cucharas River basin. The status of existing reservoirs and associated conveyance infrastructure and investigation of potential storage sites in Task 1b are used to refine the cost estimates beyond a unit acre-foot cost used in previous draft memorandum. The findings presented herein and to be discussed at the July 21, 2016 public meeting are intended to prepare the stakeholders to narrow the list of preferred storage sites for the more detailed yield analysis and cost-benefit analysis to be addressed in Task 2 – Storage Study.

APPROACH

In addition to discussions at the February 2016 and May 2016 public meetings, interviews were held with representatives of each the Collaborative stakeholders and associated water users to identify current and future demands, water supplies, existing infrastructure, and operations used to meet demands. The Water District 16 commissioner, dam safety engineer, and local experts in non-consumptive water uses were also interviewed. Infrastructure maintenance needs, focused on reservoir rehabilitation, were identified. The most recent Division of Water Resources Dam Safety Branch inspection reports for existing dams were reviewed and site visits were completed for existing dams where access was granted. Planned infrastructure developments and storage opportunities were also discussed and reviewed in the field. A variety of hydrologic input and water use records were gathered and reviewed in the context of identifying supply and demand throughout the Cucharas River basin.

A demand-supply analysis was conducted to estimate the sufficiency of existing infrastructure and water supplies to meet current and future demand levels, in dry and average years. The unmet demands were quantified and the amount of storage and/or additional yield necessary to meet the shortages was computed. Site visits to 26 existing reservoirs and 8 proposed reservoir sites were completed during June 2016 in order to better understand how the reservoir sites might provide multiple benefits to Collaborative stakeholders. We accompanied the Dam Safety Engineer, Mark Perry, during the visits to the reservoirs owned and maintained by the city of Walsenburg. Site visits to other locations were approved beforehand by property owners. Representatives from Cucharas Sanitation and Water District participated in site visits to its existing and potential reservoir sites located in the Upper Cucharas River basin. A reporter from the Huerfano World Journal also participated in our field inspection for Wahatoya Reservoir.

The majority of sites under consideration have physical storage capacities (i.e., normal storage, or storage up to the spillway crest elevation) of greater than 25 acre-feet, with only three sites with

physical capacity of less than 25 acre-feet. Specifics regarding the status of existing infrastructure and the repair and development needs for existing and proposed sites were used to develop a matrix (see Appendix A) characterizing different attributes of the sites at which we were able to conduct site visits. A similar matrix (Appendix B) was developed for potential new reservoir sites. The matrices can be used to compare and contrast the opportunities and deficits of the various reservoir sites. The matrices and accompanying memorandum should be used by the stakeholders in determining which storage sites should be included in the list of preferred reservoirs for more detailed analysis in Task 2.

Our previous effort to estimate construction and rehabilitation costs used a unit price per acre-foot ($7,500) for developing storage capacity. Rehabilitation costs were estimated as a function of reservoir storage capacity and the age of the dam. This approach was based on limited information for the reservoirs and therefore assumed commonality between reservoirs old and new, small and large. This approach can be misleading since estimates of construction and rehabilitation costs are dependent on the specifics of the storage unit and its location. As evidenced during the site visits, the reservoirs in the basin show a wide range of maintenance needs that are not necessarily directly related to age or size of the structure. The variability in cost between units is demonstrated in the estimates that have been developed for various stakeholders, including the town of La Veta, city of Walsenburg, and Two Rivers Water Company. These studies show a range of rehabilitation costs from $5,000[1] to $15,400[2] per acre-foot of storage capacity, with the wide variation in rehabilitation costs due to the specific rehabilitation requirements for each of the dams. The cost of new dam construction could vary from $540 per acre-foot[3] to $20,000 per acre-foot, with a commonly accepted planning level unit cost of $10,000 per acre-foot. Therefore, development of cost estimates should be deferred in this task and developed for the preferred reservoir sites to be analyzed further in Task 2.

FINDINGS AND RESULTS

The Collaborative stakeholders represent both consumptive and non-consumptive water uses within the Cucharas River basin. Consumptive demands come predominantly from irrigation, municipal supply, and some self-supplied commercial interests. Based on the extent to which data were available, irrigation demand and supplies were analyzed over a 1980 to 2014 study period. This period includes patterns of wet, dry, and average hydrologic years that evidences the variability of water supply in the basin. The period also includes 2002, which is often used to define the dry-year yield for planning purposes. The demands and supplies for municipal entities were analyzed over a sustained drought period with available supply based on dry-year yields. Non-consumptive water uses have not yet been quantified but will be incorporated into the Task 2 analysis as more information becomes available.

A description of the current and future demands identified for the various uses is included below. This information is followed by a discussion of the adequacy of water supplies, infrastructure, and operations to meet the demands.

[1] Based on La Veta North Lake Dam rehabilitation cost estimate from *Storage Feasibility Report, Town of La Veta,* prepared by Colorado River Engineering, Oct 2011, and escalated to 2016 costs.
[2] Based on City Lake rehabilitation cost estimate from *Conceptual Design Report, Walsenburg City Lake Dam and Reservoir*, prepared by RJH Consultants, Inc., Apr 2015, and escalated to 2016 costs.
[3] Based on new roller compacted concrete dam for Cucharas Valley Reservoir, 60,000 acre-foot alternative, *Cucharas Dam Preliminary Design Report*, prepared by GEI Consultants, Inc., March 2010, and escalated to 2016 costs.

WATER DEMANDS

AGRICULTURE

The agricultural demand was estimated for the entire study area, using data developed for the Colorado Division of Water Resources (DWR) Consumptive Use (StateCU) model. The StateCU model estimates water supply-limited crop demands based on irrigated acreage, crop mix, climate data, and river diversions. Livestock water demands are included as part of the agriculture demand.

A 1978 Study on the Water Resources of Huerfano County included an estimate of 11,400 acres irrigated in the Cucharas River basin. This estimate excluded an unknown amount of small, isolated acreage. GIS shapefiles of irrigated acreage (2012) provided by the Division 2 office included 10,860 acres of irrigated land in the Cucharas River basin. The majority of agricultural land is irrigated from the Cucharas River and Middle Creek, as shown on Figure 1 and summarized in Table 1. This is because the mainstem Cucharas River and Middle Creek typically have water throughout the summer irrigation season. Lesser amounts of land are irrigated on Wahatoya Creek, which has water for the majority of the year before drying up in the late-summer months. The remaining areas in the basin have limited water supply and, typically, smaller amounts of irrigated acreage.

Table 1
Cucharas Basin
Irrigated Acreage

Watershed Area	Irrigated Acreage* (approx.)
Upper Cucharas River	2,431
Middle Creek	1,982
Wahatoya Creek	1,540
North Abeyta Creek	387
Western Arroyos	170
Eastern Tributaries	1,642
Lower Cucharas River	2,708
Total	10,860

* Based on DWR 2012 GIS shapefile

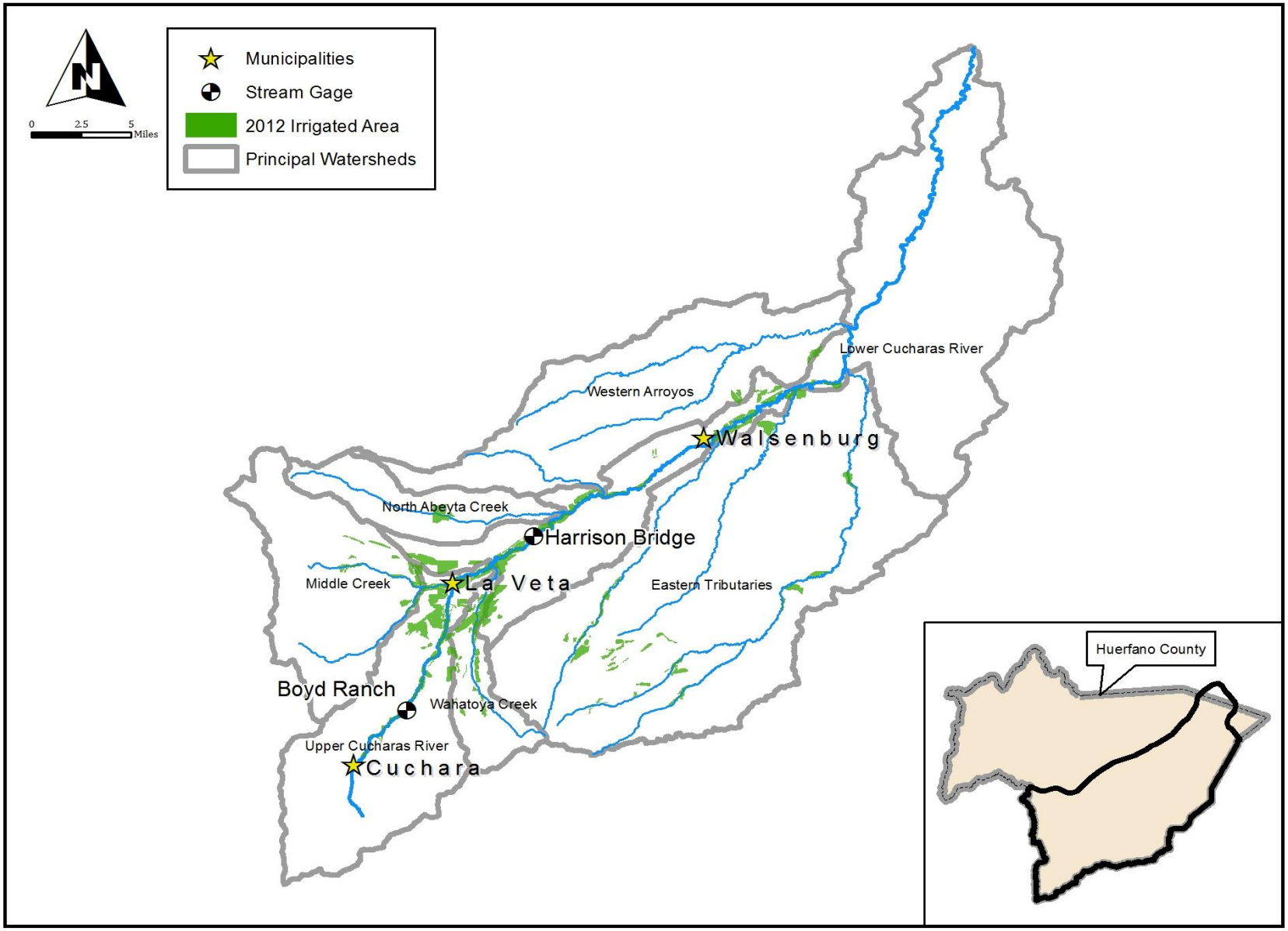


Figure 1 – Cucharas Basin Study Area

An average value of 11,200 irrigated acres from the 1978 and 2012 reports was used to estimate demand and supply over the 1980-2014 period. Future demand was assumed to equal the current demand, which is consistent with the relatively steady amount of land under irrigation over the last 30-plus years.

Agricultural statistical inventory data for counties in Colorado is developed by the National Agricultural Statistical Service (NASS) and is stored in the DWR HydroBase water resources database. Although the crop mix within Huerfano County has changed over the 1980-2014 period, alfalfa hay represents a significant percentage of the irrigated crops over time. Alfalfa was used as the irrigated crop in the StateCU model. The model relied on basin-specific climate data from the Walsenburg weather station.

The potential consumptive use (PCU) represents the maximum amount of water that can be consumed by crop irrigation. A portion of the PCU is satisfied by precipitation. The remaining crop demand is the crop irrigation water requirement (IWR), which represents the maximum consumptive use of water applied to the crops. The average PCU and IWR over the 1980-2014 period is approximately 2.69 acre-feet per acre and 2.07 acre-feet per acre, respectively. The demand for the irrigated lands in the basin totals approximately 23,000 acre-feet per year for both the current scenario and future scenario. The monthly distribution of irrigation demand is presented with diversions and estimated shortages in Table 4.

Water demands for livestock was estimated based on historical county agricultural statistics and water use rates of 10, 3, and 2 gallons per head per day for cattle, hogs, and sheep, respectively. The NASS inventory data was prorated based on the aerial extent of the county that is made up by the Cucharas basin, which is estimated as 48 percent. Livestock counts have reduced over time. Cattle inventory averaged about 25,000 head over the 1980-2014 period. Hog and sheep counts were available, most recently, during the 1980s and therefore do not contribute much to the livestock water demand of about 275 acre-feet per year. The livestock demand is assumed to be satisfied by diversions to irrigation. Livestock water demands may also be met by stock water ponds or storage releases but those operations are not explicitly represented in the analysis.

Municipal, Commercial, and Industrial

Municipal and industrial (M&I) and commercial water demands were estimated based on information gathered from the Cucharas Sanitation & Water District (CSWD), town of La Veta, the city of Walsenburg, and local and state officials. M&I demands were based on service area population, water treatment plant delivery records, system losses, river diversions for direct use and storage, and reservoir operations. The population data was gathered from U.S. Census publications and records maintained by the Colorado Department of Local Affairs (DOLA). This information was supplemented by historical and projected future population data for municipalities and counties, and per capita demand rates. Discussions with County and municipal public officials did not identify any self-supplied commercial demands (i.e., that do not receive their water supply from the municipal providers) in excess of a few acre-feet, Therefore, commercial water demands were not separately analyzed.

The population in Huerfano County has ranged from about 6,000 to 8,000 persons over the last 30 years. The population peaked in the early-2000s and the most recent census (2010) accounted for 6,711 persons. The population served by the public water suppliers in the Cucharas River basin has been on a general downward trend over the same period. The current population of the Cucharas basin is estimated at 5,286 persons.

The annual M&I demand in the Cucharas basin is approximately 1,766 acre-feet. Current demands are a combination of 2010 and 2015 values dependent on the source of data used for the demands. Demands for the unincorporated population are calculated on DOLA county and municipal population data and a per capita use rate of 155 gallons per day, based on information from the Surface Water Supply Index (2010) report.

Table 2 includes the key M&I entities, the percentages of the Huerfano County population included in the Cucharas basin, and the total M&I water demand for both current and future scenarios.

Table 2
Cucharas Basin
Municipal, Commercial and Industrial Demand

Water User	Population*		Demand (ac-ft/yr)	
	2010	2050	2010	2050
Cucharas S&WD	1,400	1,760	107	149
La Veta	793	996	325	408
Walsenburg	3,038	5,121	1,106	2,212
Unincorporated	1,315	1,652	228	287
Total	6,546	6,641	1,766	3,056

* Cucharas S&WD values include year-round and seasonal population.
Walsenburg future values based on city's current planning numbers.

A portion of the current and future CSWD demand accounts for augmentation of evaporative losses (approx. 15 acre-feet per year) from a number of off-channel ponds located throughout the District's service area.

The city of Walsenburg provided future demand estimates for its 50-year planning horizon. The city's water demand in 2065 is estimated to be double the current demand. The increase is attributable to both population growth and expanded demand for commercial interests and other uses. CSWD and the town of La Veta did not provide estimates of future water demands. Future demands for these entities and for the unincorporated population were developed based on the DOLA population projections for Huerfano County. The DOLA projections extend through 2050, at which time the county population is estimated to have grown approximately 26 percent from the 2010 population. The future potable demand for these entities was estimated to be 126 percent of the current demand.

System operations for the municipalities were simulated over a three-year drought planning horizon based on hydrology, yield, and operations during 2002. Future losses from municipal deliveries (pipelines, water treatment plants, etc.) are assumed to be 10 percent of diversions, based on planning estimates provided by the city of Walsenburg. An associated demand that is necessary to incorporate into planning efforts is the loss associated with evaporation from reservoirs. This loss can be significant, especially for storage units located in the lower reaches of the basin where evaporation losses may be up to 20 percent higher than occurs at higher elevations.

CSWD does not currently operate its Britton Ponds; therefore, evaporative loss from these units is not considered to increase the District's water demand. Evaporative losses from the town of La Veta and city of Walsenburg's storage units do increase the municipalities' demand for water. Gross evaporation losses of about 45 inches (3.75 feet) per year are estimated for the area near these two municipalities,

based on National Weather Service maps (NOAA NWS-33) that are typically used in water resources analyses.

At full capacity of the reservoirs, the average annual evaporation loss for the Town of La Veta and City of Walsenburg is approximately 120 acre-feet and 1,651 acre-feet, respectively. These values represent the upper bound of evaporative losses since they are based on the maximum surface areas listed in Table 3. We used 85 percent of the maximum evaporation loss for planning purposes in order to address fluctuating water levels. Incorporation of these evaporation losses increases the current and future demands for La Veta and Walsenburg, the values for which are also included in Table 3.

Table 3
Town of La Veta and City of Walsenburg
Reservoir Evaporation and Municipal Demands

Structure Name	Estimated Surface Area (ac)	Evaporation Max. (ac-ft/yr)	Total Demand (ac-ft)*
Town of La Veta			
La Veta Town Lakes	32	120	
	Current Demand		427
	Future Demand		510
City of Walsenburg			
Wahatoya Reservoir	29	109	
Daigre Reservoir	15	56	
City Lake (Walsenburg Reservoir)	44	165	
Horseshoe Reservoir (Lake Miriam)	162	608	
Martin Reservoir (Lake Oehm)	190	713	
	TOTAL	1,651	
	Current Demand		2,509
	Future Demand**		3,615

* Total demand equal to M&I Demand (Table 1) + 85% of Maximum Evaporation loss
** Walsenburg is evaluating potential impacts from additional climate change on future supplies and demands, which are not represented in this table.

Note the three-year operational model developed for this task represents one particular scenario with a certain magnitude and distribution of demands, supplies, operations, and losses for the different water users. Other scenarios with different values can be used for all of the input variables and operations approaches, depending on the planning objective. For example, municipalities could plan for water supply from direct diversions only, without the benefit of storage releases; analyses of sufficiency of supply could use an estimated yield reduced by assumed reductions to available flows in the future; et cetera. Nonetheless, the analyses developed for Task 1 are considered appropriate for planning purposes.

NON-CONSUMPTIVE WATER USE

Based on review of available literature and data and communication with members of the Basin Roundtable and personnel of the U.S. and Colorado Forest Service, Colorado Parks and Wildlife (CPW), and Colorado Watershed Assembly, personnel, one of the demands for non-consumptive uses relate to habitat for native fish species. Other non-consumptive water uses important to river basin operations include, among others, maintenance of watershed health and development of recreational opportunities (fishing, boating, and birding) and new wetlands or other aquatic and riparian habitat. All of the non-consumptive uses can benefit from cooperative multi-use storage in the basin. In addition, there can also be incidental improvements to downstream water quality due to reservoir storage related to reduced selenium and nutrients.

The Colorado Water Conservation Board has water rights for instream flows in the upper reaches of the Cucharas River, White Creek, Dodgeton Creek, and Chaparral Creek. These amounts of these water rights were developed based on information gathered and analyzed by CPW. The demands for water vary over the season, corresponding with the hydrograph (i.e., higher during runoff, lowest during the winter) and range from a maximum of 3.0 cfs on the tributaries and 4.9 cfs on the upper Cucharas River. The instream flow demands are satisfied by native inflows. The diversions and consumptive uses associated with other water uses occur below the instream flow reaches and therefore do not affect the supply to meet these non-consumptive demands.

Various fish species – brook, brown, and rainbow trout and other native fish species have been identified in the Cucharas River and primary tributary watersheds and some reservoirs located in the basin. There are locations where flathead chub, which is a species of concern, have been inventoried. CPW personnel indicated further analysis of current use and flows during the winter and summer months are necessary prior to quantifying flow requirements for fish species.

We have not yet received specific demands (e.g., flow rates, water volumes, or lake levels) for non-consumptive uses in response to our outreach. We have also not been able to identify similar demands or appropriate objectives to be met as part of a storage project. For example, we could develop a water demand related to a certain amount of acres of wetlands vegetation based on a location and size of desired wetland. Nonetheless, increased flows will typically improve riparian habitat and the non-consumptive demands for water would be a second beneficiary for any releases made from upper basin reservoirs for uses further downstream. These conditions would also benefit environmental and recreational demands for water. On this last point, public access to reservoir storage sites could have a notable impact on the tourism-related economy. Current estimates are that only about 20 percent of Huerfano County is public land. The recreational opportunities are limited and the demand is high. This is easily seen by the number of users at Blue Lake and Bear Lake, for example. Therefore, increased availability of publicly accessible storage sites could satisfy some of the recreational demand and provide benefit to the surrounding community.

We will incorporate any non-consumptive demands that are identified into the yield analysis operational model developed in Task 2.

WATER SUPPLY AND SHORTAGES

AGRICULTURE

The majority of water supply for irrigation comes from surface water diversions that are supplemented by storage releases in some locations. Available diversion records for irrigation use from the DWR database were used to estimate the supply for livestock and agriculture. The average annual river diversion to irrigation identified for the 1980-2014 period, after water use by livestock, is 13,100 acre-feet per year, or approximately 1.17 acre-feet per acre. In drought years, such as 2002, diversions for irrigation have been recorded on the order of 16 percent of the average, or approximately 0.20 acre-feet per acre. In some years, not all of the approximately 160 ditches included in this analysis have diversion records maintained, so the actual supply for irrigation is likely higher. In addition, the water supply from wells, springs, and storage releases are difficult to quantify and are not explicitly included in the analysis.

The average annual crop consumptive use from precipitation and diversions in the Cucharas basin is approximately 13,500 acre-feet, on average, for the 1980-2014 period and 5,600 acre-feet during 2002. The average annual crop consumptive use from diversions only is about 6,500 acre-feet, on average, and 1,000 acre-feet during 2002. The analysis assumes conveyance losses of 10 percent associated with river diversions and a maximum farm efficiency of 60 percent associated with the range of irrigation practices, primarily flood irrigation, that are used within the basin. The basin-wide CU rate is 0.58 acre-feet per acre, or approximately 28 percent of the IWR. This leaves an irrigation shortage in excess of 16,500 acre-feet, on average, and over one-and-a-half times as much in a drought year similar to 2002. Storage releases for irrigation do address some of these shortages but the use of storage to meet irrigation demands is considered limited.

Average-year irrigation demands and water shortages for the basin-wide analysis are presented in Table 4. As noted above, the StateCU analysis for this task looked at the basin, in aggregate. More detail regarding the demand and availability of water for the bigger ditches and for the various tributary basins will be available from the water allocation modeling to be completed in Task 2. The more detailed analysis of supplies and demands will also improve the analysis and findings regarding agricultural supply during drought cycles.

Table 4
Cucharas Basin
Irrigation Demands and Shortages

Month	River Diversion (ac-ft)	Demand / IWR (ac-ft)	Consumptive Use (ac-ft)	Shortage (ac-ft)
Jan	51	0	0	0
Feb	47	0	0	0
Mar	175	25	3	22
Apr	767	942	296	646
May	3,066	2,932	1,533	1,399
Jun	4,361	5,114	2,320	2,794
Jul	2,347	5,629	1,267	4,362
Aug	1,193	4,406	644	3,762
Sep	597	3,222	323	2,899
Oct	325	850	128	722
Nov	104	9	5	4
Dec	70	0	0	0
Total	13,103	23,129	6,518	16,611
Per Acre	1.17	2.07	0.58	1.48

MUNICIPAL, COMMERCIAL, AND INDUSTRIAL

The water supplies for the three municipal providers are a combination of direct flow rights and storage units consisting of both reservoirs and treated water storage tanks. The following analysis focuses on the use of direct flow rights and reservoir storage.

Cucharas Sanitation & Water District

CSWD's water rights portfolio consists primarily of direct flow rights on the mainstem Cucharas River and Baker Creek and Dodgeton Creek tributaries. The district's intakes at these locations are alternate points of diversion for CSWD's prorata ownership in the Calf Pasture Ditch and Ballejos Ditch (various amounts, various priorities).

The District has storage rights for Britton Pond Nos. 1, 2, and 3 located near the Town of Cuchara (estimated total capacity of 20 acre-feet) and a storage right for the not-yet-constructed 7,000 acre-foot White Creek Reservoir (aka Cucharas Pass Reservoir) located below the White Peak range and north of the ridge separating the White Creek basin from the upper Cucharas River. The Britton Ponds are apparently not actively used although they could be accessed for supply with the installation of delivery infrastructure. Another storage option identified by CSWD personnel would be development of a new, above-ground reservoir in the Baker Creek drainage. This site would likely require a water court filing for a junior storage right and possibly an alternate point of diversion and exchange of the District's other water rights to the reservoir.

Based on information provided by CSWD personnel and the water commissioner, the direct flow water rights are typically sufficient to meet current demands and may also be sufficient to meet future demands. The direct flow rights are also used to augment evaporative depletions from ponds located within the District service area. The true yield of the water rights is unknown since the District has not experienced a situation where supply has been insufficient to meet demand. Irrespective of the yield

associated with its water rights, the District could benefit from additional storage for drought protection.

Future demand, supply, and shortages for CSWD are presented in Table 5. We looked at records of supply from the District's network of intake pipelines to estimate available supply. Diversion data are not complete for all sites for all years. Records of average historical diversions were used for the Task 1 demand-supply analysis. On annual basis, the historical supply is sufficient to meet the Future Demand, as illustrated in Table 5. Yet this analysis illustrates a need for storage to balance months with excess supply against months where the diversions are not sufficient to meet demand.

The water allocation modeling to be completed in Task 2 will estimate the yield of the District's water rights and diversions subject to the priorities of downstream water rights. In addition, storage operations will be simulated to illustrate the benefits from operations with the existing Britton Ponds and new and/or increased storage capacity added to the District's portfolio.

Table 5
Cucharas Sanitation & Water District
Future Demand, Supply, and Shortage

Month	Demand (ac-ft)	Supply (ac-ft)	Year 1, 2, and 3 Shortages (ac-ft)
Jan	9.9	16.5	-6.6
Feb	8.7	13.3	-4.6
Mar	11.8	13.4	-1.6
Apr	12.1	11.7	0.4
May	17.1	14.0	3.1
Jun	26.7	22.3	4.4
Jul	28.1	28.0	0.1
Aug	25.6	14.0	11.6
Sep	21.2	17.8	3.4
Oct	16.9	13.5	3.4
Nov	7.8	17.4	-9.6
Dec	10.4	16.5	-6.1
Total	196	198.3	26.3 shortage
			28.6 excess

Town of La Veta

La Veta's water rights portfolio includes junior rights at the La Veta pipeline (1.48 cfs) and senior rights in the Francisco Daigre Mill Ditch (1.5 cfs of Read 1 and Read 3 priorities) that are diverted for direct use and storage at the La Veta pipeline. The town also owns 41 percent of the Mexican Ditch water right (2 cfs of 4.9 cfs Read 14 priority), which was changed to municipal uses and exchange to the City's diversion and storage facilities.

The District has junior storage rights (416 acre-feet total) for the La Veta Town Lakes. The two lakes are located adjacent to the town's water treatment plant and filled via the La Veta pipeline. The available capacity in the Town Lakes is estimated at approximately 313 acre-feet, with no dead storage.

The Town's direct flow water rights, supplemented by storage releases, is typically sufficient to meet demands in average and wet years. The yield of the direct flow rights during drought years, backed up by water in storage, is sufficient to meet current demands. Using a three-year drought cycle and the yield at the La Veta pipeline during 2012, the town is estimated to have an unmet future demand of about 350 acre-feet total over the drought period. Note the 2012 yield for the La Veta pipeline was used in the analysis since it was less than the yield during the 2002 water year.

Future demand, supply, and shortages for the Town of La Veta are presented in Table 6. The storage operations are not presented in the table but the lakes were operated to release to the demand, as needed, or to divert to storage, in times of excess. The shortages in the table represent the amount and timing of shortages that must be met from other water sources.

Table 6
Town of La Veta
Future Demand, Supply, and Shortage

Month	Demand (ac-ft)	Supply (ac-ft)	Shortages (ac-ft)		
			Year 1	Year 2	Year 3
Jan	37	2	0	0	35
Feb	34	0	0	0	34
Mar	30	8	0	15	23
Apr	25	14	0	13	13
May	41	23	0	21	21
Jun	38	64	0	0	0
Jul	47	37	0	0	0
Aug	62	27	0	32	32
Sep	56	25	0	34	34
Oct	51	27	0	27	27
Nov	46	42	0	8	8
Dec	43	37	0	10	10
Total	510	305	0	159	236

City of Walsenburg

Walsenburg's water rights portfolio includes direct flow rights and storage rights available for diversion and storage at multiple locations. The City's primary diversion point is the Walsenburg Pipeline, located not far upstream of the Town of La Veta. The pipeline conveys water into Wahatoya and Daigre Reservoirs (383 acre-feet total capacity) and continues on to the 472-acre-foot City Lake (aka Walsenburg Reservoir), which essentially serves as a forebay to the City's water treatment plant. The City also owns direct flow water rights in the Coler Ditch (aka Lake Miriam Ditch) that diverts from the Cucharas River above its confluence with North Abeyta Creek. The Coler Ditch is used to convey water to Horseshoe Reservoir and Martin Reservoir (5,254 acre-feet total capacity). These reservoirs, located within Lathrop State Park, are operated to support recreational uses by limiting drawdown and to predominantly serve as backup supply for the city during extreme drought periods. The reservoirs are also used to release small amounts of water to the Cucharas River to augment out-of-priority depletions associated with the supply for the Northlands area and to meet return flow obligations associated with operations with the City's changed water rights. A portion of the water in Horseshoe Reservoir and Martin Reservoir is owned by "Minority Owners"; the amount varies over time. The possible effects of the Minority Ownership are not addressed explicitly in the analysis.

The City direct flow rights consist of early changes of use of its prorata ownership of Read 1, 2, 3, and 4 priorities (the Ackerman rights, 6.875 cfs out of total 7.7453 cfs ownership), a recent change of use of the City's one-sixth ownership of the Gomez Ditch (Read priority 10 for 0.533 cfs and Killian priority 124 for 1.167 cfs), and ownership of an unchanged portion (3.22 cfs) of the 5.605 cfs Walsenburg Ditch water right (Read 5 priority).

The City's direct flow water rights, supplemented by storage releases from its reservoirs located outside of Lathrop State Park is typically sufficient to meet demands in average and wet years. Despite the amount of senior water rights held by the city, the yield during drought years is limited by physical supply available from the Cucharas River. The City estimates its dry-year yield is approximately 2,153 acre-feet, based on conditions evidenced in 2002. This drought-year supply and allowing for the drawdown of Horseshoe Reservoir and Martin Reservoir no more than occurred in 2002 (approx. 1,000 acre-feet total), is considered sufficient to meet the City's current demand. Using a three-year drought cycle and these operational limitations, the city is estimated to have an unmet future demand of about 3,200 acre-feet total over the drought period.

Future demand, supply, and shortages for the City of Walsenburg presented in Table 7. The storage operations are not presented in the table but the reservoirs were operated to release to the demand, as needed, or to divert to storage, in times of excess. The shortages in the table represent the amount and timing of shortages that must be met from other water sources.

Table 7
City of Walsenburg
Future Demand, Supply, and Shortage

Month	Demand (ac-ft)	Supply (ac-ft)	Shortages (ac-ft)		
			Year 1	Year 2	Year 3
Jan	183	235	0	0	0
Feb	188	194	0	0	0
Mar	215	534	0	0	0
Apr	272	161	0	0	0
May	380	130	0	0	83
Jun	487	84	0	347	411
Jul	483	45	0	443	443
Aug	445	13	0	433	433
Sep	356	174	0	200	200
Oct	248	167	0	97	97
Nov	184	197	0	7	7
Dec	175	224	0	0	0
Total	3,615	2,158	0	1,526	1,674

FUTURE SUPPLY

The different water users in the basin have a need for additional supply throughout the year and to provide for drought protection over successive years. The main objective of the Storage Study is to determine how best to maximize the benefit among the various users from the development of new storage capacity in the basin. Opportunities include a combination of the development of new storage,

rehabilitation and/or enlargement of existing storage, and cooperative storage operations between stakeholders.

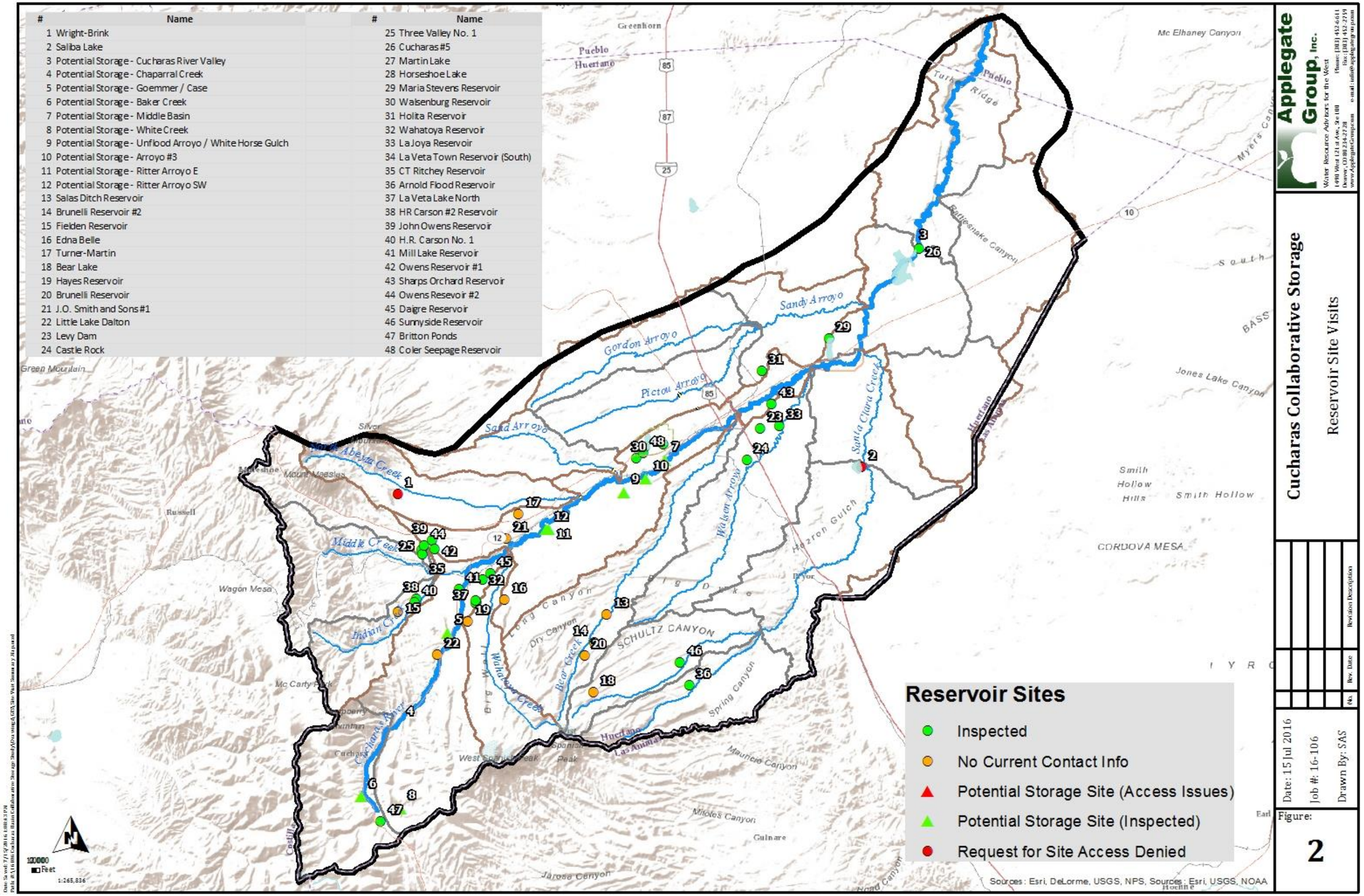
The list of reservoirs originally identified for further review was based, in part, on the availability of dam safety inspection reports that provide a certain amount of detail regarding hazard classification and dam condition. The reports by the Dam Safety Office are completed for jurisdictional dams (i.e., greater than 10 feet in dam height). These reservoirs and other smaller reservoirs were discussed at the public meetings in an effort to identify the most promising storage units.in helping to address shortages to irrigation and M&I demands, and to support non-consumptive uses.

In response to those discussions and to consider the opportunity provided by cooperative operations of multiple smaller reservoirs, we expanded the reservoir list to include storage units with capacity of 25 acre-feet or more. This increased the number of reservoirs under consideration to a total of 42 reservoirs. Site visits to 26 of the reservoirs were carried out in June 2016 (see Figure 2). The remaining 16 sites were not visited for the following reasons:

- Four sites identified in the State's dam database that do not exist (based on aerial photo inspections): Campbell Reservoir, Columbine #2 Reservoir, Willow Reservoir, and Atencio Reservoir (note these sites are not included in Figure 2).
- Two sites where the current owner was contacted, but the owner indicated they do not want to participate in this study: Antonio D Valdez Reservoir and Wright-Brink Reservoir. Note that the owners of Sunnyside Reservoir and Arnold Flood Reservoir allowed us to inspect the dam, but indicated they do not want to participate further in this study.
- Ten sites where current contact information could not be found for the dam owner: Brunelli Reservoir Nos. 1 and 2, Salas Ditch Reservoir, Turner-Martin Reservoir, Edna Belle Reservoir, Fielden Reservoir, Bear Lake, Hayes Reservoir, J.O. Smith and Sons Reservoir #1, and Little Lake Dalton.

Site visits were limited to dam sites where our team received owner approval to access the sites. A summary of the conditions evidenced during those site visits is included in the matrix in Appendix A. The color-coded matrix qualifies dam and site characteristics related to the magnitude of rehabilitation and construction costs and operational advantages anticipated from the reservoir sites.

In addition to the existing reservoirs that were reviewed and inspected, potential new reservoir sites were also identified and inspected where accessible. Our team was able to access 8 of the 10 potential new reservoir sites for site inspections. Field inspections for the potential new reservoir sites were focused on the assessment of the site suitability for dam construction (geotechnical and topographic constraints), ability to gravity feed water to fill the reservoirs, permitting constraints, and likely hazard classification. A summary of the conditions evidenced during those site visits is included in the matrix in Appendix B.



#	Name	#	Name
1	Wright-Brink	25	Three Valley No. 1
2	Saliba Lake	26	Cucharas #5
3	Potential Storage - Cucharas River Valley	27	Martin Lake
4	Potential Storage - Chaparral Creek	28	Horseshoe Lake
5	Potential Storage - Goemmer / Case	29	Maria Stevens Reservoir
6	Potential Storage - Baker Creek	30	Walsenburg Reservoir
7	Potential Storage - Middle Basin	31	Holita Reservoir
8	Potential Storage - White Creek	32	Wahatoya Reservoir
9	Potential Storage - Unflood Arroyo / White Horse Gulch	33	La Joya Reservoir
10	Potential Storage - Arroyo #3	34	La Veta Town Reservoir (South)
11	Potential Storage - Ritter Arroyo E	35	CT Ritchey Reservoir
12	Potential Storage - Ritter Arroyo SW	36	Arnold Flood Reservoir
13	Salas Ditch Reservoir	37	La Veta Lake North
14	Brunelli Reservoir #2	38	HR Carson #2 Reservoir
15	Fielden Reservoir	39	John Owens Reservoir
16	Edna Belle	40	H.R. Carson No. 1
17	Turner-Martin	41	Mill Lake Reservoir
18	Bear Lake	42	Owens Reservoir #1
19	Hayes Reservoir	43	Sharps Orchard Reservoir
20	Brunelli Reservoir	44	Owens Resevoir #2
21	J.O. Smith and Sons #1	45	Daigre Reservoir
22	Little Lake Dalton	46	Sunnyside Reservoir
23	Levy Dam	47	Britton Ponds
24	Castle Rock	48	Coler Seepage Reservoir

ADDITIONAL YIELD NEEDED

Irrigation water shortages occur throughout the watershed, based on both anecdotal information and the analysis presented herein. Agricultural water users may benefit from different conservation measures, including lining ditches and laterals, more use of gated pipe, and sprinkler irrigation. The irrigation shortages would benefit from additional storage in the basin and the source of said storage water would primarily be available along Wahatoya Creek, Middle Creek and its tributaries, and the mainstem of the Cucharas River.

The Cucharas Sanitation & Water District has a need for reservoir storage to balance its excess supply and shortages based on the demand-supply analysis presented above. The District has not fully evaluated the potential for future conservation measures but maintenance of its delivery infrastructure is needed and a potential need for additional storage for treated water has been identified as a possible limitation on future operations that should be explored further.

The Town of La Veta has a shortage of approximately 400 acre-feet to meet its future demand based on the demand-supply analysis presented above. The Town indicated no conservation measures are currently planned but maintenance of its delivery infrastructure will be necessary in the short- to medium-term. The Town changed the use of its Mexican Ditch water rights and has recently installed augmentation stations and recorders on the ditch system. This will enable it to benefit from additional yield during average and wet years when exchange potential exists between the ditch system (located approximately four miles downstream of Walsenburg) and the Town of La Veta. The lack of exchange potential during dry years evidences another demand for additional storage – under the Mexican Ditch and near the town – to allow La Veta to firm up the estimated 122 acre-feet average-year yield of its ownership in the Mexican Ditch. The Town previously estimated a $350K cost for development of a 30 acre-foot reservoir under the Mexican Ditch. The Town's ditch rights, though, would satisfy only a portion of its unmet demand. La Veta's existing storage facilities and options for developing and increasing storage near the town to store Mexican Ditch credits and other supplies are good candidates to be further investigated in the yield analysis and cost-benefits analysis conducted in Task 2.

The City of Walsenburg has a shortage of approximately 3,200 acre-feet to meet its future demand based on the demand-supply analysis presented above. The City has also not fully evaluated the potential for future conservation measures but maintenance of its delivery infrastructure is needed, particularly for City Lake as it may be subject to a storage restriction in the near future. Previous estimates for this rehabilitation effort range between $4.4M and $6.5M. A portion of the City's unmet demand could be satisfied by changing the use of the City's Walsenburg Ditch water right. A rough estimate of the prorata Walsenburg Ditch dry-year yield is on the order of about 300 acre-feet, based on the 2002 diversion records and 40 percent CU rate. Remaining shortages would likely need to come from additional storage capacity and/or relaxation of operational limitations currently in place on its storage units. Rehabilitating La Joya Reservoir to store the city's previously changed Gomez Ditch water rights and other supplies could also be part of the solution.

As noted above, information provided regarding non-consumptive demands has been made available on a mostly qualitative level. Therefore, we have been unable to quantify the non-consumptive demands and shortages. CPW personnel are currently researching their file information and indicated they hope to provide us with recommendations on how best to quantify

these demands. Additional information received from CPW, Collaborative stakeholders, and other interested parties will be incorporated into the detailed yield analysis conducted during Task 2.

SITE INSPECTION RESULTS SUMMARY

Site inspections were completed the week of June 20th, and were completed with two teams of two dam engineers. Site inspection reports were completed for each of the 26 existing dams that were inspected. Results of the site inspections are discussed below.

Embankment seepage was the most common dam maintenance issue observed. Seepage was observed to occur through the dam embankments, and was documented either by noting wet soils at the downstream toe of the dam, and/or patches of vegetation at the downstream toe. Embankment seepage is common for earthen and rockfill dams constructed in the early 20th century, primarily because of porous materials and lack of seepage mitigation (e.g., blanket filter and toe drain). Some of the dams have been retrofitted to include toe drains, whether constructed using standard dam construction practice or simply consisting of trenches downstream of the dam to route seepage water away from the downstream toe. It is a common practice to retrofit existing dams by adding a toe drain to safely convey water pressure away from the dam, which could be considered for rehabilitating existing dams. Holita Reservoir is an example of a reservoir that could potentially be enlarged, but current seepage issues would need to be addressed prior to modifying the dam.

Dam embankments within the basin are generally too steep on the upstream side of the dam due to the use of concrete rubble to address erosion. The embankments were not originally designed with proper sloping and riprap with bedding. Dam owners have consequently dumped riprap in an attempt to compensate for wave runup erosion. The City of Walsenburg reservoirs are examples of concrete rubble that has resulted in over-steepened embankments. If existing reservoirs were to be enlarged, the concrete rubble should be removed, and replaced with properly sloped embankments protected by designed riprap and bedding consistent with the underlying embankment material properties.

Dams in the Cucharas basin are generally long (greater than 500 feet), primarily because of the flat topography in the middle and lower portions of the basin. The costs of enlarging or rehabilitating the long embankments would be high because of the high volume of material necessary to treat the entire length of the embankment. Combining existing reservoirs, such as La Veta South and North Town Lakes, or Martin and Horseshoe Reservoirs, was considered but the cost could be elevated as a result of the length of the intervening embankments.

Inspections of the seven potential new reservoir sites generally indicated the following:

- Upper basin storage (i.e., near and upstream of La Veta) typically has ideal geotechnical and topographic conditions for dam construction, but yield to these sites may be fairly limited because of relatively small contributing drainage area.
- Middle basin storage (i.e., between Walsenburg and La Veta) had less ideal topographic conditions, and may be limited to sites on arroyos that drain to the Cucharas River. Storage capacity at these sites is likely limited on the order of 50 acre-feet at a given site. Yield would be relatively high for middle basin storage sites if infrastructure was available to fill

the sites via gravity from the Cucharas River. Otherwise, yield may be limited to unpredictable stormwater runoff with varied volume and timing.

- Lower basin storage (i.e., downstream of Walsenburg) may have yield limited by the exchange potential on the Cucharas River. These sites were generally limited to replacement of existing or previously abandoned reservoir sites such as the Cucharas Valley Reservoir.

SPECIFIC STORAGE OBSERVATIONS AND POTENTIAL SITES FOR FURTHER STUDY

The intent of the storage component of Task 1 is to provide a summary of existing reservoir conditions, and also an initial analysis of potential new reservoir sites. The long list of reservoir sites will be screened to identify a handful (approximately 6 sites) of the most promising sites for the analyses in Task 2. The Task 2 analysis will also include development of conceptual design drawings and feasibility level cost estimates. Conceptual design drawings will include the site plan and profile, and identify the major infrastructure components to either rehabilitate/enlarge existing storage, or construct new storage. Additional detail on the level of information to be included in feasibility level cost estimates is provided below.

Summary tables of existing reservoir and potential new reservoir sites are provided in Appendix A and Appendix B, respectively. These tables should be discussed by stakeholders and used to identify the preferred reservoir sites for Task 2 effort.

The upper basin (upstream from La Veta) has opportunities both for enlargement of existing reservoirs, and for construction of new reservoir sites. Storage facilities located in the upper basin benefit from reduced evaporation losses although physical supply for storage may be limited.

- The Cucharas Sanitation & Water District has existing storage units with the Britton Ponds. These units could possibly be enlarged, lined, and have delivery infrastructure installed at a good cost basis since the storage units are already in place. However, our site inspection indicated these ponds would require a high dam and result in low storage volume as a result of a steep valley (approximately 30 percent grade).

Two existing reservoir sites near the town of La Veta could possibly be rehabilitated and/or expanded, but are located adjacent to the Cucharas River and would need approval from current dam owners.

- The La Veta Town Lakes have embankment seepage and need outlet structures installed. Rehabilitation of the North Lake Dam, including breaching the dam, reconstructing the outlet works, and installing a toe drain filter system has been estimated to cost approximately $410K[4]. The Town's engineer estimated work on the South Lake Dam to address seepage and associated issues would cost on the order of $500K. There is potential to enlargement both reservoirs coincident with the rehabilitation effort. The reservoirs could possibly be expanded by removing the existing berm separating the lakes, and that material could be used as embankment enlargement/replacement material.
- HR Carson #1 and #2 are located approximately 1.5 miles west of the Town of La Veta along Indian Creek upstream of its confluence with Middle Creek. These reservoirs have a total normal storage capacity of approximately 100 acre-feet, but only about 35 acre-feet of that

[4] Based on La Veta North Lake Dam rehabilitation cost estimate from *Storage Feasibility Report*, *Town of La Veta*, prepared by Colorado River Engineering, Oct 2011, and escalated to 2016 costs.

capacity is currently used. There is the potential to enlarge or combine these two reservoirs into one, with a potential increased storage of 50 to 100 acre-feet. These sites were the only existing storage facilities upstream of Middle Creek that we identified for potential expansion, and that could be used to address irrigation shortages along the lower part of Middle Creek.

Four potential new reservoir sites identified in the upper basin on tributaries to the Cucharas River that could be used to make supplement releases to meet irrigation shortages were inspected during out site visits. These upper basin sites would benefit from lower evaporative losses than storage units located lower in the basin. In addition, these sites are appealing since they could be operated to reduce water shortages for users located lower in the river basin and may be good multi-use sites that provide recreational opportunities at and around the reservoir locations.

- The West Baker Creek site is located in the areas of the defunct ski resort. The location is technically advantageous considering the valley shape and geology, and could be filled in part using existing CSWD infrastructure on Baker Creek. There would also be potential for multiple uses/benefits, as a result of public access for fishing to help relieve the overuse of the Bear Lake area further up the basin.
- The Chaparral Creek site would have similar technically advantageous geology and topography for dam construction as West Baker Creek. This site may not have as high of yield as West Baker Creek, and it is uncertain whether it would be possible to gravity fill this site from the Cucharas River. Based on input from the water commissioner, there is an existing diversion from the Cucharas River just downstream of "the Gap" that delivers water to a location on the west side of the Cucharas River at a similar elevation as the Chaparral Creek Reservoir site (approximate elevation 8,020 feet based on the USGS quadrangle map). Without prior owner approval, we were not able to access this site, however we understand the property is currently for sale and the future owners should be contacted to discuss the possible development and operation of storage on the property.
- Another potential reservoir site is located along the west side of the Cucharas River, approximately 2 miles southwest of the Town of La Veta. The location of the Goemmer/Case Reservoir has been previously analyzed for dam construction in a gap within one of the radial basaltic dikes from the Spanish Peaks. Applegate Group has estimated storage capacity at the Goemmer Reservoir site would be approximately 170 acre-feet, assuming a 45-foot high dam (i.e., less than the 50-foot height cutoff for a "large" dam as classified by the Division of Water Resources). The site is well situated with the surrounding geology and may be a good candidate for reservoir storage for multiple beneficiaries. It is our understanding the storage site could be gravity filled from the Cucharas River through an existing ditch. It should be noted that the existing storage right for 125 acre-feet at the Goemmer Reservoir site is a different location approximately 2.5 miles southwest of this Goemmer/Case Reservoir site.
- The White Creek Reservoir site has a conditional 7,000 acre-foot storage right owned by CSWD. The reservoir is tributary to the Cucharas River downstream of the District's service area but could benefit the District via exchange to local storage and/or augmentation deliveries. The reservoir site could provide benefits to many users in the basin. However, yield for the reservoir located within the upper reaches of White Creek needs to be quantified to determine the viability for this site.

The middle basin (La Veta to Walsenburg) has a few sites that could be rehabilitated or enlarged, and several potential new reservoir sites that would have relatively small storage volume.

- Wahatoya and Daigre Reservoirs could be enlarged if existing dam safety concerns are addressed. Wahatoya Reservoir would need to be modified so the outlet was not constantly pressurized, and the existing spillway would need to be enlarged. The area around the reservoir appears to be sufficient for enlargement of the existing embankment, and the north embankment is an efficient structure in its tie into existing geology.
- The Coler Seepage Reservoir dam was apparently washed out in the 1920s, but could be reconstructed to the existing 108.3 acre-foot absolute storage right. This site is located in Lathrop State Park, and could provide multiple uses (e.g., recreation, municipal, and agricultural irrigation). The cause for the original dam washing out would need to be investigated further, and any new dam would need to be constructed to withstand potential flooding.
- Castle Rock Reservoir (approximately 2.5 miles southeast of Walsenburg) has a normal storage capacity of 126 AF according to the Dam Safety inventory, but the currently abandoned previous storage right was 850 acre-feet. The existing embankment appears in generally good condition, but the outlet would need to rehabilitated (the existing conduit may still need to be properly abandoned). The water yield would need to be quantified to determine how easily/often this reservoir could be filled from Bear Creek via the Castle Rock Ditch.

Potential new storage sites in the middle basin were generally limited to relatively small storage volume locations (approximately 20 to 25 acre-feet) on arroyos that are tributary to the Cucharas River. The yield of these arroyo sites would be limited to stormwater runoff, or could potentially be increased if diversions to these sites could be made from the Cucharas River. However, construction cost would also be lower than some of the higher yield storage sites in the upper basin.

- The Ritter Arroyo had two potential sites on the two forks of the Ritter Arroyo. Both sites would likely be significant hazard because of downstream roads.
- The Unflood Arroyo storage site is approximately one mile southeast of Walsenburg's City Lake. This site could be slightly larger than the Ritter Arroyo site.

Lower Basin (downstream of Walsenburg) storage could be achieved through a combination of enlargement and/or rehabilitation of existing reservoirs. The opportunities for new reservoir sites appeared to be limited to sites near the Cucharas Valley Reservoir.

- Maria Stevens Reservoir is currently restricted to storage of only the senior water right (2,400 acre-feet), but possibly another 850 acre-feet could be added if seepage along the south embankment is addressed. This volume is equal to the junior water right for the reservoir, and is rarely in priority. The current operator of the reservoir is open to the idea of storing more water in the reservoir. The location and existing conveyance infrastructure could make this site available for storage of excess supplies available to other water users. The additional storage may be beneficial to the existing fish population and could serve as a replacement supply for late-season diversions by the upstream users..
- La Joya Reservoir could potentially be enlarged and the current owner is amenable to participating in this study. The reservoir has 238 acre-feet of normal storage capacity. The absolute storage right of 178 acre-feet would need a supplemental storage water right to satisfy the additional 60 acre-feet of active storage capacity. However, the reservoir would require maintenance associated with embankment conditions, including seepage, outlet conditions, spillway capacity, and freeboard requirements.

New storage options in the lower basin would likely be limited to replacement of the Cucharas Valley Reservoir.

- Cucharas Valley Reservoir historically stored over 22,000 acre-feet in the early-1980s, just prior to significant seepage problems resulting in a storage restriction being placed on the dam. The seepage problems have persisted for over 30 years, there is currently a zero storage restriction, and we understand the Dam Safety office has ordered the dam to be breached later this year. Nonetheless, the owner of the site, Two Rivers Company, has indicated its court efforts to reverse that order is likely to succeed and allow the company to further pursue its efforts to reinstate the Cucharas Valley Reservoir as a viable storage unit. Reconstruction costs for Cucharas Valley Reservoir were estimated as $27M in a previous report.[5] The reservoir is located low in the basin. The dam could play a role in basin operations by storing large floods at the bottom of the basin and serve as a replacement source to facilitate upper basin diversions against downstream senior water rights that may have placed a call on the river. Similar to the discussion regarding releases from Maria Stevens Reservoir, the benefit of storage releases from Cucharas Valley Reservoir will need to be compared against the limited exchange potential that exists above the reservoir during low flow periods.

COST ESTIMATES

Specific cost estimates for the long list of reservoirs were not developed in Task 1 due to the wide range of rehabilitation needs, upgrades, and anticipated development needs identified amongst existing and potential new reservoir sites. Identification of a preferred list of 6 reservoir sites through consultation with Collaborative stakeholders will be incorporated into the more analysis to be conducted in Task 2.

Feasibility level cost estimates will be developed by estimating quantities of primary project elements and unit costs based on the following sources:

- Publicly available bid price data for similar work (e.g., Urban Drainage Flood Control District and Colorado Department of Transportation cost databases).
- Cost estimates we have received for previous bids from Colorado contractors.
- Manufacturers' budgetary price estimates.

Feasibility level cost estimates will include the following allowances: 15 percent for unlisted items, and 15 percent for construction contingency. Cost estimates will be consistent with Class 4 estimates as defined by the Association for the Advancement of Cost Estimating (AACE). This class is typically used for conceptual level design (i.e., less than 20 percent complete), and is suitable for use in submitting applications for construction funding.

The cost-benefit analysis conducted on the preferred sites in Task 2 will consider the specific rehabilitation requirements for each existing dam based on its condition and hazard classification and will address the ditch and pipeline infrastructure costs that are associated with the current reservoir configurations. A similar cost-benefit analysis will be completed for potential new

[5] Based on new roller compacted concrete dam for Cucharas Valley Reservoir, 60,000 acre-foot alternative, *Cucharas Dam Preliminary Design Report*, prepared by GEI Consultants, Inc., March 2010, and escalated to 2016 costs.

reservoir sites, and will consider the potential storage volume, potential yield, and constraints associated with geotechnical and topographical conditions. The potential yield and estimated reductions to water shortages from operations estimated in Task 2 will provide another input to the matrix to quantify the benefits of dam rehabilitation or construction and cooperative operations between users, reservoir sites, et cetera that could lead to more efficient systems.

CONCLUSIONS

This report summarizes the current and future demands in the Cucharas Basin and estimated shortages to these demands based on existing water supplies, including storage reservoirs. Reservoir site inspections were completed for 26 of the 42 reservoirs identified in the basin with storage capacity of at least 25 acre-feet. Potential new reservoir sites were also investigated for 10 possible locations, of which we were able to complete site inspections for eight of these sites. This long list of 26 existing reservoirs and 8 potential new reservoir locations will be screened to identify approximately six sites for detailed yield analysis and feasibility level cost estimates in Task 2.

Reservoir sites analyzed for the Task 1 effort are summarized in Figure 2, Appendix A, and Appendix B. The sites described in this memorandum are suggested for consideration by the Collaborative stakeholders, and input from the stakeholders on these sites (or others preferred by the stakeholders) will be useful in completing the screening process at the beginning of Task 2 for determining the short list for the final feasibility level analysis. It should be noted that input from the collaborative stakeholders at this point in the process is critical in shaping the outcome of this study. The final recommendations at the conclusion of this study will identify collaborative storage projects for future design and funding requests, and will be influenced by stakeholder input as well as our engineering analysis.

APPENDIX A -
INSPECTION SUMMARY FOR EXISTING RESERVOIR SITES

Reservoir Name	Other Names	Dam ID	Normal Storage (AF)	Inspection Completed	Inspection Date	Inspection Notes	Maintenance Requirements - See Legend Below					Notes
							Seepage	Outlet	Spillway	Freeboard	Embankment	
50 AF+ RESERVOIRS												
CUCHARAS VALLEY RES	CUCHARAS #5	160108	7,414	YES	6/21/2016		X	X	X		X	ZERO AF RESTRICTION ON RESERVOIR
ANTONIO D VALDEZ RES	SALIBA LAKE	160324	4,880	NO	9/23/2015*	REQUEST FOR ACCESS DENIED		X			X	UNABLE TO INSPECT DAM DUE TO ACCESS ISSUES; MAINTENANCE REQUIREMENTS BASED ON 2015 DAM SAFETY INSPECTION
CAMPBELL RESERVOIR		160104	3,650	NO	N/A	RESERVOIR DOES NOT EXIST	N/A	N/A	N/A	N/A	N/A	RESERVOIR IDENTIFIED FROM DAM SAFETY INVENTORY; NO OTHER INFORMATION FOUND ON CAMPBELL RES. OR CAMPBELL STORAGE RT
MARTIN LAKE	LAKE OEHM	160218	3,077	YES	6/21/2016					X	X	
HORSESHOE LAKE	LAKE MIRIAM	160112	2,760	YES	6/21/2016					X		
COLUMBINE #2 RESERVOIR		160105	2,507	NO	N/A	RESERVOIR DOES NOT EXIST	N/A	N/A	N/A	N/A	N/A	RESERVOIR IDENTIFIED FROM DAM SAFETY INVENTORY; NO OTHER INFORMATION FOUND ON COLUMBINE #2 RES. OR COLUMBINE #2 STORAGE RT
MARIA STEVENS RESERVOIR		160221	2,101	YES	6/21/2016		X			X		
WALSENBURG RESERVOIR	CITY LAKE	160327	430	YES	6/21/2016		X	X	X		X	
HOLITA RESERVOIR		160214	400	YES	6/22/2016		X	X	X	X	X	
WAHATOYA RESERVOIR		160326	330	YES	6/23/2016		X	X	X		X	
LA JOYA RESERVOIR	FARR LAKE	160412	238	YES	6/22/2016		N/A	X	X	X	X	RESERVOIR DRY
DAIGRE RESERVOIR		160109	174	YES	6/23/2016		X	X	X		X	
SUNNYSIDE RESERVOIR		160321	163	YES	6/21/2016	OWNER DOES NOT WANT TO PARTICIPATE IN STUDY	X	X	X	X	X	
CASTLE ROCK		160134	126	YES	6/21/2016		N/A	X	X	X	X	RESERVOIR ABANDONED
LA VETA TOWN RESERVOIR (SOUTH LAKE)	LA VETA LAKE SOUTH	160219	110	YES	6/21/2016		X	X	X	X	X	
COLER SEEPAGE RESERVOIR		#N/A	108	YES	6/23/2016		N/A	N/A	N/A	N/A	N/A	RESERVOIR DOES NOT EXIST
WRIGHT - BRINK		160406	100	NO	N/A	OWNER DOES NOT WANT TO PARTICIPATE IN STUDY	N/A	N/A	N/A	N/A	N/A	
OWENS RESERVOIR NO 1		160238	100	YES	6/23/2016		N/A	X	X		X	RESERVOIR DRY
C T RITCHEY RESERVOIR	HARRY P. DAIGLE	160311	97	YES	6/22/2016		X	X	X	X	X	RESERVOIR ABANDONED
ARNOLD FLOOD RESERVOIR		160127	96	YES	6/21/2016	OWNER DOES NOT WANT TO PARTICIPATE IN STUDY	X	X	X	X	X	
BRUNELLI RES NO 1		160103	85	NO	9/09/2013*	NO CURRENT CONTACT INFO FOR OWNER	X		X	X	X	UNABLE TO INSPECT DAM DUE TO ACCESS ISSUES; MAINTENANCE REQUIREMENTS BASED ON 2013 DAM SAFETY INSPECTION
LA VETA TOWN RESERVOIR (NORTH LAKE)	LA VETA LAKE NORTH	160414	82	YES	6/21/2013			X		X	X	
SALAS DITCH RESERVOIR		160404	72	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
TURNER - MARTIN		160323	66	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
EDNA BELLE		160203	65	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
HR CARSON RESERVOIR NO 2		160409	60	YES	6/22/2016				X		X	
MILL LAKE		160229	53	YES	6/23/2016		N/A	X	X		X	DAM BREACHED
25 - 50 AF RESERVOIRS												
ATENCIO		160128	46	YES	6/22/2016		N/A	N/A	N/A	N/A	N/A	NO EVIDENCE OF RESERVOIR AT REFERENCED LOCATION; DAM SAFETY NOTES INDICATE RESERVOIR MAY NOT HAVE BEEN CONSTRUCTED
SHARPS ORCHARD		160119	45	YES	6/22/2016			X			X	
BRUNELLI RESERVOIR #2		160130	43	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	

APPENDIX A -
INSPECTION SUMMARY FOR EXISTING RESERVOIR SITES

Reservoir Name	Other Names	Dam ID	Normal Storage (AF)	Inspection Completed	Inspection Date	Inspection Notes	Maintenance Requirements - See Legend Below					Notes
							Seepage	Outlet	Spillway	Freeboard	Embankment	
FIELDEN RESERVOIR		160206	42	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
LEVY RESERVOIR		160220	40	YES	6/22/2016		N/A	X	X	X	X	RESERVOIR DRY; PORTION OF EMBANKMENT LOCATED DURING SITE INSPECTION, BUT NO INFRASTRUCTURE
BEAR LAKE		N/A	40	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
HAYES RESERVOIR		160213	33	YES	6/22/2016	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A		RESERVOIR INSPECTED FROM ROAD; RESERVOIR EMPTY
CARSON, H. R. #1	H. R. CARSON #1	160132	32	YES	6/22/2016		X	X	X		X	
J. O. SMITH AND SONS #1	SMITH	160120	28	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
OWENS, JOHN	JOHN OWENS	160302	28	YES	6/23/2016		X	X	X		X	RESERVOIR DRY
THREE VALLEY NO. 1	NEW C.T. RITCHEY DAM	160416	28	YES	6/22/2016		N/A	N/A	N/A	N/A	N/A	RESERVOIR IS A LINED PIT USED FOR AUGMENTATION
LITTLE LAKE DALTON		N/A	26.9	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
< 25 AF RESERVOIRS												
OWENS RESERVOIR NO 2		160301	18	YES	6/23/2016		N/A				X	RESERVOIR DRY
WILLOW RESERVOIR		160328	15	NO	N/A	RESERVOIR UNABLE TO BE LOCATED	N/A	N/A	N/A	N/A	N/A	NO LOCATION DATA AVAILABLE; SECTION-TOWNSHIP-RANGE NOT PROVIDED IN DECREE OR STRUCTURE SUMMARY
BRITTON PONDS		N/A	4	YES	6/22/2016	HIGH DAM NEEDED (STEEP VALLEY) AND MINIMAL STORAGE (NARROW)		X	X			

Legend

	Seepage	Outlet	Spillway	Freeboard	Embankment
X	No engineered collection system; cloudy	Pressurized without filter/encasement; severe corrosion	Non-existent or severley damaged	< 3 ft	Over steep; dense rodent holes; heavy brush
X	Seepage, but managed with eng collection system	Pressurized with filter/encase; mild corrosion	Undersized; mild erosion	3 to 5 ft	Mildly steep; spare rodent holes; light brush
	No seepage issues	Acceptable and operable	Maintained and sized appropriately	> 5 ft	Riprap protection and approp slope, veg manag

APPENDIX B -
SITE INSPECTION SUMMARY FOR POTENTIAL NEW STORAGE

Evaluation Criteria - See Legend Below

Site Name	Latitude	Longitude	Nearest City	Water Source	Basin Location	Estimated Hazard Class	Site Visit	Potential Storage	Geology	Operations	Yield	Permitting	Public Perception	Cost	Description
GOEMMER / CASE	37.47002	-105.02873	La Veta (u/s)	Cucharas River	Upper Basin	Significant - High	YES	+	+	+	+	+	+	-	RESERVOIR SITE LOCATED ON RILING CREEK, APPROX 2 MILES UPSTREAM (CUCHARAS) FROM LA VETA
W BAKER CREEK	37.35105	-105.10767	Cuchara (u/s)	S. Baker Creek	Upper Basin	Significant - High	YES	+	+	+	+	-	+	-	CHANNEL), UPSTREAM FROM CONFLUENCE WITH BAKER CREEK
WHITE CREEK	37.3425	-105.07199	Cuchara (u/s)	White Creek	Upper Basin	Significant - High	YES	+	+	-	+	-	+	-	RESERVOIR SITE LOCATED APPROX. 1.5 MI SE OF CUCHARAS oF WHITE CREEK
CHAPARRAL CREEK	37.408	-105.06775	Cuchara (d/s)	Chaparral Creek	Upper Basin	Significant	No	+	+	?	+	-	+	-	YIELD DEPENDS ON ABILITY TO GRAVITY FILL FROM CUCHARAS (BRGOCH THINKS FEASIBLE)
MIDDLE BASIN	37.59538	-104.83086	Walsenburg (u/s)	Cucharas River	Middle Basin	High	YES	+	+	+	+	-	+	-	RESERVOIR SITE LOCATED ADJ CUCHARAS IN RIVER VALLEY (EAST OF HORSESHOE/MARTIN RESERVOIRS)
CUCHARAS RIVER VALLEY	37.75363	-104.59884	Walsenburg (d/s)	Cucharas River	Lower Basin	Low - Significant	NO	+	-	+	-	-	-	-	DOWNSTREAM FROM EXISTING CUCHARAS RIVER VALLEY RESERVOIR
RITTER ARROYO SW	37.54494	-104.93868	La Veta (d/s)	Cucharas River	Middle Basin	Significant	YES	-	-	+	-	-	+	+	POTENTIAL RESERVOIR SITE WOULD BE LOCATED IN RITTER ARROYO EAST OF CUCHARAS RIVER AND CR 350
RITTER ARROYO E	37.54501	-104.93702	La Veta (d/s)	Cucharas River	Middle Basin	Significant	YES	-	-	+	-	-	+	+	POTENTIAL RESERVOIR SITE WOULD BE LOCATED IN RITTER ARROYO EAST OF CUCHARAS RIVER AND CR 350
ARROYO 3	37.58166	-104.84836	Walsenburg (u/s)	Cucharas River	Middle Basin	Low - Significant	YES	-	-	+	-	-	+	+	AND 342.2, DUE SOUTH (APPROX. 1.7 MI) OF WALSENBURG RESERVOIR
UNFLOOD ARROYO / WHITE HORSE GULCH	37.57183	-104.86777	Walsenburg (u/s)	Cucharas River	Middle Basin	Significant - High	YES	-	-	+	-	-	+	+	POTENTIAL RESERVOIR SITE LOCATED APPROX. 1 MI SE OF WALSENBURG RESERVOIR

Legend

	Potential Storage	Geology	Operations	Yield	Permitting	Public Perception	Cost
-	<50 ac-ft	Sandy & conducive to erosion	Inability to gravity feed; remote location	Limited to stormwater runoff; exchange pot limited	On-channel permits (CWA 404), Federal Nexus	Minimal public access. Potential water export.	>$10k per ac-ft normal storage
+	>50 ac-ft	Shallow bedrock, low erosion potential	Gravity feed; proximity to water supply	Concistent supply; near demands.	Off-channel location limited permits	Multiple uses and public access	<$10k per ac-ft normal storage