PREPARED FOR:

PREPARED BY:

WASHINGTON COUNTY WATER CONSERVANCY DISTRICT

SEPTEMBER 2022

UPDATED:
JANUARY 2023

REGIONAL WATER MASTER PLAN

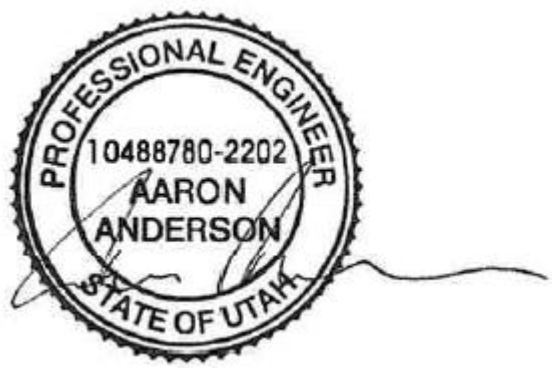
REGIONAL WATER

MASTER PLAN

SEPTEMBER 2022

(UPDATED JANUARY 2023)

SENSITIVE INFORMATION HAS BEEN REDACTED FOR SECURITY PURPOSES



Prepared for:

WASHINGTON COUNTY
WATER
CONSERVANCY
DISTRICT

Prepared by:

BOWEN COLLINS
& ASSOCIATES

SUMMARY OF REPORT REVISIONS, JANUARY 2023 UPDATE

BC&A made minor revisions and additions to the Regional Water Master Plan after the original study was finalized in September 2022. The revisions and additions included in the updated version (January 2023) are as follows:

- The Executive Summary was revised to provide a more comprehensive overview of the report.
- Additional discussion was added to Chapter 2 regarding the estimated distribution of indoor and outdoor water use for existing and future users.
- Table 2-21 in Chapter 2 was updated so the totals correctly match the values for each individual area serviced.
- In Chapter 4, references to “culinary” water were replaced with “potable” water.
- In Chapter 4, timing of Project S-9 was changed to the correct year (from 2024 to 2025)
- Figure 5-1 in Chapter 5 was modified to remove sensitive information regarding the specific location of the district’s existing infrastructure for security purposes.
- In Chapter 7, the replacement values of some system components were updated. This also adjusted the recommended level of annual funding for system rehabilitation and replacement.

The revisions made to the report did not impact the recommendations regarding capital improvement projects used to develop the 2022 Regional Water Impact Fee Facilities Plan and Impact Fee Analysis. Please contact the Washington County Water Conservancy District with any questions regarding these revisions.

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EXECUTIVE SUMMARY

INTRODUCTION

This Regional Water Master Plan (Master Plan) evaluates anticipated increases in water demand through 2070 in the Washington County Water Conservancy District (district)'s service area and identifies investments needed to meet future demand over the next 10 years. Bowen Collins & Associates (BC&A) prepared the Master Plan at the district's request.

PROJECTED GROWTH

Washington County is home to nearly 200,000 permanent residents (2020 U.S census report) and is projected to more than double in size in the next 30 to 40 years. Temporary residents and visitors increase the county's population by an additional 33%. Washington County's current water resources and existing infrastructure are insufficient to serve projected future growth, even when applying more aggressive conservation requirements and reuse of treated wastewater.

PROJECTED WATER DEMAND

Future water demand was estimated through an analysis of historical water demand trends in conjunction with an updated source sizing standard for new development of 0.59 acre-feet per year (AFY) per equivalent residential connection (ERC). An ERC represents a typical single family residential connection. It is estimated that the district service area will need 71,764 AFY of potable water and 16,775AFY of secondary water by 2032. By 2070, potable water demand is estimated at 117,574 AFY with 57,845 AFY for secondary irrigation under the current water conservation targets.

WATER CONSERVATION GOALS

Washington County has achieved an approximately 30% reduction in per capita use since the year 2000. The Master Plan outlines several conservation measures planned to help achieve short and long-term conservation goals, such as new landscape ordinances, conservation rebate programs, and penalties for high water use. It also presents a target conservation scenario through the year 2070. This target scenario involves reducing total (all potable and secondary) water use in Washington County an additional 23% by 2070. The district has adopted this goal in its 2021 water conservation plan.

INVENTORY AND EVALUATION OF STORAGE AND CONVEYANCE SYSTEMS

The district's water system is composed of diversions, reservoirs, springs, wells, storage tanks, treatment plants, hydropower plants, and pipelines. These components work together to divert, treat, store, and deliver water to wholesale and retail customers throughout the county. Currently, the combined peak production capacity of the district and RWSA systems amounts to about 78,000 gallons per minute (gpm) of potable water and 25,000 gpm for secondary irrigation.

Based on the construction cost of existing projects, escalated to today's dollars, a total "replacement cost" of the district's system is $947 million dollars.

EVALUATION OF LOCAL WATER SUPPLIES

The burden of developing new water resources falls to the district because RWSA partner water supplies are approaching their full development capacity and the Utah State Engineer has concluded that the Virgin River Basin is fully allocated. Consequently, the district has made maximizing local resources a key priority, while also pursuing additional conservation, reuse, agricultural conversions and regional supply development projects to meet future demand. The district and its RWSA partners have a combined estimated reliable annual supply of approximately 64,100AFY of potable water and 21,700 AFY of secondary water. Based on current growth projections and conservation goals, demand will begin to exceed water supply in 2028. This gap between supply and demand will continue an upward trajectory until the Lake Powell Pipeline is completed and increases supply.

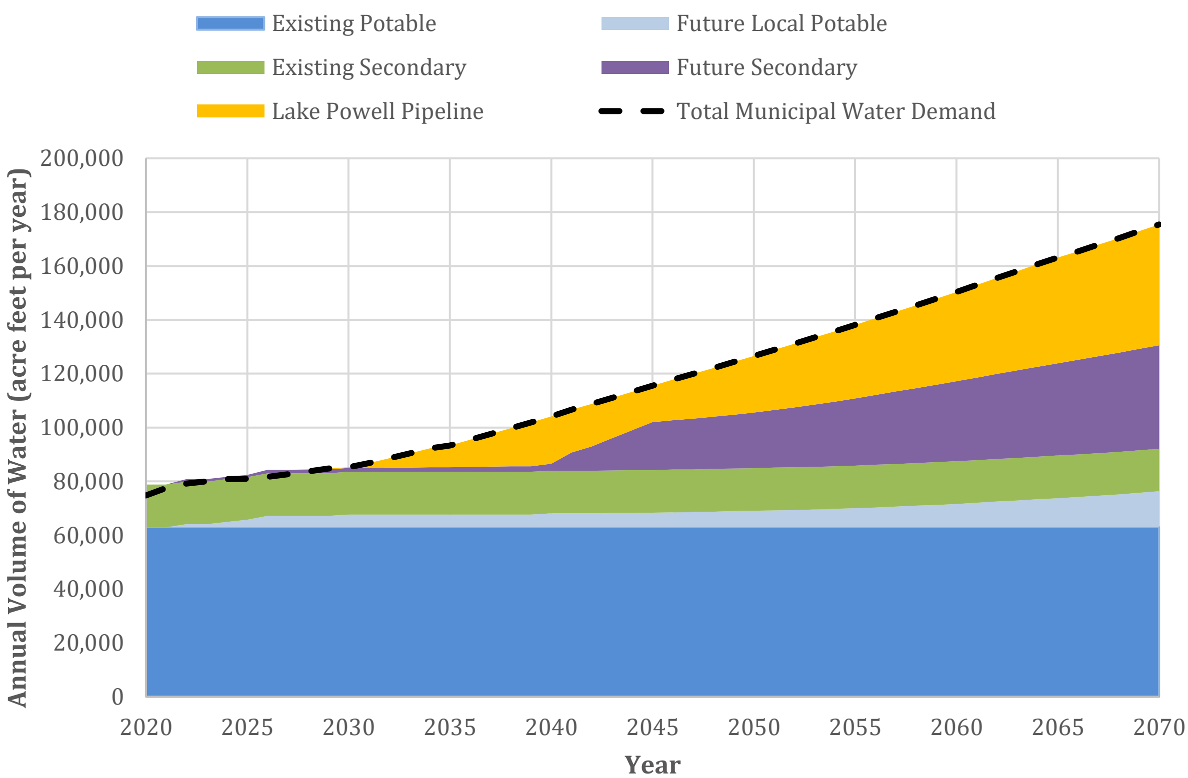


Figure ES-1 – Total Projected Water Supply Need vs. Existing and Future Water Supply

RECOMMENDATIONS

After considering the projected growth, local supplies and existing infrastructure, the Master Plan recommends additional projects to help prevent a water supply shortage.

Recommendations include the development of new sources of water and new water production facilities. These recommendations specifically include up to five new wells, the Lake Powell Pipeline, and the expansion of local secondary irrigation and reuse water systems. In addition, the plan recommends expansions to both the Sand Hollow Groundwater Treatment Plant and the Quail Creek Water Treatment Plant to increase production capacity.
Additional storage capacity will also be needed to accommodate the anticipated growth. The combination of recommended new storage tanks and upgrades to treatment facilities will yield

nearly 30 million gallons of additional capacity. This additional storage is needed to meet demand when it exceeds the system's production capacity. It will also serve as emergency storage in any event that would adversely affect water production, and as storage for fire suppression as required by the local fire authority.

Recommendations for both new resource development and existing infrastructure optimization projects are provided in Table ES-1.

This Master Plan is a working document. The recommended improvements identified in this report are based on information available at the time of the study. If future growth or development patterns change significantly from those assumed and documented in this report, or if different projects are identified that can better meet the water needs of Washington County, the recommendations may need to be revised in a future update.

Table ES-1
Recommended 10-Year Capital Improvement Projects

Project	Description	Estimated Cost (2022 Dollars)	Project Completion Year
S-1	Cottam Well 3	$1,977,000	2023
S-2	Sand Hollow Well 7	$1,815,000	2023
S-3	Sand Hollow Well 15	$1,815,000	2024
S-4	Ash Creek Pipeline/Toquer Reservoir Project	$92,395,000	2025
S-5	Sullivan Wells Project (Wells, Pipelines)	$14,663,000	2026
S-9	Quail Creek WTP 80 MGD Expansion	$130,000,000	2025
S-12	Dry Wash Reservoir	$15,465,000	2024
S-13	Graveyard Wash Reservoir	$17,794,000	2024
ST-1	Cottam Well 3 MG Tank	$6,330,000	2023
ST-2	Sand Hollow 2 MG Tank B	$6,050,000	2024
ST-3	Quail Creek 10 MG Tank B	$25,988,000	2025
ST-4	Sullivan Wells 1 MG Tank	$3,307,000	2026
C-1	Sand Hollow North Dam to West Dam Pipeline	$3,660,000	2023
C-2	Quail Creek to Cottam Pump Stations and Pipeline, Phase 1	$10,610,000	2024
C-3	Quail Creek to Cottam Pump Stations and Pipeline, Phase 2	$11,922,000	2028
C-5	Regional Pipeline to Sand Hollow Booster Pump	$2,904,000	2025
C-6	Hurricane Valley Booster Pump Station	$2,306,000	2023
C-7	Toquerville Springs to Cottam Pipeline Pump Station	$926,000	2028
	Total Improvements	**$349,927,000**	

CHAPTER 1
INTRODUCTION

INTRODUCTION

Washington County Water Conservancy District (district) has retained Bowen Collins & Associates (BC&A) to prepare a Regional Water Master Plan (Master Plan). This report focuses primarily on the communities that have entered into the Regional Water Supply Agreement (RWSA), but also accounts for water use outside of the current RWSA service area. The purpose of the Master Plan is to evaluate the different components of the district's water system and identify improvements that will be needed to accommodate the growing needs of the county.

SCOPE OF SERVICES

The general scope of this project involved a thorough analysis of the district's water production, treatment, storage, transmission facilities and their ability to meet the current and future water needs of its customers. The project also included an extensive evaluation of the water supplies owned and managed by the RWSA partner communities. As part of the Master Plan, BC&A completed the following tasks.

Task 1: Collect and review data needed to develop the Master Plan

Task 2: Review population growth estimates for Washington County developed by the Kem C. Gardner Policy Institute

Task 3: Evaluate current water use patterns, identify a proposed source sizing standard, and project future system water demands

Task 4: Evaluate existing and potential future water supplies of the district and RWSA partners

Task 5: Evaluate district finished water storage facilities

Task 6: Evaluate district water treatment facilities

Task 7: Evaluate district conveyance facilities

Task 8: Identify future water system improvements needed to meet existing and future needs

Task 9: Provide planning level cost estimates for recommended projects

Task 10: Develop a 10-year plan for capital system improvements and system renewal

Task 11: Document results of the analysis

This Master Plan is a working document. The recommended improvements identified in this report are based on information available at the time of the study. If future growth or development patterns change significantly from those assumed and documented in this report, or if different projects are identified that can better meet the water needs of Washington County, the recommendations may need to be revised in a future update. The district should plan to update this Master Plan every three to five years.

ACKNOWLEDGMENTS

The BC&A team wishes to thank the following individuals from the district and RWSA partners for their assistance and support during this project:

Zachary Renstrom	District General Manager
Brie Thompson	District Associate General Manager, Operations & Planning
Corey Cram	District Associate General Manager, Project Development
Brock Belnap	District Associate General Manager, Lake Powell Pipeline
Dave Jessop	District Operations Manager
Whit Bundy	District Engineer
Karry Rathje	District Communications & Government Affairs Manager
Randy Johnson	District Project Manager
Trinity Stout	District Project Manager
Jordan Jones	District Project Inspector
Jodi Richins	District Attorney
Morgan Drake	District Attorney
Emily Kagan	District Technical and Administrative Assistant
Karen Barnum	District Accountant
Scott Taylor	St. George City Water Services Director
Kade Bringhurst	St. George City Special Projects Manager
Mike Shaw	Washington City Public Works Director
Lester Dalton	Washington City Asst. Public Works Director
Ken Richins	Hurricane City Water Department Manager
Chuck Gillette	Ivins City Public Works Director/City Engineer
Tom Jorgensen	Ivins City Asst. Public Works Director
Dustin Mouritsen	Santa Clara City Water Department
Derek Imlay	La Verkin City Public Works Director
Lance Gubler	Toquerville City Public Works Director
Ed Bowler	District Board of Trustees
Victor Iverson	District Board of Trustees
Michele Randall	District Board of Trustees
Kress Staheli	District Board of Trustees
Adam Bowler	District Board of Trustees
Chris Hart	District Board of Trustees
Kevin Tervort	District Board of Trustees

PROJECT STAFF

This project was performed by the BC&A team members listed below. Team members' roles on the project are also listed. The project was completed in BC&A's St. George, Utah office. Questions may be addressed to Aaron Anderson at (435) 656-3299.

Todd Olsen	Principal in Charge
Keith Larson	Principal
Aaron Anderson	Project Manager/Project Engineer
Mike Hilbert	Clerical

CHAPTER 2
WATER DEMAND PROJECTIONS

INTRODUCTION

This chapter evaluates the impacts that population growth, water use, and conservation are projected to have on the demand for water within the district's service area. The projected quantity of water needed to supply existing and future users, known as a source sizing standard, is a critical component of the Master Plan. Anticipated population growth and water use within the district's service area directly impacts the demand for water, and consequently, the need for, and timing of, capital improvements. The district provides wholesale water to municipalities that have signed the Regional Water Supply Agreement (RWSA, referred to as a "RWSA partner") and retail water to developments in unincorporated county areas, each of which has its own unique growth trends and water needs.

The goal of this Master Plan is to evaluate and identify the need for *regional* water system improvements driven by the collective demands of the service area. BC&A coordinated extensively with each RWSA partner to gather input and recommendations regarding the planning projections in this report and how total projected growth in the county should be allocated to each individual city. To the extent possible, the information contained in the respective master plans of each RWSA partner has been addressed and incorporated into this study[1].

PROJECTED GROWTH IN WASHINGTON COUNTY

The district provides water to nearly 200,000 full-time residents of Washington County as well as a significant "temporary" population consisting of part-time residents, tourists, and other visitors. This temporary population increases the total peak population in Washington County by up to 33%, according to a 2017 study[2] conducted by the Kem C. Gardner Institute. The Washington County Assessor's office reports that approximately 20% of housing units in Washington County are second (non-primary) homes. In addition, Washington County's permanent residential base population is growing at a very rapid rate. Table 2-1 displays the estimated permanent population of Washington County from 2016 – 2020 as reported by the Utah Population Committee.

Table 2-1
Historical Population Estimates for Washington County

Year	Population	% Increase
2015	154,615	--
2016	160,371	3.7%
2017	165,592	3.3%
2018	171,042	3.3%
2019	180,549	5.6%
2020	187,878	4.1%

1 Since the district operates and develops regional water system infrastructure capable of delivering water to a number of different cities, minor inaccuracies in the assumed allocation of growth for each city within a given region of the service area that is supplied by common infrastructure will not have a significant impact on the results or recommendations of this study.

2 "Washington County Temporary Resident Population Estimated, 2017". Kem C. Gardner Institute. March 2019.

In 2017, the Kem C. Gardner Institute developed growth projections through the year 2065 for each county in the State of Utah. In 2018, the Gardner Institute released two supplemental growth projections[3] consisting of "high" and "low" growth scenarios. The "high" and "low" growth projections provide an upper and lower bound to the original "baseline" projections released in 2017. A summary of these different growth scenarios from 2016 - 2020 is shown in Table 2-2.

Table 2-2
Historical Population Growth Projections for Washington County

Year	Low	Baseline	High
2016	160,359	160,359	160,359
2017	166,435	166,534	166,514
2018	172,885	173,226	173,246
2019	179,252	179,953	180,134
2020	185,395	186,618	187,134

The estimated population for the year 2020 shown in Table 2-1 surpasses the "high" growth projection shown in Table 2-2, indicating that Washington County has outpaced the "high" growth scenario from the Kem C. Gardner projection. Thus, it is prudent for the district to at a minimum prepare for growth in line with the "high" growth projection.

For the purposes of this Master Plan, the "high" growth projection was used to develop growth and water demand estimates. Table 2-3 and 2-4 provide summaries of the projected county population and number of households through the year 2065 according to the 2018 study. The scope of this Master Plan is to evaluate increases in water demand in relation to growth through the year 2070 (50-year planning window). For the years beyond 2065, population and household growth rates similar to those projected in the five years prior to 2065 were used.

3 Technical Memorandum. "Washington County Long-Term Projection Scenarios." January 30, 2018.

Table 2-3
Kem C. Gardner Population Growth Projections for Washington County, UT

Washington County Population			
Year	Low	Baseline	High
2010	138,579	138,579	138,579
2015	154,602	154,602	154,602
2020	185,395	186,618	187,078
2025	212,942	219,019	221,476
2030	238,686	251,636	256,759
2035	266,619	286,768	296,483
2040	293,718	320,956	337,051
2045	321,755	355,549	377,316
2050	351,732	391,468	417,124
2055	384,192	429,295	458,141
2060	419,269	468,830	501,382
2065	455,846	508,952	546,490

Table 2-4
Kem C. Gardner Household Growth Projections for Washington County, UT

Washington County Households			
Year	Low	Baseline	High
2010	46,607	46,607	46,607
2015	55,377	55,377	55,377
2020	69,040	69,547	69,837
2025	81,192	83,595	84,719
2030	91,846	96,972	99,232
2035	103,291	111,434	115,690
2040	114,286	125,452	132,357
2045	125,835	139,895	149,097
2050	138,491	155,260	166,008
2055	152,358	171,615	183,593
2060	166,893	188,271	201,665
2065	181,827	204,976	220,279

ESTABLISHING A SOURCE SIZING STANDARD

The Utah Division of Drinking Water (UDDW) specifies minimum requirements for the sizing of public drinking water facilities in Utah Administrative Code (UAC) R309-510. Its minimum source sizing requirement dictates that water systems have source capacity to meet demands under the "highest day of consumption," or peak day, as well as be able to supply "one year's supply of water," or average yearly demand. Historical water use data was collected, organized and evaluated to identify the demand trends of existing customers and to establish a "source sizing standard" for the district's wholesale and retail customers.

R309-510 provides guidelines as to how the source sizing standard should be determined. Prior to 2018, the source sizing standard for community water systems was a standardized value divided into an indoor and outdoor water use component. The indoor component was the same across the state, while the outdoor component varied based on geographical location (i.e. higher irrigation rates were applied in hotter and drier regions as compared to cooler and wetter regions).

In 2018, the Utah Legislature made modifications to the Utah Safe Drinking Water Act (Utah Code 19-4). In short, the modifications updated some of the requirements for individual public water systems to collect and relay water use information directly to the State of Utah Division of Water Rights (UDWRi). The modifications also require UDDW to use the data to establish system-specific source sizing requirements for each water system, as opposed to using a state-wide sizing standard.

In order to provide consistency in water planning, the district utilized the new UDDW methodology to update its source sizing requirements for all its customers. The source sizing standard will be implemented by the district to evaluate and size regional infrastructure needed to provide water to its RWSA partners and retail customers.

The source sizing standard is based on water usage per "equivalent residential connection" (ERC). UAC Rule R309-510 defines the ERC as:

> *a term used to evaluate service connections to consumers other than the typical residential domicile. Public water system management is expected to review annual metered drinking water volumes delivered to non-residential connections and estimate the equivalent number of residential connections that these represent based upon the average annual metered drinking water volumes delivered to true single family residential connections. This information is utilized in the evaluation of the system's source and storage capacities.*

In order to identify the water use for a typical single family residence, or ERC, historical water use records for the RWSA partner cities were evaluated. To assemble a sample set representative of its overall service area, BC&A collected potable water use data from all RWSA partners. The data was evaluated for the period of 2018 – 2020 (the UDDW requires a minimum of 3 years of water use data be used to determine the source sizing standard per ERC). The data provided by each municipality was then organized and sorted to include only water meters for single family residential connections. For some municipalities in the county, accounting records do not distinguish between single family and multi-family properties; in these instances, the residential water use data for the given city was not included in the overall sample set. In addition, single family potable meter accounts that are known to also have a secondary irrigation connection were also removed from the sample set since their metered potable water use would not include water used for irrigation.

Upon compiling this data set of metered potable water use records for single family homes in the county, the data was further sorted to solely identify *primary* single-family residences. As previously discussed, non-primary residences make up about 20% of the housing units in Washington County. Many of these units are second homes that are occupied for only a portion of the year, and others serve as vacation rental properties that have year-round occupancies. Using property ownership records provided by the Washington County Assessor's Office, the single family meters in the data set were categorized as either primary or non-primary. When comparing the average water use between primary residences and a non-primary residences, non-primary homes use approximately 8% less water annually than primary homes. For the purposes of identifying a source sizing standard per ERC for the district, meters servicing non-primary homes were excluded from the sample set for the following reasons:

- Homes that are currently a non-primary residence can at any time be sold to a primary resident, potentially changing the water use trends for that unit.
- It is uncertain whether the current ratio of primary to non-primary homes in Washington County will remain the same in the future (i.e. growth trends may shift more to primary residences).

Using this finalized sample set of single family, primary residence potable water meters, average annual and average daily demand per connection was calculated. The results of this evaluation are shown in Table 2-5.

Table 2-5
Summary of Annual and Average Daily Metered Water Use for Single Family Residential Connections in Washington County, 2018-2020

Year	# of Single Family Residential Meters Sampled	Total Annual Metered Water Use from Sample Set (gallons)	Average Metered Annual Water Use per Connection (gal/year)	Average Metered Daily Water Use per Connection (gal/day)
2018	18,091	3,506,540,138	193,828	531
2019	19,181	3,436,834,632	179,179	491
2020	20,094	3,990,035,230	198,568	544

The values shown in Table 2-5 represent the *metered* volume of water delivered to customers and do not account for water that is lost or unaccounted for in the system, also referred to as "non-revenue water" (i.e. water that is produced from a source but not sold to an end user). Non-revenue water can come from line flushing through fire hydrants, fire flows, system leaks, meter inaccuracies, theft, and other unmetered uses. Non-revenue water impacts the amount of water both the district and its RWSA partners must produce to meet end-user demands, and it was accounted for by comparing water produced by the district and the individual RWSA partners to the metered water use sold to customers. Table 2-6 provides a summary of the combined water sales and water production for the district, RWSA partners, and the town of Virgin from 2018 – 2020.

Table 2-6
Summary of Total Water Use & Total Water Sales[1]

Year	Total Metered Water Use (acre-feet)	Total Water Produced (acre-feet)[1]	Total Estimated Non-Revenue Water (%)
2018	40,539.7	47,343.8	14.37%
2019	39,597.5	45,587.4	13.14%
2020	44,721.6	51,464.7	13.10%

[1]Includes water production and sales for the district, St. George, Washington, Hurricane, Ivins/Kayenta, Santa Clara, La Verkin, Toquerville, and Virgin.

As shown in Table 2-6, non-revenue water has ranged from 13% - 15% over the past few years for the combined municipal and district water systems. Based on a water use data report[4] funded by the Utah Department of Natural Resources (DNR), the average percentage of non-revenue water for systems across the State of Utah is 15%, and observed non-revenue water in Washington County is on par with, or slightly better than, the state as a whole. The district and RWSA partners are working to improve metering accuracy and have established goals to further eliminate system losses. The district has set a goal to reduce non-revenue water to 12% by the year 2070.

Incorporating the combined non-revenue water from the RWSA partner water distribution systems and the district's regional infrastructure, Table 2-7 provides a summary of the total source production per ERC from 2018 – 2020.

Table 2-7
Total Source Production per ERC, 2018 - 2020

Year	Metered Annual Water Use per Connection (gal/year)	% Non-Revenue Water	Total Annual Source Production per ERC (gal/year)	Total Average Daily Source Production per ERC (gal/day)
2018	193,828	14.37%	**226,355**	**620**
2019	179,179	13.14%	**206,285**	**565**
2020	198,568	13.10%	**228,502**	**626**

RECOMMENDED SOURCE SIZING STANDARD – AVERAGE ANNUAL SOURCE CAPACITY PER ERC

In conjunction with the new source sizing requirements established by the Utah Legislature, the UDDW provided guidelines for calculating source sizing standards. The guidelines include using a minimum of 3 years of historical water use data and include the calculation of a "system variation factor" for determining the final source sizing standard. Based on historical water use data, the system variation factor aims to quantify the magnitude of potential fluctuations in demand and applies this range to the source sizing standard. The steps involved in the calculation are as follows:

1. Determine per ERC water usage values from a minimum of 3 years.

[4] "State of Utah Water Use Data Collection Program Report". Prepared for the Utah Department of Natural Resources by Bowen Collins & Associates and Hansen Allen & Luce Engineers. January 2018.

2. Select the highest value from the data set.
3. Apply a "system-specific variation factor" to the highest value in the data set using the formula below:

$$Variation\ Factor\ (\%) = \frac{Highest\ Year\ Value - Lowest\ Year\ Value}{Lowest\ Year\ Value}$$

Using this system variation factor methodology, Table 2-8 displays the recommended annual average and daily average source sizing standard for the district service area.

Table 2-8
Recommended Source Sizing Standard[5]

Year	Average Annual Demand and Average Daily Demand per ERC, Including RWSA Partner and District Non-Revenue Water
2018	226,355 gallons/year
2019	206,285 gallons/year
2020	228,502 gallons/year
Maximum Value (2020)	**228,502 gallons/year**
Minimum Value (2019)	**206,285 gallons/year**
System Variation Factor	**10.77%**
Recommended Source Sizing Standard, Average Annual Demand (Max Value + [Max Value x System Variation Factor])	**254,000 gallons/year[1]**
Recommended Source Sizing Standard, Average Daily Demand	**696 gallons/day**

[1]Value rounded up to the nearest 1,000 gallons/year.

PEAK DAY DEMAND

In addition to meeting average annual and daily demands, water sources must also have adequate capacity to meet peak day demands. Peak day demand represents the total system demand on the highest water use day in a given year, which typically occurs during the summer when irrigation demands are highest.

The district relies on several water sources, including wells, springs, and surface water. The majority of potable water produced by the district comes from the Quail Creek Water Treatment Plant (QCWTP) which is delivered to customers via the Regional Pipeline. Since RWSA partners read retail

5 The source sizing standard proposed for this master plan is based on 3 years of water use data from 2018 to 2020. If data from the year 2016 and 2017 is included in the calculation (for a total of 5 years of historical data), the source sizing standard increases to 286,000 gallons per year (0.88 AFY) per ERC. Considering that water use per ERC has generally trended down since 2016, and because it is anticipated that water use will continue to trend down in the future, the source sizing standard based on 3 years of data was used for this master plan.

meters on a monthly basis for billing, peak day demand for a given connection cannot be determined directly from meter records. However, about 94% of the water produced and delivered by the district is conveyed through the Regional Pipeline, so the demand patterns of this pipeline provide an excellent indication of the overall seasonal peaking characteristics of end users. Table 2-9 provides a summary of the total annual, average daily, and peak daily flow in the Regional Pipeline from 2018 - 2020.

Table 2-9
Average Day and Peak Day Deliveries through the Regional Pipeline

Year	Total Annual Volume Delivered through Regional Pipeline (MG)	Average Daily Flow Delivered through Regional Pipeline (MGD)	Peak Day Flow Delivered through Regional Pipeline (MGD)	Ratio of Peak Day Demand to Average Day Demand
2018	7,570.6	20.7	44.6	2.15
2019	6,497.8	17.8	39.9	2.24
2020	8,320.3	22.8	47.0	2.06
			Average Ratio	**2.15**

As shown in Table 2-9, the ratio of peak day demand to average day demand from the district's primary water source has been relatively consistent over the past 3 years with an average ratio of peak day demand to average day demand of 2.15. For the purpose of this Master Plan, this ratio has been applied to the calculation of peak day demand per ERC. Under this assumption, Table 2-10 summarizes the recommended peak day source sizing requirement per ERC by applying each year's respective peaking factor to the average daily demand for the same year.

Table 2-10
Recommended Peak Day Source Sizing Requirement per ERC

Year	Average Annual Metered Water Use Per ERC (gal/year)	Average Daily Metered Use per ERC (gal/day)	Peak Day to Average Day Demand Ratio	Estimated Peak Day Demand per ERC	% Non-Revenue Water	Peak Day Source Production per ERC (gal/day)
2018	193,828	531	2.15	1,142	14.37%	1,334
2019	179,179	491	2.24	1,100	13.14%	1,266
2020	198,568	544	2.06	1,121	13.10%	1,290
Maximum Value	**198,568**	**544**		**1,142**		**1,334**
Minimum Value	**179,179**	**491**		**1,100**		**1,266**
System Variation Factor						**5.37%**
Recommended Peak Day Source Sizing Standard						**1,406**

ESTIMATED DISTRIBUTION OF INDOOR AND OUTDOOR DEMAND

For planning purposes, it is beneficial to understand the breakdown of water use between indoor and outdoor applications. Indoor water demand includes the use of toilets, showers, washing machines, and other fixtures, the majority of which ultimately ends up in a sewer collection system (unless the home utilizes a septic tank and drain field for wastewater treatment and disposal). Outdoor demand is primarily related to irrigation of grass, trees, shrubs, gardens, etc., but also includes some recreational use, car washing, patio washdowns, and other uses for water outside of the home.

To estimate the breakdown of indoor and outdoor water use in Washington County, municipal and industrial (M&I) water use data from the City of St. George for different customer categories was evaluated. The data used spans from the year 2016 – 2020. Indoor water use was estimated based on winter water demand when outdoor irrigation is limited. Assuming the indoor component of water demand stays relatively constant throughout the year, any water use above winter demands was assumed to be used outdoors. Table 2-11 provides a summary of this water use data. As shown in the table, based on historical demands, it is estimated that an ERC uses 40% of its water indoors and 60% of its water outdoors.

Table 2-11
Summary of Estimated Historical Municipal and Industrial Indoor & Outdoor Potable Water Use

2016 - 2020 (5-Year Summary)						
User Type	**Average Number Connections in Sample**	**Indoor Use (gal)**	**Outdoor Use (gal)**	**Total Use (gal)**	**Estimated % Indoor**	**Estimated % Outdoor**
Residential	19,061	8,868,894,363	15,244,646,488	24,113,540,851	37%	63%
Commercial	1,211	2,256,527,410	1,442,504,425	3,699,031,835	61%	39%
Institutional	264	457,959,390	1,357,109,600	1,815,068,990	25%	75%
Industrial	38	372,909,760	118,776,820	491,686,580	76%	24%
Total	**20,590**	**11,956,290,923**	**18,163,037,333**	**30,119,328,256**	**40%**	**60%**

WATER CONSERVATION GOALS AND ESTABLISHING A SOURCE SIZING STANDARD FOR NEW DEVELOPMENT

In November of 2019, the DNR published a report[6] that established regional conservation goals throughout the state. The report contains a number of conservation measures that could be used to meet short and long-term conservation goals and also presents different conservation scenarios through the year 2065. Among these scenarios is an aggressive conservation option that involves reducing total (all potable and secondary) water use in Washington County by an additional 23% by 2070 (in addition to the approximately 30% per capita water use reduction already achieved since the year 2000). The district has adopted this goal as part of its 2021 water conservation plan[7].

Achieving this level of conservation will require significant efforts by the district and the customers it serves. Existing customers will need to adjust their water use behavior, update plumbing fixtures,

[6] "Utah's Regional M&I Water Conservation Goals". Prepared for the Utah Department of Natural Resources by Hansen, Allen & Luce and Bowen Collins & Associates. November 2019.

[7] "Water Conservation Plan". Washington County Water Conservancy District. Updated October 2021.

and modify their landscaping. New users will have to immediately adopt more aggressive water-saving practices. The district will help facilitate these changes, but will depend on its RWSA partners to pass and enforce ordinances on new development to achieve these goals.

Given existing and new users will have differing water demands, the district is proposing two different source sizing standards in this Master Plan. One standard will be for existing customers, determined by historical water use data, and another for new users. The standard for new users will be calculated to align with the district's long-term conservation goals. In essence, this approach aims to incentivize developers and new users to adopt construction methods and standards that are conducive to meeting the district's conservation goals. The proposed approach is straight forward: determine the target source sizing standard per ERC by the year 2070 and provide that amount of water to new users *beginning in 2023.*

The target source sizing standard per ERC that corresponds to the aggressive conservation goal in DNR's report was calculated and will be used to develop construction standards and other measures aimed at new users. This was done by applying the water conservation goal to the ERC source sizing standard as follows:

1. **Calculate end-user metered water use that corresponds to the reduced source sizing standard**: As shown in Table 2-5, the highest average metered water use per ERC from 2018 -2020 was 198,568 gallons per year. Using this value as the baseline and applying the percent reduction in water use of 23.19%, the target for future annual average metered use per ERC is **152,527 gallons per year.**

   This same process was applied for peak day demand using the highest value from the 3-year data set (**1,142 gallons per day peak day demand in 2018**). Applying the 23.19% water use reduction goal, the target future peak day demand (end user demand at the meter) per ERC is **877 gallons per day**.

2. **Apply Non-Revenue Water and a System Variation Factor**: For average annual demand, the proposed source sizing standard for new construction uses a value of 13.1% for non-revenue water, consistent with the highest annual source production year from the 3-year data sample from 2018 – 2020 (see Table 2-7). For peak day demand, the non-revenue percentage from the respective year with the highest peak day demand was used (2018, 14.37%). A system variation factor has also been applied to the source sizing standard for new development (10.77% for average annual demand per ERC and 5.37% for peak day demand per ERC). Based on these assumptions, Table 2-12 provides the recommended source sizing standards per ERC for new construction.

Table 2-12
Recommended Average Annual and Peak Day Source Sizing per ERC for New Construction

	A	B	C	D	E	
Source Sizing Scenario	**High-Year Metered Use for Existing ERC**	**Target Average Metered Use for Future ERC (A x 76.81%)**	**% Non-Revenue Water[1]**	**Target Source Production Requirement per Future ERC (B ÷ (100 - C))**	**System Variation Factor[2]**	**Target Future Source Sizing Standard per ERC (D+(D x E))**
Average Annual Demand per ERC (gallons/year)	198,568	152,527	13.10%	175,520	10.77%	**195,000[3]**
Peak Day Demand per ERC (gallons/day)	1,142	877	14.37%	1,024	5.37%	**1,079[4]**

[1]Non-revenue water value taken from the respective year in which the use occurred.
[2]See Table 2-8 and 2-10 for calculation of system variation factor.
[3]Value rounded up to the nearest 1,000 gallons.
[4]Value rounded up to the nearest gallon.

IMPLEMENTING A SOURCE SIZING STANDARD FOR NEW DEVELOPMENT

The district is actively working with its RWSA partners to determine actions that will reduce water use of new connections to less than or equal to the proposed annual average and peak day source sizing standards for new construction. The district has worked closely with the RWSA partners to identify and implement measures aimed at helping to reach the short and long-term conservation goals in the county. These measures include:

Enactment of ordinances that promote water efficiency. *The district and RWSA partners worked together to draft and enact new landscape ordinances. These ordinances include standards for new development which limit irrigated landscaping and are designed to result in water use at or below the proposed source sizing standard for new users.*

Penalties for high water use. *The district's board has adopted an excess water use surcharge on the community's highest water users. A similar fee is proposed to be assessed for new connections at a lower threshold to incentivize new users to use at or below the proposed source sizing standard. Penalties for violating landscape, time of day, and water waste ordinances are also under consideration by the RWSA partners.*

Advanced water metering. *RWSA partners are in various phases of implementing automatic metering infrastructure (AMI). AMI user portals provide customers notification of leaks and other information on water use. RWSA partners are also considering requiring dual residential metering (indoor & outdoor meters) and submetering of multifamily and commercial development to improve water use monitoring.*

Public outreach*. The district and RWSA partners currently have extensive conservation programs that include educational outreach, rebates, and an extensive media campaign. Conservation programs are being expended further to include additional rebates, including funding to replace grass with water-efficient landscaping.*

Ongoing evaluation of water use data. *The district will frequently gather and evaluate system water usage data on an ERC basis. This water use data can be organized by a variety of factors, such as age of home and size of home, to help distinguish which current conservation efforts are most effective and if additional measures are needed to ensure that the proposed source sizing standards for new development are met. Water use data is also being reviewed on a monthly basis with RWSA partners, providing water system managers with a real-time look at water use trends.*

ESTIMATED INDOOR AND OUTDOOR WATER FOR FUTURE USERS

The previous section outlines a number of water-saving measures aimed at reducing the water use of new development in the county service area. Under current conditions, it is estimated that potable water is used 40% indoors and 60% outdoors. The proposed source sizing standard for new development represents a significant reduction in water use per ERC compared to current trends, and it is anticipated that this reduction in overall water use will come mostly from a reduction is outdoor water use for landscaping. This considered, the 40/60 ratio is expected to change in the future, with a larger portion of demand shifting to indoor use.

To estimate the anticipated breakdown of indoor and outdoor demand for future water users, BC&A evaluated water use data for existing single family residential customers (primary residences without secondary irrigation) whose average water use currently falls in line with the proposed source sizing standard (or in other words, users that are already meeting the new standards for efficient water use). Using an evaluation of indoor and outdoor water use similar to that provided for existing customers, Table 2-13 provides a summary of estimated indoor and outdoor water use for existing single family homes whose annual water use is approximate to the proposed source sizing standard per ERC for new development. As shown in the table, it is projected that indoor water use will account for approximately 43% of total use of new development with the proposed source sizing standard, and the remaining 57% coming from outdoor use.

Table 2-13
Estimated Breakdown of Indoor & Outdoor Water Use for Proposed Source Sizing Standard for New Development

# of Connection Sampled[1]	Estimated Indoor Use (gal)	Estimated Outdoor Use (gal)	Total Use (gal)	Estimated % Indoor	Estimated % Outdoor
374	23,245,120	30,185,970	53,431,090	43%	57%

[1]Data provided by City of St. George from the year 2017.

ESTIMATING TOTAL ERC COUNT SERVICED BY THE DISTRICT AND PROJECTING FUTURE WATER DEMAND

In order to project future water demand within the district service area, it is necessary to identify current water needs and source utilization. To do this, an existing ERC count for the areas serviced by the district must be determined. The ERC represents a typical single family residential water user and these connections are almost always serviced by a 5/8-inch or ¾-inch water meter. Therefore, for the purposes of this planning document, a 5/8-inch or ¾-inch meter that is serviced by the district has been assumed to have the value of 1 ERC. Users that require a larger volume or flow rate of water than a typical home are required to install a larger water meter service connection, and the larger meter represents a greater water demand than what is associated with 1 ERC.

Using historical water use records for various meter sizes, an ERC equivalency ratio was established for 1-inch, 1.5-inch, and 2-inch water meters. Since there are very few 3-inch or larger water meters in the county from which to analyze historical water use, ERC equivalency for 3-inch and larger meters was estimated using the American Water Works Association (AWWA) "M-1 Manual: Principles of Water Rates, Fees, and Charges"[8]. Table VII.2-5 from the M-1 manual provides a list of meter capacity ratios to convert larger meters sizes to an equivalent number of 5/8-inch meters. Table 2-14 provides a summary of the ERC equivalency ratios used in the Master Plan.

Table 2-14
Estimated ERC Equivalency by Meter Size

Meter Size	5/8" & 3/4"	1"	1.5"	2"	3"	4"	6"	8"	10"	12"
ERC Equivalency[1,2]	1	2.5	6.2	10.3	16	25	50	80	210	265

[1]1" – 2" equivalency ratios based on historical water use data.
[2]Equivalency ratios for 3" meters and larger from AWWA M-1 manual meter capacity ratios.

Relying on the equivalency ratios in Table 2-14 and information provided by the RWSA partners, a summary of total estimated ERCs within the RWSA communities is provided below in Table 2-15.

[8] "Principles of Water Rates, Fees, and Charges: Manual of Water Supply Practices M-1". 7th Edition. American Water Works Association, 2017.

Table 2-15
Total ERC Counts[1] for RWSA Partners, Year 2020

		Meter Size								
		3/4"	*1"*	*1.5"*	*2"*	*3"*	*4"*	*6"*	*8"*	*Total*
		Meter Conversion Ratios								
City		*1*	*2.5*	*6.2*	*10.3*	*16*	*25*	*50*	*80*	
St. George City	Potable Water Meters	27,985	1,004	442	693	17	7	4	0	30,152
	ERC Count	**27,985**	**2,510**	**2,740**	**7,138**	**272**	**175**	**200**	**0**	**41,020**
Washington City	Potable Water Meters	11,843	175	75	91	20	7	4	0	12,215
	ERC Count	**11,843**	**438**	**465**	**937**	**320**	**175**	**200**	**0**	**14,378**
Hurricane City	Potable Water Meters	7,610	108	52	71	3	6	7	6	7,863
	ERC Count	**7,610**	**270**	**322**	**731**	**48**	**150**	**350**	**480**	**9,962**
Ivins City	Potable Water Meters	3,636	13	10	31	4	5	0	0	3,699
	ERC Count	**3,636**	**33**	**62**	**319**	**64**	**125**	**0**	**0**	**4,239**
Santa Clara City	Potable Water Meters	2,800	18	13	7	1	0	0	0	2,839
	ERC Count	**2,800**	**45**	**81**	**72**	**16**	**0**	**0**	**0**	**3,014**
La Verkin City	Potable Water Meters	1,529	14	5	7	2	0	0	0	1,557
	ERC Count	**1,529**	**35**	**31**	**72**	**32**	**0**	**0**	**0**	**1,699**
Toquerville City	Potable Water Meters	664	0	0	1	0	0	0	0	665
	ERC Count	**664**	**0**	**0**	**10**	**0**	**0**	**0**	**0**	**674**
Total RWSA	Potable Water Meters	56,067	1,332	597	901	47	25	15	6	58,990
	ERC Count	**56,067**	**3,330**	**3,701**	**9,280**	**752**	**625**	**750**	**480**	**74,986**

[1]As of the end of the calendar year 2020.

The district also provides service to additional wholesale and retail customers:

- **Town of Virgin**
- **Kayenta Water Users (KWU)**: KWU is a small water system within Ivins City limits. The development operates its own water system and receives wholesale water from the district. The current agreement between the district and KWU allows for up to 552 connections within the Kayenta development.
- **Casa de Oro & Homespun Village**: Casa de Oro and Homespun Village are small communities located off I-15 north of Leeds. The district operates a small retail water system to service these two developments.
- **Hurricane Valley Water System (HVWS)**: HVWS is a small residential development south of Hurricane City near the Bench Lake area that is not within Hurricane City's municipal

boundary. The district currently provides retail water service to this community as well as Sand Hollow State Park.

- **Kolob Retail Water System**: This small cabin community near Kolob Reservoir is mainly comprised of secondary housing units that are occupied for a portion of the year. It is fed by small local wells and a spring owned and operated by the district. This is an isolated water system that is not connected to the district's main water system and is not included in the totals for the purpose of this Master Plan.

These other communities included in the total ERC counts are shown below in Table 2-16.

Table 2-16
Total ERC Counts for Other Communities Serviced by the District, Year 2020[1]

Name of Community	ERC Count
Town of Virgin	451
Kayenta Water Users	406
Hurricane Valley Water System & Sand Hollow State Park	240
Casa de Oro & Homespun Village	44
Total	**1,141**

[1]As of the end of calendar year 2020

Between the RWSA partners and additional service areas, an estimated **76,127 ERCs** were receiving potable water service from the district by the end of the year 2020.

With the district providing water to 91.7% of Washington County's 2020 population estimate (187,878 people), approximately 15,617 people are *not* receiving water service from the district. A detailed determination of ERC values for each community not currently serviced by the district is outside of the scope of this analysis, but ERCs in these communities can be estimated by assuming the same ERC to population ratio found in areas currently serviced by the district. Under this assumption, the estimated total ERC count for areas not serviced by the district in 2020 is **6,899 ERCs.**

Estimating Growth Rates for Individual Communities Serviced by the District

The Kem C. Gardner growth projections shown in Table 2-3 and 2-4 provide an estimate for county-wide population and household growth, but do not provide projections for subcounty (individual city) growth. Although the district's water production, treatment, and conveyance systems are very much interconnected, it is important to evaluate and consider how the distribution of future growth may impact the need and location of future capital improvements.

BC&A worked closely with the district and RWSA partners to establish a future growth model consistent with the overall assumptions presented in the Kem C. Gardner study for the county. The water demand projections for this Master Plan account for the estimated growth within each individual city. These estimates were developed by evaluating each city's:

- Historical growth trends
- Current master planning documents
- Large, planned development areas and other high-growth areas
- Development constraints resulting from a limited availability of developable land

The future growth forecast, depicted in Table 2-17, is expressed in terms of ERCs through the year 2070. Note the following regarding Table 2-17:

- Since growth is presented in terms of ERCs, the projections are based on the Washington County household growth rate from the Kem C. Gardner study.

- Growth is presented in terms of "Potable Water ERCs" because they are determined using each city's potable water meter counts. A portion of the total water demand associated with this ERC count is (or will be) offset by secondary irrigation water.
- It has been assumed that by the year 2040, the district will supply water to additional communities throughout the county. It is not known which communities will be supplied water first, but it is assumed that water will be supplied to 97.9% of the county by 2070, which is reflected in the values shown in the table.

Table 2-17
Total ERC Counts for Washington County[1]

		St. George City		*Washington City*		*Hurricane City*		*Ivins City*		*Santa Clara City*		*La Verkin City*		*Toquerville City*		*Town of Virgin*		*Other Retail Systems Serviced by the District*		*Communities Not Currently Serviced by the District[2]*		
Year	**Projected Percent Increase in Households for Washington County**	**Estimated Growth Rate**	**ERCs**	**Estimated Growth Rate**	**ERCs**	**Estimated Growth Rate**	**ERCs**	**Estimated Growth Rate**	**ERCs**	**Estimated Growth Rate**	**ERCs**	**Estimated Growth Rate**	**ERCs**	**Estimated Growth Rate**	**ERCs**	**Estimated Growth Rate**	**ERCs**	**Estimated Growth Rate**	**ERCs**	**Estimated Growth Rate**	**Total ERCs**	**Estimated ERCs Serviced in the Future**
2020			41,020		14,378		9,962		4,239		3,014		1,699		674		451		690		6,899	0
2021	4.49%	4.61%	42,909	5.10%	15,111	5.30%	10,490	4.54%	4,431	3.50%	3,119	4.00%	1,767	12.00%	755	3.05%	465	1.50%	700	1.50%	7,003	0
2022	4.23%	4.38%	44,787	4.70%	15,821	4.78%	10,991	4.30%	4,622	3.20%	3,219	3.90%	1,836	11.50%	842	3.08%	479	1.50%	711	1.50%	7,108	0
2023	3.92%	3.98%	46,567	4.31%	16,503	4.56%	11,492	3.90%	4,802	3.10%	3,319	3.80%	1,906	11.50%	939	3.00%	493	1.50%	722	1.50%	7,214	0
2024	3.65%	3.73%	48,306	3.90%	17,147	4.01%	11,953	3.70%	4,980	3.00%	3,418	3.70%	1,976	11.00%	1,042	2.90%	508	1.50%	732	1.50%	7,323	0
2025	3.42%	3.49%	49,992	3.51%	17,749	3.92%	12,421	3.30%	5,144	2.90%	3,517	3.50%	2,045	10.50%	1,152	2.70%	521	1.50%	743	1.50%	7,432	0
2026	3.31%	3.27%	51,628	3.54%	18,377	3.90%	12,905	3.20%	5,309	2.80%	3,616	3.30%	2,113	10.00%	1,267	2.69%	535	1.50%	755	1.50%	7,544	0
2027	3.19%	3.16%	53,258	3.38%	18,997	3.60%	13,370	3.20%	5,479	2.70%	3,714	3.25%	2,182	10.00%	1,393	2.50%	549	1.50%	766	1.50%	7,657	0
2028	3.22%	3.14%	54,928	3.53%	19,668	3.70%	13,865	3.20%	5,654	2.60%	3,810	3.20%	2,251	10.00%	1,533	2.50%	563	1.50%	777	1.50%	7,772	0
2029	3.18%	3.10%	56,628	3.46%	20,348	3.60%	14,364	3.20%	5,835	2.50%	3,905	3.20%	2,323	10.00%	1,686	2.40%	576	1.50%	789	1.50%	7,888	0
2030	3.17%	3.06%	58,362	3.49%	21,057	3.58%	14,878	3.20%	6,021	2.50%	4,003	3.20%	2,398	10.00%	1,855	2.30%	589	1.50%	801	1.50%	8,007	0
2031	3.13%	3.04%	60,138	3.40%	21,773	3.58%	15,411	3.10%	6,208	2.50%	4,103	3.10%	2,472	9.00%	2,022	2.28%	603	1.50%	813	1.50%	8,127	0
2032	3.18%	3.03%	61,961	3.50%	22,535	3.80%	15,996	3.10%	6,401	2.50%	4,206	3.10%	2,549	9.00%	2,204	2.20%	616	1.50%	825	1.50%	8,249	0
2033	3.17%	3.02%	63,832	3.41%	23,304	3.80%	16,603	3.10%	6,599	2.50%	4,311	3.10%	2,628	9.00%	2,402	2.28%	630	1.50%	837	1.50%	8,373	0
2034	3.11%	3.00%	65,745	3.35%	24,085	3.53%	17,190	3.08%	6,802	2.50%	4,419	3.00%	2,707	8.50%	2,606	2.29%	645	1.50%	850	1.50%	8,498	0
2035	2.99%	2.86%	67,623	3.20%	24,855	3.33%	17,762	3.00%	7,006	2.50%	4,529	3.00%	2,788	8.50%	2,828	2.28%	659	1.50%	863	1.50%	8,626	0
2040[3]	2.73%	2.54%	76,675	2.98%	28,780	3.01%	20,603	2.82%	8,052	2.50%	5,124	2.68%	3,182	7.08%	3,980	2.23%	736	1.50%	929	1.50%	9,292	25
2045[3]	2.41%	2.25%	85,706	2.60%	32,715	2.64%	23,471	2.53%	9,123	2.44%	5,781	2.38%	3,579	4.74%	5,017	2.12%	817	1.00%	977	1.62%	10,070	500
2050[3]	2.17%	1.83%	93,839	2.52%	37,049	2.70%	26,813	2.26%	10,200	2.28%	6,470	2.08%	3,967	3.34%	5,912	2.01%	903	1.00%	1,027	2.11%	11,178	1,900
2055[3]	2.03%	0.67%	97,024	3.86%	44,766	3.79%	32,291	1.36%	10,911	2.12%	7,186	2.01%	4,382	2.98%	6,847	2.01%	997	1.00%	1,079	2.72%	12,782	3,800
2060[3]	1.90%	0.10%	97,510	3.81%	53,979	3.83%	38,970	0.30%	11,075	2.10%	7,973	1.90%	4,814	2.81%	7,865	1.98%	1,100	1.00%	1,134	3.70%	15,329	7,000
2065[3]	1.78%	0.10%	97,999	3.30%	63,506	3.19%	45,595	0.10%	11,130	1.94%	8,777	1.18%	5,105	2.58%	8,933	1.99%	1,214	1.00%	1,192	3.75%	18,428	11,200
2070[3]	1.57%	0.10%	98,490	2.89%	73,214	2.05%	50,462	0.10%	11,186	1.53%	9,469	1.00%	5,366	2.20%	9,960	1.98%	1,339	1.00%	1,253	3.89%	22,299	16,340

[1]Note than one ERC does not necessarily equate to 1 full ERC of potable water demand. Many existing and future ERCs will be serviced through the combination of potable and secondary irrigation water.
[2]Includes all communities except Enterprise, UT.
[3]Growth rate shown is the average of the given year and the previous 4 years.

EXISTING AND FUTURE POTABLE AND SECONDARY IRRIGATION WATER SUPPLY NEEDS

For the purpose of this Master Plan, existing potable and secondary irrigation water needs, along with projected future potable and secondary water needs, were accounted for using the following steps:

1. Calculate the total number of ERCS serviced with potable water (as shown in Tables 2-15 and 2-16) and the associated total gross water demand (assuming all water supplied comes from the potable water system).
2. Identify the number and size of all secondary irrigation connections meeting M&I needs and estimate total secondary irrigation demand using water use data from DNR[9].
3. For each secondary irrigation connection serving a residential unit[10], reduce the potable water demand for that many ERCs by the outdoor component of the source sizing standard. Based on overall water use trends, indoor water use accounts for approximately 40% of total potable water demand, with outdoor irrigation accounting for 60%. Therefore, an ERC with both a potable and secondary water connection would, on average, use potable water for 40% of its total demand (indoor) and secondary irrigation water for 60% for its total demand (outdoor). This is illustrated in Figure 2-1.
4. Project gross total water demand and offset future potable water outdoor demand with secondary irrigation demand in accordance with the assumed availability of secondary water for each RWSA partner.
5. Add together the individual potable water and secondary irrigation demand projections for each RWSA partner system and district retail system to determine total potable water and secondary irrigation needs.

[9] dwre-utahdnr.opendata.arcgis.com

[10] Adjustments made to projected demand that take into account the use of secondary irrigation water were applied differently to standard residential meters and larger meters servicing non-standard residential developments or non-residential developments. For a typical residential home, a 5/8-inch or ¾-inch meter is the standard meter size for potable service, regardless of whether the home has a secondary irrigation connection or not. In these cases, although the home has the standard potable meter size, its total potable water use is significantly less than a full ERC (since potable water is only being used indoors). For such a home, it is necessary to account for the volume of water that is supplemented from the secondary irrigation system and not needed from the potable water system and an adjustment in demand is implemented as described above.

However, larger developments with secondary service such as a school or industrial user typically have a large diameter (1" or greater) potable water meter to meet high indoor water demand and a large diameter secondary irrigation meter for watering fields and other turf areas. In these cases, it has been assumed that the potable and secondary irrigation connections have been appropriately sized for their specific duty, and that each meter represents its full ERC equivalency.

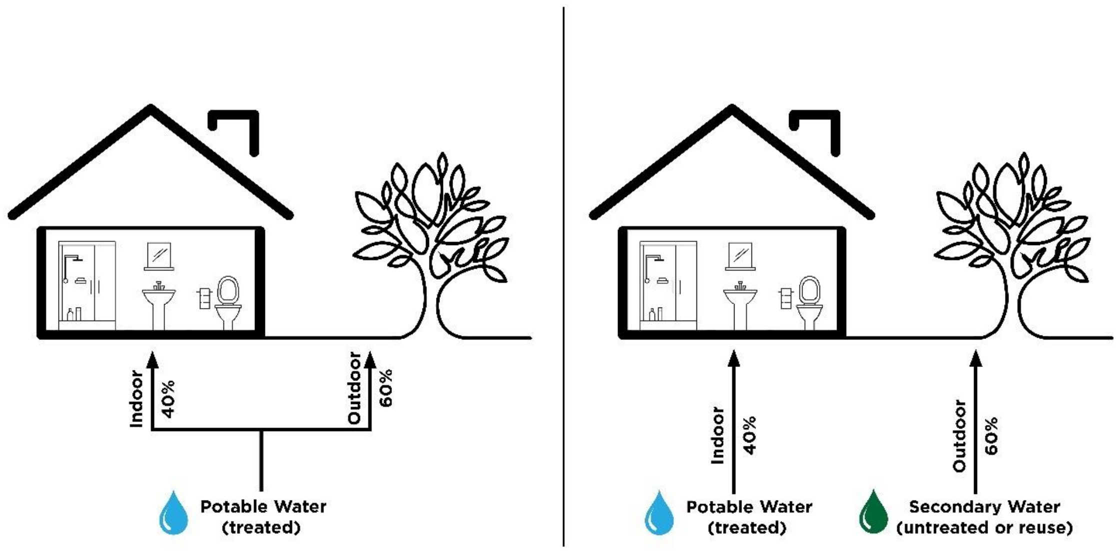


Figure 2-1. Potable Only vs. Combined Service Units

In order to complete these steps, the extent to which secondary irrigation water can reasonably offset potable water demands in each RWSA partner system needed to be estimated. Below is a description of each RWSA partner's respective water use plan for potable and secondary water:

St. George City

St. George City is the largest of the district's wholesale water customers and maintains the most extensive secondary irrigation system in the county. Based on the assumptions recorded in the St. George Culinary Master Plan[11] and Secondary Irrigation Master Plan[12], St. George plans to extend secondary irrigation service into a number of newly developing areas within the city. It is estimated that approximately 71.9% of all future demand will be met through potable water supplies, with 28.1% of demand being met from secondary irrigation supplies. These percentages have been used to estimate the future distribution of demand in St. George between potable and secondary water.

Washington City

Washington City currently meets most of its water needs with potable water. There are a few golf courses and parks within the city that utilize secondary irrigation water. A select number of residential homes in the downtown area utilize a flood irrigation system supplied by untreated sources. Washington City currently requires all new development to install pressurized secondary irrigation infrastructure with the intent to eventually provide those customers with secondary water. Washington City has developed a draft secondary irrigation master plan[13] including specific phases for extending service throughout the majority of the city. Based on the information found in the master plan, the city plans to eventually extend secondary irrigation service to approximately 75% of its service area. However, before this level of expansion can occur, a substantial source of secondary water and a large storage reservoir (or combination of reservoirs) will be needed to

[11] "Culinary Water Master Plan". Prepared by Bowen Collins & Associates. 2018.

[12] "Secondary Irrigation Master Plan" Prepared by Bowen Collins & Associates. 2018.

[13] "Washington City Secondary Water Master Plan Update Phase 11". Prepared by Sunrise Engineering. October 2020.

supply the system. For this Master Plan, it has been assumed that a regional secondary irrigation reservoir will come online by the year 2040, at which time the city will begin to charge up the dry irrigation lines installed over the years, offsetting a significant amount of demand on the potable water system. It is expected that, once the secondary water is readily available, this transition would occur over a period of 4-5 years, at which point 75% of customers would be provided secondary irrigation water going forward.

Hurricane City

Hurricane City operates a municipal secondary irrigation system that receives raw water from the Quail Creek Pipeline. The system primarily services the downtown area of Hurricane City north of Goulds Wash, but also provides services to a few other developments. The Hurricane Canal Company operates a large irrigation system in the downtown area of Hurricane south of Goulds Wash and into the Bench Lake area. Hurricane City recently adopted an ordinance requiring all new development to install pressurized secondary irrigation infrastructure. The city's long-term water plan to is extend secondary pressurized irrigation throughout its entire service area. For this Master Plan, it is projected that Hurricane City will continue to expand a secondary irrigation system (with lines that may temporarily remain dry for the time being), and that by the year 2040, a significant supply of secondary water and secondary storage will be available to charge up additional regions of the system. It is expected that this transition will occur over the course of 4-5 years, at which point all dry irrigation lines built to that point will be operational, and that all new development beyond that point in time will receive secondary irrigation water.

Ivins City

Ivins City does not currently operate its own municipal secondary irrigation system, but does utilize shares in the Ivins Irrigation Company to irrigate a park, cemetery, and school. Some residents/subdivisions in Ivins also own shares in the irrigation company and use the water for irrigation. As documented in the Ivins City Culinary Water Master Plan[14] and Secondary Irrigation Master Plan[15], the city has a phased plan to extend secondary irrigation to the majority of its service area (excluding some areas on the northwest side of the city as well as the Kayenta development). The city's current shares in the irrigation company are not enough to support any significant expansion of a pressurized irrigation system, so new sources and storage facilities will be needed before Ivins can significantly expand its system. It is projected that, by the year 2025, new secondary irrigation storage will be available for Ivins City on the west side of the county. Once the supplies are available, Ivins City will proceed with the phased plan to expand its secondary irrigation system.

Santa Clara City

Santa Clara currently utilizes secondary irrigation in a select few areas in the city, including parks and schools. A limited number of homeowners have shares in the local irrigation company and use the water for irrigation purposes. Through discussion with Santa Clara City management, the city plans to include some minor expansion of their secondary irrigation system within areas that are in close proximity to the existing secondary irrigation infrastructure. It is projected that Santa Clara City will extend secondary irrigation to approximately 800 new ERCS within the 50 year planning window of this study.

[14] "Culinary Water Master Plan". February 21, 2019. Prepared by Bowen Collins & Associates

[15] "Secondary Irrigation Master Plan". February 21, 2019. Prepared by Bowen Collins & Associates

La Verkin City

La Verkin operates one of the more extensive secondary irrigation systems in the county. The system is fed from a connection to the Quail Creek Pipeline. Most of the existing development within La Verkin has access to a secondary irrigation connection. Through discussions with La Verkin city management, the city is planning to continue to expand the secondary irrigation system to all areas within the lower section (west side) of the city. The city does not currently intend to utilize secondary irrigation on the La Verkin East Bench, or "topside", of the city. It is estimated that about 53% of future development in La Verkin will be serviced with secondary irrigation, with the remaining 47% serviced solely by the potable water system.

Toquerville City

The district manages and operates the Toquerville Secondary Water System (TSWS) that provides secondary irrigation to M&I and agricultural users in Toquerville City. The system utilizes water from Toquerville Springs, but will begin using water from the Ash Creek Pipeline/Toquer Reservoir Project once completed. The district is planning to fully utilize the water available from the Ash Creek Pipeline Project, but does not have plans to further expand the TSWS system at this time. As agricultural land is developed, the system will be used to service the new development.

Other Communities in Washington County

For the other communities located throughout the county that are currently serviced by the district or that are anticipated to be serviced in the future, it is has been assumed that they will fully utilize their respective secondary irrigation sources.

ESTIMATING EXISTING SECONDARY M&I DEMANDS

In order to accurately estimate current and future potable water demands, it is necessary to estimate how current M&I secondary irrigation supplies offset potable water demands. The DNR maintains secondary water use records for all public water system across the state. Many cities also report secondary irrigation use to UDWRi. Not all secondary water end use is metered, and some of the reported values are estimates. Metering efforts are expected to improve as secondary irrigation systems are expanded. Table 2-18 provides the secondary water use estimates from 2017 – 2019 (the 3 most recent years available) for the cities currently serviced by the district as reported by DNR. Table 2-19 provides the same information for the other communities in Washington County not currently serviced by the district.

Table 2-18
Estimated Municipal and Industrial Secondary Irrigation Use[1,2] (RWSA Partners Communities and town of Virgin), 2017 - 2019

City	2017 Estimated Secondary M&I Water Use (acre-feet)	2018 Estimated Secondary M&I Water Use (acre-feet)	2019 Estimated Secondary M&I Water Use (acre-feet)	3-Year Maximum Secondary M&I Water Use (acre-feet)
Hurricane[2]	2,581	3,138	1,101	2,148
Ivins	108	125	128	128
La Verkin	1,783	1,650	1,674	1,783
Santa Clara	269	190	181	269
St. George	6,385	6,644	5,637	6,644
Toquerville[2]	684	678	212	684
Virgin	84	395	419	419
Washington[2]	2,086	2,030	1,969	1,665
Total	**13,979**	**14,851**	**11,322**	

[1]Water use data available at https://dwre-utahdnr.opendata.arcgis.com/pages/municipal-and-industrial-data
[2]In the case that a given city's estimated secondary water demand exceeds its estimated reliable supply, existing secondary irrigation demand was adjusted in the projections to match the city's reliable water supply estimate.

Table 2-19
Estimated Municipal and Industrial Secondary Irrigation Use (Non-RWSA Partner Communities), 2017 - 2019

City/District	2017 Estimated Secondary M&I Water Use (acre-feet)	2018 Estimated Secondary M&I Water Use (acre-feet)	2019 Estimated Secondary M&I Water Use (acre-feet)	3-Year Maximum Secondary M&I Water Use (acre-feet)
Hildale - Colorado City	0.0	0.0	33.9	33.9
Big Plains - Apple Valley	0.0	N/A	0.0	0.0
Rockville Pipeline Co.	85.1	38.8	220.9	220.9
Springdale Town Water System	746.8	728.6	760.3	760.3
Kayenta Water Users Inc.	0.0	0.0	0.0	0.0
Winchester Hills Water Co.	0.0	0.0	0.0	0.0
Angell Springs SSD	0.0	19.5	20.5	20.5
Zion Canyon Water System	0.0	0.0[1]	0.0	0.0
Leeds Domestic Water Users Assoc.	88.6	192.9	201.1	201.1
Diamond Valley Acres	0.0	0.0	0.0	0.0
Gunlock SSD	6.6	38.0	43.5	43.5
Dammeron Valley Water Works LLC	0.0	0.0	0.0	0.0
Veyo Culinary Water Association	182.8	152.4	317.2	317.2
Pine Valley Mt. Farms	0.0	0.0	0.0	0.0
Pine Valley Irrigation Co.	53.7	19.4	2.4	53.7
Central Culinary Water Co.	19.4	38.9	37.4	38.9
Dixie Deer SSD	0.0	0.0	0.0	0.0
Mountain Springs Water Co.	0.0	0.0	0.0	0.0
Harmony Heights HOA	N/A	N/A	N/A	N/A
Harmony Farms Water Users	0.0	0.0	0.0	0.0
New Harmony Water System	128.0	129.2	124.3	129.2
Olympus Academy	N/A	N/A	N/A	N/A
Big Plains - Cedar Point	0.0	0.0	0.0	0.0
Washington County WCD - Cottam (Casa De Oro)	0.0	0.0	0.0	0.0
Washington County WCD - Sand Hollow (Hurricane Valley Retail)	0.0	N/A	0.0	N/A
North Valley Ranches Subdivision	0.0	0.0	0.0	0.0
Total	**1310.8**	**1357.7**	**1761.5**	

[1]Value reported on DWR records appeared to be erroneous. Value has been adjusted to better match estimates from other years.

Source Sizing Requirement for Secondary Irrigation

Secondary irrigation water is planned to play a larger role in meeting the growing water needs of the county in the future and is anticipated to be available to more residential, commercial, institutional, and industrial customers. It is important that customers using secondary irrigation systems are provided a comparable level of access and reliability to water as customers connected solely to potable water systems. As identified previously in this chapter, the potable water system is evaluated on the basis of ERCs and a source sizing standard. To be consistent, it is recommended that a similar approach be taken with secondary irrigation water. By doing so, secondary irrigation water can offset the potable water source sizing standard at a 1:1 ratio with the same system variation factor applied.

Table 2-20 provides the recommended total source sizing values for each city's secondary water supply based on the last 3 years of available water use data, the estimated percentage of non-revenue water determined for the potable water system, and the recommended system variation factor for the potable water system. These values effectively serve as the "starting point" for the secondary water need for each respective community. As each city grows and the total potable water system ERC count increases, the outdoor component of some ERCs is removed from the total potable source sizing requirement and moved to the secondary irrigation source sizing requirement. This approach provides for more accurate accounting of the actual supply that will be needed from the potable and secondary irrigation systems, respectively.

Table 2-20
Existing Secondary Water Source Sizing Requirements

City	3-Year Maximum Secondary M&I Water Use (AFY)	Source Production Requirement Including Non-Revenue Water (Assumed 13.1%)	Total Recommended Secondary Irrigation Source Sizing Requirement, AFY (System Variation Factor 10.77%)
Hurricane City	2,148	2,472	2,738[1]
Ivins	128	147	163
La Verkin City Water System	1,783	2,051	2,272
Santa Clara City	269	309	342
St. George City Water System	6,644	7,646	8,469
Toquerville Town Water System	684	787	872[2]
Virgin	419	483	535
Washington City	1,665	1,916	2,122[3]
Total RWSA			**17,514**
Other Communities	1,819	2,093	2,319
Total County-Wide			**19,833**

[1]Value exceeds Hurricane City reliable secondary water supply and was adjusted to 1,636 AFY to match reliable secondary supply. See Chapter 4 for more information.
[2]Value exceeds available reliable supply for Toquerville and was adjusted to 632 AFY to match reliable secondary supply. See Chapter 4 for more information.
[3]Value exceeds Washington City reliable secondary water supply and was adjusted to 1,093 AFY to match reliable secondary supply. See Chapter 4 for more information.

PROJECTED POTABLE AND SECONDARY IRRIGATION DEMAND

The following tables provide the water supply requirement projections for potable water and secondary water under 2 scenarios:

1. **No Additional Conservation Scenario**: This scenario represents the projected demand using the current source sizing standard for existing users with no reduction in use due to conservation or non-revenue water reduction. The "No Additional Conservation" scenario is shown in Table 2-21 (annual average demand) and 2-23 (peak day demand).
2. **Target Conservation Scenario**: This scenario accounts for the conservation goal presented previously in this chapter and represents the planning scenario for this Master Plan. It assumes that the required source sizing standard for existing users will be reduced by approximately 23% by the year 2070, and that a 23% reduction in use resulting from new construction standards will be reflected in the required source sizing standard for new users growth starting in 2023. It also assumes non-revenue water will decrease to 12% by 2070. The "Target Conservation" scenario is shown in Table 2-22 (annual average demand) and 2-24 (peak day demand).

Table 2-21
Projected Average Annual Potable and Secondary Irrigation Water Supply Requirement, No Additional Conservation Scenario (acre-feet per year)

		St. George City		*Washington City*		*Hurricane City*		*Ivins City*		*Santa Clara City*		*La Verkin City*		*Toquerville City*		*Town of Virgin*		*Other Retail Systems Serviced by District*		*Communities not Currently Serviced by the District*			
Year	Overall ERC Growth Rate	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary[1]	Total Potable	Total Secondary
2020		31,382	8,469	11,520	1,093	9,000	1,636	3,251	162	2,338	342	886	2,272	366	632	350	535	536	0	0	0	59,629	15,141
2021	4.49%	32,437	8,882	12,089	1,093	9,411	1,636	3,400	162	2,412	350	922	2,289	410	651	361	535	544	0	0	0	61,986	15,597
2022	4.23%	33,485	9,292	12,641	1,093	9,800	1,636	3,548	162	2,482	357	955	2,306	458	670	372	535	552	0	0	0	64,294	16,050
2023	3.92%	34,479	9,681	13,171	1,093	10,170	1,655	3,688	162	2,552	365	987	2,323	514	689	383	535	561	0	0	0	66,506	16,502
2024	3.65%	35,450	10,061	13,671	1,093	10,509	1,674	3,826	162	2,622	372	1,020	2,340	576	708	394	535	569	0	0	0	68,637	16,944
2025	3.42%	36,392	10,429	14,138	1,093	10,854	1,693	3,954	162	2,692	380	1,053	2,357	642	727	405	535	577	0	0	0	70,706	17,375
2026	3.31%	37,305	10,786	14,626	1,093	11,211	1,712	3,350	935	2,761	387	1,084	2,374	712	746	416	535	586	0	0	0	72,051	18,568
2027	3.19%	38,215	11,142	15,108	1,093	11,553	1,731	3,390	1,027	2,829	395	1,117	2,391	791	765	426	535	595	0	0	0	74,024	19,079
2028	3.22%	39,148	11,507	15,629	1,093	11,918	1,750	3,428	1,125	2,897	402	1,149	2,408	881	784	437	535	604	0	0	0	76,090	19,604
2029	3.18%	40,097	11,878	16,158	1,093	12,286	1,769	3,466	1,228	2,963	409	1,183	2,426	981	803	447	535	613	0	0	0	78,194	20,141
2030	3.17%	41,065	12,257	16,708	1,093	12,667	1,788	3,502	1,337	3,032	417	1,218	2,444	1,093	822	458	535	622	0	0	0	80,364	20,692
2031	3.13%	42,056	12,645	17,264	1,093	13,061	1,808	3,583	1,401	3,102	424	1,253	2,462	1,203	841	468	535	631	0	0	0	82,623	21,208
2032	3.18%	43,074	13,043	17,856	1,093	13,497	1,827	3,666	1,468	3,174	432	1,288	2,481	1,326	860	479	535	641	0	0	0	85,001	21,738
2033	3.17%	44,119	13,452	18,453	1,093	13,950	1,846	3,750	1,538	3,248	439	1,325	2,500	1,461	879	489	535	651	0	0	0	87,446	22,281
2034	3.11%	45,187	13,869	19,060	1,093	14,386	1,865	3,835	1,610	3,325	447	1,362	2,520	1,600	898	501	535	660	0	0	0	89,916	22,836
2035	2.99%	46,236	14,280	19,658	1,093	14,812	1,884	3,919	1,685	3,403	454	1,400	2,539	1,753	917	512	535	670	0	0	0	92,364	23,387
2036	2.92%	47,277	14,687	20,269	1,093	15,239	1,903	4,009	1,756	3,483	462	1,438	2,559	1,919	936	523	535	680	0	0	0	94,838	23,930
2037	2.79%	48,281	15,079	20,874	1,093	15,661	1,922	4,098	1,829	3,566	469	1,476	2,579	2,090	955	535	535	690	0	0	0	97,271	24,461
2038	2.71%	49,287	15,473	21,486	1,093	16,083	1,941	4,186	1,903	3,651	477	1,512	2,598	2,238	974	547	535	701	0	0	0	99,690	24,993
2039	2.64%	50,287	15,864	22,098	1,093	16,506	1,960	4,273	1,979	3,738	484	1,548	2,617	2,397	993	559	535	711	0	0	0	102,118	25,525
2040	2.57%	51,290	16,257	22,171	1,629	16,923	1,979	4,359	2,057	3,828	492	1,585	2,636	2,553	1,012	572	535	722	0	19	0	104,022	26,596
2041	2.51%	52,296	16,650	20,893	3,511	14,542	4,795	4,391	2,191	3,920	499	1,622	2,656	2,704	1,031	584	535	729	0	39	0	101,721	31,867
2042	2.46%	53,300	17,043	19,328	5,687	13,946	5,836	4,420	2,329	4,015	506	1,659	2,675	2,849	1,050	597	535	736	0	58	0	100,908	35,661
2043	2.40%	54,299	17,434	17,658	7,976	13,251	6,975	4,445	2,472	4,107	514	1,697	2,695	2,984	1,069	610	535	744	0	155	0	99,950	39,669
2044	2.37%	55,312	17,830	15,874	10,374	12,460	8,217	4,464	2,618	4,203	521	1,734	2,714	3,126	1,088	622	535	751	0	311	0	98,856	43,897
2045	2.33%	56,333	18,229	13,977	12,880	11,569	9,560	4,479	2,769	4,301	529	1,771	2,734	3,264	1,107	635	535	759	0	388	0	97,475	48,343
2046	2.26%	57,338	18,622	14,303	13,147	11,755	9,838	4,507	2,911	4,396	536	1,806	2,752	3,389	1,126	648	535	766	0	621	0	99,529	49,467
2047	2.19%	58,290	18,995	14,641	13,424	11,949	10,130	4,532	3,056	4,495	544	1,842	2,771	3,507	1,145	661	535	774	0	777	0	101,468	50,599
2048	2.15%	59,237	19,365	14,980	13,701	12,145	10,424	4,551	3,204	4,595	551	1,878	2,790	3,626	1,164	674	535	782	0	1,010	0	103,478	51,733
2049	2.13%	60,100	19,703	15,370	14,020	12,365	10,754	4,567	3,355	4,696	559	1,915	2,809	3,745	1,183	688	535	790	0	1,243	0	105,479	52,917
2050	2.13%	60,874	20,006	15,828	14,395	12,608	11,118	4,577	3,508	4,799	566	1,952	2,829	3,864	1,202	701	535	798	0	1,476	0	107,477	54,158
2051	2.11%	61,398	20,210	16,398	14,861	12,917	11,581	4,592	3,648	4,902	574	1,990	2,849	3,983	1,221	716	535	805	0	1,709	0	109,410	55,478
2052	2.05%	61,821	20,376	17,024	15,373	13,241	12,067	4,591	3,780	5,003	581	2,028	2,869	4,106	1,240	730	535	814	0	1,942	0	111,299	56,821
2053	2.02%	62,195	20,522	17,670	15,902	13,573	12,566	4,578	3,908	5,105	588	2,067	2,889	4,233	1,259	745	535	822	0	2,253	0	113,241	58,169
2054	2.00%	62,517	20,648	18,371	16,475	13,917	13,082	4,547	4,023	5,210	596	2,106	2,909	4,365	1,278	759	535	830	0	2,563	0	115,186	59,547
2055	1.99%	62,652	20,701	19,125	17,092	14,310	13,671	4,505	4,132	5,318	603	2,147	2,931	4,496	1,297	775	535	838	0	2,952	0	117,116	60,962
2056	1.95%	62,706	20,722	19,909	17,734	14,717	14,282	4,504	4,192	5,427	611	2,188	2,952	4,631	1,316	790	535	847	0	3,418	0	119,137	62,343
2057	1.91%	62,761	20,743	20,692	18,375	15,119	14,885	4,396	4,342	5,540	618	2,230	2,974	4,771	1,335	806	535	855	0	3,884	0	121,053	63,807
2058	1.88%	62,815	20,765	21,481	19,020	15,531	15,503	4,401	4,346	5,654	626	2,272	2,996	4,909	1,354	822	535	864	0	4,350	0	123,099	65,145
2059	1.87%	62,869	20,786	22,266	19,662	15,953	16,136	4,405	4,351	5,772	633	2,316	3,019	5,050	1,373	838	535	872	0	4,894	0	125,234	66,494
2060	1.86%	62,924	20,807	23,061	20,313	16,385	16,784	4,410	4,355	5,892	641	2,349	3,037	5,191	1,392	855	535	881	0	5,437	0	127,384	67,863
2061	1.87%	62,978	20,829	23,892	20,992	16,803	17,411	4,414	4,359	6,008	648	2,378	3,052	5,337	1,411	872	535	890	0	6,059	0	129,630	69,236
2062	1.84%	63,033	20,850	24,707	21,660	17,229	18,050	4,418	4,363	6,127	656	2,406	3,066	5,481	1,430	889	535	899	0	6,758	0	131,947	70,609
2063	1.79%	63,087	20,871	25,523	22,327	17,643	18,671	4,423	4,367	6,248	663	2,433	3,081	5,630	1,449	907	535	908	0	7,379	0	134,181	71,964
2064	1.74%	63,142	20,893	26,330	22,987	18,044	19,273	4,427	4,372	6,366	670	2,462	3,096	5,776	1,468	925	535	917	0	8,078	0	136,466	73,292
2065	1.68%	63,196	20,914	27,131	23,643	18,444	19,872	4,432	4,376	6,479	678	2,485	3,108	5,926	1,487	943	535	926	0	8,700	0	138,662	74,612
2066	1.50%	63,251	20,935	27,826	24,211	18,812	20,424	4,436	4,380	6,591	685	2,509	3,120	6,060	1,506	962	535	935	0	9,321	0	140,702	75,797
2067	1.61%	63,306	20,957	28,663	24,896	19,175	20,969	4,441	4,384	6,694	693	2,533	3,133	6,197	1,525	981	535	945	0	10,020	0	142,955	77,092
2068	1.59%	63,361	20,978	29,512	25,591	19,473	21,416	4,445	4,389	6,792	700	2,558	3,146	6,337	1,544	1,001	535	954	0	10,797	0	145,229	78,298
2069	1.57%	63,416	21,000	30,382	26,303	19,739	21,815	4,449	4,393	6,885	708	2,582	3,159	6,481	1,563	1,020	535	963	0	11,729	0	147,648	79,475
2070	1.56%	63,471	21,021	31,279	27,036	19,956	22,140	4,454	4,397	6,979	715	2,607	3,172	6,629	1,582	1,040	535	973	0	12,692	0	150,079	80,598

[1]It is not anticipated that the district will provide secondary irrigation water to communities that are not currently serviced by the district. It is assumed that these communities will fully utilize their own respective secondary irrigation supplies.

Table 2-22
Projected Average Annual Potable and Secondary Irrigation Water Supply Requirement, Target Conservation Scenario (acre-feet per year)

		St. George City		*Washington City*		*Hurricane City*		*Ivins City*		*Santa Clara City*		*La Verkin City*		*Toquerville City*		*Town of Virgin*		*Other Retail Systems Serviced by District*		*Communities not Currently Serviced by the District*			
Year	Overall ERC Growth Rate	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary[1]	Total Potable	Total Secondary
2020		31,382	8,469	11,520	1,093	9,000	1,636	3,251	162	2,338	342	886	2,272	366	632	350	535	536	0	0	0	59,629	15,141
2021	4.49%	32,437	8,882	12,089	1,093	9,411	1,636	3,400	162	2,414	348	922	2,289	410	651	361	535	544	0	0	0	61,988	15,595
2022	4.23%	33,093	9,084	12,438	1,086	9,647	1,626	3,493	161	2,455	351	949	2,287	439	670	367	531	547	0	0	0	63,429	15,796
2023	3.92%	33,482	9,102	12,656	1,069	9,775	1,614	3,547	158	2,477	351	970	2,264	468	689	370	523	545	0	0	0	64,291	15,770
2024	3.65%	33,874	9,128	12,861	1,052	9,888	1,604	3,603	156	2,500	352	992	2,243	502	708	373	515	543	0	0	0	65,137	15,757
2025	3.42%	34,025	8,984	12,931	1,026	9,913	1,579	3,620	152	2,504	349	1,009	2,201	535	727	373	502	537	0	0	0	65,447	15,519
2026	3.31%	34,406	9,018	13,144	1,011	10,054	1,571	3,015	696	2,530	350	1,030	2,182	576	746	377	495	536	0	0	0	65,669	16,069
2027	3.19%	34,796	9,061	13,358	997	10,188	1,564	3,002	767	2,556	351	1,052	2,165	625	765	380	488	536	0	0	0	66,494	16,156
2028	3.22%	35,218	9,120	13,610	983	10,345	1,558	2,990	840	2,583	352	1,076	2,150	682	784	384	481	536	0	0	0	67,424	16,269
2029	3.18%	35,659	9,191	13,870	970	10,509	1,552	2,980	917	2,609	353	1,100	2,135	747	803	387	475	537	0	0	0	68,398	16,396
2030	3.17%	35,889	9,098	14,034	947	10,586	1,531	2,946	988	2,618	352	1,119	2,100	816	822	388	463	532	0	0	0	68,928	16,301
2031	3.13%	36,479	9,268	14,374	939	10,818	1,534	2,988	1,033	2,657	355	1,147	2,097	892	841	393	459	535	0	0	0	70,284	16,525
2032	3.18%	37,104	9,457	14,749	932	11,087	1,537	3,033	1,081	2,699	358	1,176	2,096	977	860	399	456	539	0	0	0	71,764	16,775
2033	3.17%	37,760	9,661	15,133	925	11,374	1,541	3,081	1,130	2,744	361	1,206	2,096	1,072	879	405	452	543	0	0	0	73,319	17,046
2034	3.11%	38,440	9,878	15,528	918	11,651	1,546	3,130	1,182	2,791	365	1,237	2,097	1,171	898	411	449	548	0	0	0	74,907	17,334
2035	2.99%	38,867	9,912	15,797	901	11,820	1,534	3,154	1,226	2,818	365	1,262	2,076	1,275	917	414	441	547	0	0	0	75,954	17,372
2036	2.92%	39,626	10,194	16,244	899	12,132	1,546	3,217	1,279	2,877	370	1,296	2,087	1,396	936	422	440	554	0	0	0	77,763	17,751
2037	2.79%	40,350	10,462	16,685	897	12,436	1,557	3,281	1,334	2,937	374	1,329	2,098	1,521	955	431	439	561	0	0	0	79,530	18,116
2038	2.71%	41,078	10,731	17,131	895	12,743	1,568	3,342	1,390	2,999	379	1,360	2,107	1,628	974	439	438	568	0	0	0	81,288	18,483
2039	2.64%	41,804	11,001	17,580	894	13,050	1,579	3,404	1,448	3,062	384	1,393	2,118	1,744	993	448	437	575	0	0	0	83,061	18,854
2040	2.57%	42,534	11,273	17,590	1,329	13,354	1,591	3,465	1,507	3,128	389	1,425	2,129	1,858	1,012	457	436	582	0	15	0	84,408	19,665
2041	2.51%	43,267	11,546	16,604	2,756	11,461	4,137	3,484	1,610	3,195	394	1,458	2,140	1,967	1,031	466	435	587	0	30	0	82,518	24,048
2042	2.46%	44,000	11,820	15,399	4,410	11,033	4,889	3,500	1,716	3,265	399	1,491	2,151	2,072	1,050	476	435	592	0	45	0	81,871	26,870
2043	2.40%	44,732	12,096	14,123	6,141	10,536	5,713	3,514	1,826	3,334	404	1,524	2,163	2,169	1,069	485	434	597	0	119	0	81,131	29,845
2044	2.37%	45,481	12,380	12,771	7,948	9,971	6,611	3,523	1,939	3,405	409	1,557	2,174	2,272	1,088	494	433	602	0	237	0	80,313	32,983
2045	2.33%	46,240	12,669	11,341	9,831	9,336	7,584	3,531	2,056	3,478	414	1,589	2,187	2,372	1,107	503	433	607	0	297	0	79,294	36,280
2046	2.26%	46,931	12,913	11,584	9,999	9,463	7,779	3,544	2,161	3,545	418	1,619	2,193	2,461	1,126	512	431	611	0	474	0	80,743	37,021
2047	2.19%	47,583	13,142	11,836	10,175	9,598	7,983	3,555	2,270	3,613	423	1,650	2,200	2,544	1,145	521	429	616	0	593	0	82,108	37,768
2048	2.15%	48,233	13,370	12,089	10,352	9,735	8,190	3,561	2,380	3,684	427	1,681	2,208	2,628	1,164	530	428	620	0	770	0	83,531	38,519
2049	2.13%	48,823	13,578	12,384	10,561	9,893	8,424	3,566	2,493	3,756	432	1,713	2,215	2,712	1,183	539	426	624	0	948	0	84,958	39,312
2050	2.13%	49,353	13,764	12,735	10,811	10,072	8,682	3,566	2,608	3,829	436	1,745	2,224	2,796	1,202	549	425	629	0	1,125	0	86,400	40,152
2051	2.11%	49,683	13,868	13,172	11,126	10,302	9,011	3,571	2,711	3,902	441	1,777	2,232	2,880	1,221	559	424	634	0	1,303	0	87,782	41,034
2052	2.05%	49,946	13,951	13,656	11,476	10,548	9,357	3,564	2,809	3,974	445	1,810	2,242	2,967	1,240	569	422	639	0	1,480	0	89,151	41,942
2053	2.02%	50,171	14,018	14,156	11,838	10,801	9,712	3,549	2,904	4,047	450	1,843	2,251	3,057	1,259	579	421	643	0	1,716	0	90,562	42,853
2054	2.00%	50,359	14,072	14,699	12,233	11,064	10,080	3,519	2,989	4,122	455	1,878	2,261	3,151	1,278	589	420	648	0	1,952	0	91,983	43,787
2055	1.99%	50,408	14,073	15,285	12,660	11,368	10,500	3,482	3,069	4,200	459	1,912	2,271	3,244	1,297	600	419	654	0	2,248	0	93,401	44,748
2056	1.95%	50,394	14,049	15,894	13,104	11,683	10,937	3,477	3,111	4,279	464	1,948	2,282	3,340	1,316	611	417	659	0	2,602	0	94,887	45,680
2057	1.91%	50,377	14,022	16,502	13,547	11,993	11,367	3,389	3,223	4,359	468	1,984	2,293	3,440	1,335	622	416	664	0	2,956	0	96,286	46,671
2058	1.88%	50,360	13,995	17,114	13,993	12,310	11,807	3,388	3,222	4,442	473	2,021	2,304	3,538	1,354	633	415	669	0	3,310	0	97,784	47,562
2059	1.87%	50,342	13,968	17,721	14,436	12,636	12,258	3,387	3,221	4,526	478	2,058	2,315	3,638	1,373	645	414	675	0	3,723	0	99,350	48,462
2060	1.86%	50,327	13,943	18,338	14,886	12,970	12,720	3,386	3,220	4,612	482	2,087	2,323	3,739	1,392	657	412	680	0	4,135	0	100,931	49,378
2061	1.87%	50,316	13,920	18,983	15,357	13,294	13,167	3,386	3,219	4,696	487	2,112	2,329	3,843	1,411	669	411	686	0	4,606	0	102,590	50,302
2062	1.84%	50,304	13,898	19,616	15,819	13,624	13,622	3,385	3,219	4,782	492	2,135	2,335	3,946	1,430	681	410	691	0	5,137	0	104,301	51,224
2063	1.79%	50,290	13,873	20,247	16,281	13,943	14,064	3,384	3,218	4,870	496	2,159	2,341	4,052	1,449	694	409	697	0	5,608	0	105,944	52,130
2064	1.74%	50,275	13,848	20,871	16,736	14,251	14,491	3,383	3,217	4,954	501	2,183	2,346	4,156	1,468	707	408	703	0	6,137	0	107,620	53,015
2065	1.68%	50,258	13,821	21,491	17,188	14,557	14,916	3,382	3,216	5,035	505	2,203	2,350	4,263	1,487	720	406	708	0	6,608	0	109,224	53,890
2066	1.50%	50,244	13,797	22,026	17,577	14,839	15,308	3,381	3,215	5,115	510	2,223	2,354	4,357	1,506	733	405	714	0	7,078	0	110,710	54,673
2067	1.61%	50,230	13,772	22,673	18,051	15,116	15,694	3,381	3,215	5,189	515	2,243	2,358	4,454	1,525	747	404	720	0	7,607	0	112,359	55,533
2068	1.59%	50,216	13,748	23,329	18,530	15,340	16,009	3,380	3,214	5,259	519	2,264	2,363	4,554	1,544	761	403	726	0	8,194	0	114,022	56,330
2069	1.57%	50,203	13,724	24,003	19,023	15,538	16,290	3,379	3,213	5,324	524	2,284	2,367	4,656	1,563	775	402	732	0	8,899	0	115,793	57,106
2070	1.56%	50,192	13,702	24,697	19,531	15,696	16,517	3,378	3,213	5,391	528	2,305	2,372	4,760	1,582	789	400	738	0	9,628	0	**117,574**	**57,845**

[1]It is not anticipated that the district will provide secondary irrigation water to communities that are not currently serviced by the district. It is assumed that these communities will fully utilize their own respective secondary irrigation supplies.

Table 2-23
Projected Peak Day Potable and Secondary Irrigation Water Supply Requirement, No Additional Conservation Scenario (million gallons per day)

		St. George City		*Washington City*		*Hurricane City*		*Ivins City*		*Santa Clara City*		*La Verkin City*		*Toquerville City*		*Town of Virgin*		*Other Retail Systems Serviced by District*		*Communities not Currently Serviced by the District*			
Year	ERC Growth Rate	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Total Potable	Total Secondary
2020		56.60	15.27	20.78	1.97	16.23	2.95	5.86	0.29	4.22	0.62	1.60	4.10	0.66	1.14	0.63	0.96	0.97	0	0	0	107.6	27.3
2021	4.49%	58.50	16.02	21.80	1.97	16.97	2.95	6.13	0.29	4.35	0.63	1.66	4.13	0.74	1.17	0.65	0.96	0.98	0	0	0	111.8	28.1
2022	4.23%	60.39	16.76	22.80	1.97	17.67	2.95	6.40	0.29	4.48	0.64	1.72	4.16	0.83	1.21	0.67	0.96	1.00	0	0	0	116.0	28.9
2023	3.92%	62.18	17.46	23.75	1.97	18.34	2.98	6.65	0.29	4.60	0.66	1.78	4.19	0.93	1.24	0.69	0.96	1.01	0	0	0	119.9	29.8
2024	3.65%	63.93	18.14	24.65	1.97	18.95	3.02	6.90	0.29	4.73	0.67	1.84	4.22	1.04	1.28	0.71	0.96	1.03	0	0	0	123.8	30.6
2025	3.42%	65.63	18.81	25.50	1.97	19.57	3.05	7.13	0.29	4.85	0.68	1.90	4.25	1.16	1.31	0.73	0.96	1.04	0	0	0	127.5	31.3
2026	3.31%	67.28	19.45	26.38	1.97	20.22	3.09	6.04	1.69	4.98	0.70	1.96	4.28	1.28	1.35	0.75	0.96	1.06	0	0	0	130.0	33.5
2027	3.19%	68.92	20.09	27.25	1.97	20.83	3.12	6.11	1.86	5.10	0.71	2.01	4.31	1.43	1.38	0.77	0.96	1.07	0	0	0	133.5	34.4
2028	3.22%	70.60	20.75	28.19	1.97	21.49	3.16	6.18	2.03	5.22	0.73	2.07	4.34	1.59	1.41	0.79	0.96	1.09	0	0	0	137.2	35.4
2029	3.18%	72.31	21.42	29.14	1.97	22.16	3.19	6.25	2.22	5.34	0.74	2.13	4.37	1.77	1.45	0.81	0.96	1.11	0	0	0	141.0	36.3
2030	3.17%	74.06	22.10	30.13	1.97	22.84	3.23	6.32	2.41	5.47	0.75	2.20	4.41	1.97	1.48	0.83	0.96	1.12	0	0	0	144.9	37.3
2031	3.13%	75.85	22.80	31.14	1.97	23.56	3.26	6.46	2.53	5.59	0.77	2.26	4.44	2.17	1.52	0.84	0.96	1.14	0	0	0	149.0	38.3
2032	3.18%	77.68	23.52	32.20	1.97	24.34	3.29	6.61	2.65	5.72	0.78	2.32	4.47	2.39	1.55	0.86	0.96	1.16	0	0	0	153.3	39.2
2033	3.17%	79.57	24.26	33.28	1.97	25.16	3.33	6.76	2.78	5.86	0.79	2.39	4.51	2.63	1.59	0.88	0.96	1.17	0	0	0	157.7	40.2
2034	3.11%	81.49	25.01	34.37	1.97	25.94	3.36	6.92	2.91	6.00	0.81	2.46	4.54	2.89	1.62	0.90	0.96	1.19	0	0	0	162.2	41.2
2035	2.99%	83.38	25.75	35.45	1.97	26.71	3.40	7.07	3.04	6.14	0.82	2.53	4.58	3.16	1.65	0.92	0.96	1.21	0	0	0	166.6	42.2
2036	2.92%	85.26	26.49	36.55	1.97	27.48	3.43	7.23	3.17	6.28	0.83	2.59	4.62	3.46	1.69	0.94	0.96	1.23	0	0	0	171.0	43.2
2037	2.79%	87.07	27.19	37.65	1.97	28.24	3.47	7.39	3.30	6.43	0.85	2.66	4.65	3.77	1.72	0.97	0.96	1.25	0	0	0	175.4	44.1
2038	2.71%	88.89	27.90	38.75	1.97	29.01	3.50	7.55	3.43	6.58	0.86	2.73	4.68	4.04	1.76	0.99	0.96	1.26	0	0	0	179.8	45.1
2039	2.64%	90.69	28.61	39.85	1.97	29.77	3.53	7.71	3.57	6.74	0.87	2.79	4.72	4.32	1.79	1.01	0.96	1.28	0	0	0	184.2	46.0
2040	2.57%	92.50	29.32	39.98	2.94	30.52	3.57	7.86	3.71	6.90	0.89	2.86	4.75	4.60	1.83	1.03	0.96	1.30	0	0.04	0	187.6	48.0
2041	2.51%	94.31	30.03	37.68	6.33	26.23	8.65	7.92	3.95	7.07	0.90	2.93	4.79	4.88	1.86	1.05	0.96	1.32	0	0.07	0	183.5	57.5
2042	2.46%	96.12	30.74	34.86	10.26	25.15	10.52	7.97	4.20	7.24	0.91	2.99	4.82	5.14	1.89	1.08	0.96	1.33	0	0.11	0	182.0	64.3
2043	2.40%	97.93	31.44	31.84	14.38	23.90	12.58	8.02	4.46	7.41	0.93	3.06	4.86	5.38	1.93	1.10	0.96	1.34	0	0.28	0	180.3	71.5
2044	2.37%	99.75	32.15	28.63	18.71	22.47	14.82	8.05	4.72	7.58	0.94	3.13	4.89	5.64	1.96	1.12	0.96	1.35	0	0.56	0	178.3	79.2
2045	2.33%	101.59	32.88	25.21	23.23	20.86	17.24	8.08	5.00	7.76	0.95	3.19	4.93	5.89	2.00	1.15	0.96	1.37	0	0.70	0	175.8	87.2
2046	2.26%	103.41	33.58	25.79	23.71	21.20	17.74	8.13	5.25	7.93	0.97	3.26	4.96	6.11	2.03	1.17	0.96	1.38	0	1.12	0	179.5	89.2
2047	2.19%	105.12	34.26	26.40	24.21	21.55	18.27	8.17	5.51	8.11	0.98	3.32	5.00	6.33	2.06	1.19	0.96	1.40	0	1.40	0	183.0	91.3
2048	2.15%	106.83	34.92	27.01	24.71	21.90	18.80	8.21	5.78	8.29	0.99	3.39	5.03	6.54	2.10	1.22	0.96	1.41	0	1.82	0	186.6	93.3
2049	2.13%	108.39	35.53	27.72	25.28	22.30	19.39	8.24	6.05	8.47	1.01	3.45	5.07	6.75	2.13	1.24	0.96	1.42	0	2.24	0	190.2	95.4
2050	2.13%	109.78	36.08	28.55	25.96	22.74	20.05	8.25	6.33	8.65	1.02	3.52	5.10	6.97	2.17	1.26	0.96	1.44	0	2.66	0	193.8	97.7
2051	2.11%	110.73	36.45	29.57	26.80	23.29	20.89	8.28	6.58	8.84	1.03	3.59	5.14	7.18	2.20	1.29	0.96	1.45	0	3.08	0	197.3	100.1
2052	2.05%	111.49	36.75	30.70	27.72	23.88	21.76	8.28	6.82	9.02	1.05	3.66	5.17	7.41	2.24	1.32	0.96	1.47	0	3.50	0	200.7	102.5
2053	2.02%	112.16	37.01	31.87	28.68	24.48	22.66	8.26	7.05	9.21	1.06	3.73	5.21	7.63	2.27	1.34	0.96	1.48	0	4.06	0	204.2	104.9
2054	2.00%	112.75	37.24	33.13	29.71	25.10	23.59	8.20	7.26	9.40	1.07	3.80	5.25	7.87	2.30	1.37	0.96	1.50	0	4.62	0	207.7	107.4
2055	1.99%	112.99	37.33	34.49	30.83	25.81	24.65	8.12	7.45	9.59	1.09	3.87	5.29	8.11	2.34	1.40	0.96	1.51	0	5.32	0	211.2	109.9
2056	1.95%	113.09	37.37	35.90	31.98	26.54	25.76	8.12	7.56	9.79	1.10	3.95	5.32	8.35	2.37	1.42	0.96	1.53	0	6.16	0	214.9	112.4
2057	1.91%	113.19	37.41	37.32	33.14	27.27	26.84	7.93	7.83	9.99	1.12	4.02	5.36	8.60	2.41	1.45	0.96	1.54	0	7.00	0	218.3	115.1
2058	1.88%	113.28	37.45	38.74	34.30	28.01	27.96	7.94	7.84	10.20	1.13	4.10	5.40	8.85	2.44	1.48	0.96	1.56	0	7.84	0	222.0	117.5
2059	1.87%	113.38	37.49	40.15	35.46	28.77	29.10	7.94	7.85	10.41	1.14	4.18	5.44	9.11	2.48	1.51	0.96	1.57	0	8.83	0	225.9	119.9
2060	1.86%	113.48	37.52	41.59	36.63	29.55	30.27	7.95	7.86	10.63	1.16	4.24	5.48	9.36	2.51	1.54	0.96	1.59	0	9.81	0	229.7	122.4
2061	1.87%	113.58	37.56	43.09	37.86	30.30	31.40	7.96	7.86	10.83	1.17	4.29	5.50	9.63	2.54	1.57	0.96	1.60	0	10.93	0	233.8	124.9
2062	1.84%	113.68	37.60	44.56	39.06	31.07	32.55	7.97	7.87	11.05	1.18	4.34	5.53	9.89	2.58	1.60	0.96	1.62	0	12.19	0	238.0	127.3
2063	1.79%	113.77	37.64	46.03	40.27	31.82	33.67	7.98	7.88	11.27	1.20	4.39	5.56	10.15	2.61	1.64	0.96	1.64	0	13.31	0	242.0	129.8
2064	1.74%	113.87	37.68	47.48	41.46	32.54	34.76	7.98	7.89	11.48	1.21	4.44	5.58	10.42	2.65	1.67	0.96	1.65	0	14.57	0	246.1	132.2
2065	1.68%	113.97	37.72	48.93	42.64	33.26	35.84	7.99	7.89	11.68	1.22	4.48	5.60	10.69	2.68	1.70	0.96	1.67	0	15.69	0	250.1	134.6
2066	1.50%	114.07	37.76	50.18	43.66	33.93	36.83	8.00	7.90	11.89	1.24	4.52	5.63	10.93	2.72	1.73	0.96	1.69	0	16.81	0	253.8	136.7
2067	1.61%	114.17	37.79	51.69	44.90	34.58	37.82	8.01	7.91	12.07	1.25	4.57	5.65	11.18	2.75	1.77	0.96	1.70	0	18.07	0	257.8	139.0
2068	1.59%	114.27	37.83	53.22	46.15	35.12	38.62	8.02	7.92	12.25	1.26	4.61	5.67	11.43	2.78	1.80	0.96	1.72	0	19.47	0	261.9	141.2
2069	1.57%	114.37	37.87	54.79	47.44	35.60	39.34	8.02	7.92	12.42	1.28	4.66	5.70	11.69	2.82	1.84	0.96	1.74	0	21.15	0	266.3	143.3
2070	1.56%	114.47	37.91	56.41	48.76	35.99	39.93	8.03	7.93	12.59	1.29	4.70	5.72	11.95	2.85	1.88	0.96	1.75	0	22.89	0	270.7	145.4

Table 2-24
Projected Peak Day Potable and Secondary Irrigation Water Supply Requirement, Target Conservation Scenario (million gallons per day)

		St. George City		*Washington City*		*Hurricane City*		*Ivins City*		*Santa Clara City*		*La Verkin City*		*Toquerville City*		*Town of Virgin*		*Other Retail Systems Serviced by District*		*Communities not Currently Serviced by the District*			
Year	ERC Growth Rate	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Potable	Secondary	Total Potable	Total Secondary
2020		56.60	15.27	20.78	1.97	16.23	2.95	5.86	0.29	4.22	0.62	1.60	4.10	0.66	1.14	0.63	0.96	0.97	0	0	0	107.6	27.3
2021	4.49%	58.50	16.02	21.80	1.97	16.97	2.95	6.13	0.29	4.35	0.63	1.66	4.13	0.74	1.17	0.65	0.96	0.98	0	0	0	111.8	28.1
2022	4.23%	59.68	16.38	22.43	1.96	17.40	2.93	6.30	0.29	4.43	0.63	1.71	4.12	0.79	1.21	0.66	0.96	0.99	0	0	0	114.4	28.5
2023	3.92%	60.38	16.42	22.82	1.93	17.63	2.91	6.40	0.29	4.47	0.63	1.75	4.08	0.84	1.24	0.67	0.94	0.98	0	0	0	115.9	28.4
2024	3.65%	61.09	16.46	23.19	1.90	17.83	2.89	6.50	0.28	4.51	0.63	1.79	4.04	0.91	1.28	0.67	0.93	0.98	0	0	0	117.5	28.4
2025	3.42%	61.36	16.20	23.32	1.85	17.88	2.85	6.53	0.28	4.52	0.63	1.82	3.97	0.96	1.31	0.67	0.90	0.97	0	0	0	118.0	28.0
2026	3.31%	62.05	16.26	23.71	1.82	18.13	2.83	5.44	1.25	4.56	0.63	1.86	3.94	1.04	1.35	0.68	0.89	0.97	0	0	0	118.4	29.0
2027	3.19%	62.75	16.34	24.09	1.80	18.37	2.82	5.41	1.38	4.61	0.63	1.90	3.90	1.13	1.38	0.69	0.88	0.97	0	0	0	119.9	29.1
2028	3.22%	63.51	16.45	24.54	1.77	18.66	2.81	5.39	1.52	4.66	0.63	1.94	3.88	1.23	1.41	0.69	0.87	0.97	0	0	0	121.6	29.3
2029	3.18%	64.31	16.57	25.01	1.75	18.95	2.80	5.37	1.65	4.71	0.64	1.98	3.85	1.35	1.45	0.70	0.86	0.97	0	0	0	123.4	29.6
2030	3.17%	64.72	16.41	25.31	1.71	19.09	2.76	5.31	1.78	4.72	0.63	2.02	3.79	1.47	1.48	0.70	0.84	0.96	0	0	0	124.3	29.4
2031	3.13%	65.79	16.71	25.92	1.69	19.51	2.77	5.39	1.86	4.79	0.64	2.07	3.78	1.61	1.52	0.71	0.83	0.97	0	0	0	126.8	29.8
2032	3.18%	66.91	17.05	26.60	1.68	19.99	2.77	5.47	1.95	4.87	0.65	2.12	3.78	1.76	1.55	0.72	0.82	0.97	0	0	0	129.4	30.3
2033	3.17%	68.10	17.42	27.29	1.67	20.51	2.78	5.56	2.04	4.95	0.65	2.18	3.78	1.93	1.59	0.73	0.82	0.98	0	0	0	132.2	30.8
2034	3.11%	69.32	17.81	28.00	1.66	21.01	2.79	5.64	2.13	5.03	0.66	2.23	3.78	2.11	1.62	0.74	0.81	0.99	0	0	0	135.1	31.3
2035	2.99%	70.09	17.88	28.49	1.63	21.32	2.77	5.69	2.21	5.08	0.66	2.28	3.74	2.30	1.65	0.75	0.80	0.99	0	0	0	137.0	31.3
2036	2.92%	71.46	18.38	29.29	1.62	21.88	2.79	5.80	2.31	5.19	0.67	2.34	3.76	2.52	1.69	0.76	0.79	1.00	0	0	0	140.2	32.0
2037	2.79%	72.77	18.87	30.09	1.62	22.43	2.81	5.92	2.41	5.30	0.68	2.40	3.78	2.74	1.72	0.78	0.79	1.01	0	0	0	143.4	32.7
2038	2.71%	74.08	19.35	30.90	1.61	22.98	2.83	6.03	2.51	5.41	0.68	2.45	3.80	2.94	1.76	0.79	0.79	1.02	0	0	0	146.6	33.3
2039	2.64%	75.39	19.84	31.71	1.61	23.54	2.85	6.14	2.61	5.52	0.69	2.51	3.82	3.15	1.79	0.81	0.79	1.04	0	0	0	149.8	34.0
2040	2.57%	76.71	20.33	31.72	2.40	24.08	2.87	6.25	2.72	5.64	0.70	2.57	3.84	3.35	1.83	0.82	0.79	1.05	0	0.03	0	152.2	35.5
2041	2.51%	78.03	20.82	29.94	4.97	20.67	7.46	6.28	2.90	5.76	0.71	2.63	3.86	3.55	1.86	0.84	0.79	1.06	0	0.05	0	148.8	43.4
2042	2.46%	79.35	21.32	27.77	7.95	19.90	8.82	6.31	3.09	5.89	0.72	2.69	3.88	3.74	1.89	0.86	0.78	1.07	0	0.08	0	147.7	48.5
2043	2.40%	80.67	21.81	25.47	11.07	19.00	10.30	6.34	3.29	6.01	0.73	2.75	3.90	3.91	1.93	0.87	0.78	1.08	0	0.21	0	146.3	53.8
2044	2.37%	82.02	22.33	23.03	14.33	17.98	11.92	6.35	3.50	6.14	0.74	2.81	3.92	4.10	1.96	0.89	0.78	1.09	0	0.43	0	144.8	59.5
2045	2.33%	83.39	22.85	20.45	17.73	16.84	13.68	6.37	3.71	6.27	0.75	2.87	3.94	4.28	2.00	0.91	0.78	1.09	0	0.53	0	143.0	65.4
2046	2.26%	84.64	23.29	20.89	18.03	17.07	14.03	6.39	3.90	6.39	0.75	2.92	3.96	4.44	2.03	0.92	0.78	1.10	0	0.86	0	145.6	66.8
2047	2.19%	85.81	23.70	21.35	18.35	17.31	14.40	6.41	4.09	6.52	0.76	2.98	3.97	4.59	2.06	0.94	0.77	1.11	0	1.07	0	148.1	68.1
2048	2.15%	86.98	24.11	21.80	18.67	17.56	14.77	6.42	4.29	6.64	0.77	3.03	3.98	4.74	2.10	0.96	0.77	1.12	0	1.39	0	150.6	69.5
2049	2.13%	88.05	24.49	22.33	19.05	17.84	15.19	6.43	4.50	6.77	0.78	3.09	4.00	4.89	2.13	0.97	0.77	1.13	0	1.71	0	153.2	70.9
2050	2.13%	89.01	24.82	22.97	19.50	18.16	15.66	6.43	4.70	6.91	0.79	3.15	4.01	5.04	2.17	0.99	0.77	1.13	0	2.03	0	155.8	72.4
2051	2.11%	89.60	25.01	23.75	20.06	18.58	16.25	6.44	4.89	7.04	0.79	3.21	4.03	5.19	2.20	1.01	0.76	1.14	0	2.35	0	158.3	74.0
2052	2.05%	90.07	25.16	24.63	20.70	19.02	16.87	6.43	5.07	7.17	0.80	3.26	4.04	5.35	2.24	1.03	0.76	1.15	0	2.67	0	160.8	75.6
2053	2.02%	90.48	25.28	25.53	21.35	19.48	17.52	6.40	5.24	7.30	0.81	3.32	4.06	5.51	2.27	1.04	0.76	1.16	0	3.10	0	163.3	77.3
2054	2.00%	90.82	25.38	26.51	22.06	19.95	18.18	6.35	5.39	7.43	0.82	3.39	4.08	5.68	2.30	1.06	0.76	1.17	0	3.52	0	165.9	79.0
2055	1.99%	90.91	25.38	27.57	22.83	20.50	18.94	6.28	5.53	7.57	0.83	3.45	4.10	5.85	2.34	1.08	0.75	1.18	0	4.05	0	168.4	80.7
2056	1.95%	90.88	25.34	28.66	23.63	21.07	19.72	6.27	5.61	7.72	0.84	3.51	4.12	6.02	2.37	1.10	0.75	1.19	0	4.69	0	171.1	82.4
2057	1.91%	90.85	25.29	29.76	24.43	21.63	20.50	6.11	5.81	7.86	0.84	3.58	4.13	6.20	2.41	1.12	0.75	1.20	0	5.33	0	173.6	84.2
2058	1.88%	90.82	25.24	30.86	25.24	22.20	21.29	6.11	5.81	8.01	0.85	3.64	4.15	6.38	2.44	1.14	0.75	1.21	0	5.97	0	176.3	85.8
2059	1.87%	90.79	25.19	31.96	26.03	22.79	22.11	6.11	5.81	8.16	0.86	3.71	4.18	6.56	2.48	1.16	0.75	1.22	0	6.71	0	179.2	87.4
2060	1.86%	90.76	25.14	33.07	26.85	23.39	22.94	6.11	5.81	8.32	0.87	3.76	4.19	6.74	2.51	1.18	0.74	1.23	0	7.46	0	182.0	89.1
2061	1.87%	90.74	25.10	34.23	27.70	23.97	23.75	6.11	5.81	8.47	0.88	3.81	4.20	6.93	2.54	1.21	0.74	1.24	0	8.31	0	185.0	90.7
2062	1.84%	90.72	25.06	35.38	28.53	24.57	24.57	6.10	5.80	8.62	0.89	3.85	4.21	7.12	2.58	1.23	0.74	1.25	0	9.26	0	188.1	92.4
2063	1.79%	90.70	25.02	36.52	29.36	25.15	25.36	6.10	5.80	8.78	0.89	3.89	4.22	7.31	2.61	1.25	0.74	1.26	0	10.11	0	191.1	94.0
2064	1.74%	90.67	24.97	37.64	30.18	25.70	26.13	6.10	5.80	8.93	0.90	3.94	4.23	7.49	2.65	1.27	0.74	1.27	0	11.07	0	194.1	95.6
2065	1.68%	90.64	24.93	38.76	31.00	26.25	26.90	6.10	5.80	9.08	0.91	3.97	4.24	7.69	2.68	1.30	0.73	1.28	0	11.92	0	197.0	97.2
2066	1.50%	90.61	24.88	39.72	31.70	26.76	27.61	6.10	5.80	9.22	0.92	4.01	4.25	7.86	2.72	1.32	0.73	1.29	0	12.76	0	199.7	98.6
2067	1.61%	90.59	24.84	40.89	32.55	27.26	28.30	6.10	5.80	9.36	0.93	4.05	4.25	8.03	2.75	1.35	0.73	1.30	0	13.72	0	202.7	100.2
2068	1.59%	90.56	24.79	42.07	33.42	27.66	28.87	6.10	5.80	9.48	0.94	4.08	4.26	8.21	2.78	1.37	0.73	1.31	0	14.78	0	205.6	101.6
2069	1.57%	90.54	24.75	43.29	34.31	28.02	29.38	6.09	5.79	9.60	0.94	4.12	4.27	8.40	2.82	1.40	0.72	1.32	0	16.05	0	208.8	103.0
2070	1.56%	90.52	24.71	44.54	35.22	28.31	29.79	6.09	5.79	9.72	0.95	4.16	4.28	8.59	2.85	1.42	0.72	1.33	0	17.36	0	212.0	104.3

CHAPTER 3
INVENTORY OF EXISTING FACILITIES

INTRODUCTION

The district's water system is composed of multiple facilities that work together to produce, treat, store, and deliver water to wholesale and retail customers throughout the county. The purpose of this chapter is to provide a summary of the district's existing facilities. Specifically, information regarding the district's water sources, treatment, storage facilities, and conveyance network will be discussed.

DISTRICT SERVICE AREA

The district service area encompasses the entirety of Washington County, Utah. Washington County is located in the southwest corner of the State of Utah, with Iron County to the north, Kane County to the east, the state of Arizona to the south, and the state of Nevada to the west. The district service area is shown in Figure 3-1. The district currently provides water to approximately 92% of Washington County's population. By the year 2070, it is anticipated that the district will service nearly 98% of the county population.

EXISTING WCWCD SYSTEM INFRASTRUCTURE

The various facilities comprising the district's existing water system are listed and described in the following sections. The district primarily provides potable water to its wholesale and retail customers but also delivers raw (untreated) water to irrigation companies, municipal secondary irrigation systems, and other users. Figure 3-2 provides an overall schematic of the district water system.

STORAGE RESERVOIRS

Storage reservoirs play a critical role in the district's water system and are used to supply water for both potable and secondary irrigation purposes. All district reservoirs store water from a single water source – the Virgin River basin. The existing reservoirs managed by the district are summarized in Table 3-1 and described below.

Sand Hollow Reservoir

Sand Hollow Reservoir is the largest reservoir operated by the district with a total surface storage capacity of 51,360 acre-feet. This off-stream reservoir is supplied water from the Virgin River via the Quail Creek Diversion and Quail Creek Pipeline. The reservoir is located above a natural Navajo sandstone aquifer and was designed to allow water to infiltrate from the reservoir into the underlying formation, which has an estimated storage capacity of up to 300,000 acre-feet. It is estimated that, on average, approximately 7,800 acre-feet of water seeps from the reservoir into the aquifer each year. The aquifer acts as an additional storage mechanism from which water is extracted by pumping of district wells located in proximity to the reservoir.

FIGURE 3-1

SENSITIVE INFORMATION HAS BEEN REDACTED FOR SECURITY PURPOSES

FIGURE 3-2

SENSITIVE INFORMATION HAS BEEN REDACTED

FOR SECURITY PURPOSES

Quail Creek Reservoir

Quail Creek Reservoir is a 40,325 acre-foot, off-stream reservoir that receives water from the Virgin River via the Quail Creek Diversion and Quail Creek Pipeline. The reservoir is interconnected with Sand Hollow Reservoir, operating in tandem to store water for the county. Water stored in Quail Creek and Sand Hollow reservoirs feed into the Quail Creek Water Treatment Plant (QCWTP), where it is treated to potable water standards.

Kolob Reservoir

Kolob Reservoir is located north of Zion National Park on Kolob Mountain. The 5,600 acre-foot reservoir is fed by Kolob and Crystal creeks. Kolob Reservoir operates in conjunction with the Quail Creek Diversion; water released from Kolob Reservoir flows into the north fork of the Virgin River. This water eventually reaches the Quail Creek Diversion where it can be diverted and stored in Sand Hollow and Quail Creek reservoirs.

Gunlock Reservoir

Gunlock Reservoir is on the Santa Clara River near the town of Gunlock. The reservoir provides storage for irrigation companies, canal companies, municipal secondary irrigation systems, and other water right owners, including the Shivwits Band of Paiutes. The reservoir is not used to meet potable water demands. The total storage volume of Gunlock Reservoir is estimated to be 10,884 acre-feet.

Ivins Reservoir

Ivins Reservoir is a small irrigation reservoir on the west end of Ivins City. The reservoir is off-stream and is fed by excess water in Gunlock Reservoir and with reuse water from the City of St. George Water Reclamation Facility (SGWRF). The reservoir has a storage volume of 778 acre-feet.

Meadow Hollow Reservoir

Meadow Hollow Reservoir is a small, 500 acre-foot reservoir in the Cedar Mountain area north of Kolob Reservoir. Releases from Meadow Hollow Reservoir flow into La Verkin Creek and can be diverted and pumped into the Quail Creek Pipeline via the La Verkin secondary system or allowed to continue downstream to the confluence of the Virgin River, offsetting water diverted at the Quail Diversion and satisfying water rights at the Washington Fields Diversion. However, reservoir yield and seepage rates limit the availability of water to release, and the distance released flows must travel in a typically low flow creek provide limited times when releases can be utilized in a way that significantly adds to the district's overall water supply portfolio.

Ash Creek Reservoir

Ash Creek Reservoir was created during the construction of Interstate 15 in the New Harmony area. The 3,175 acre-foot reservoir is prone to high leakage into the surrounding fractured formations and is not currently utilized as an integral part of the district's water system or as a contributor to its overall water supply. The district is beginning construction of the Ash Creek Pipeline that will convey water from Ash Creek Reservoir to a new storage reservoir in Toquerville to provide a secondary irrigation supply for the east side of the service area.

Table 3-1
Summary of Existing Storage Reservoirs

Reservoir	Storage Volume (ac-ft)	Function
Sand Hollow	51,360	Potable & Secondary Irrigation
Quail Creek	40,325	Potable & Secondary Irrigation
Kolob	5,600	Potable & Secondary Irrigation
Gunlock	10,884	Secondary Irrigation
Ivins	778	Secondary Irrigation
Meadow Hollow[1]	500	Limited functionality
Ash Creek[1]	3,175	Limited functionality
Total	**108,947**	

[1]Storage in Ash Creek Reservoir and Meadow Hollow Reservoir not included in overall total.

SURFACE WATER SUPPLIES

Surface water makes up a significant portion of the district's overall water supply. Water is diverted from local rivers and creeks in the Virgin River watershed to meet potable and secondary irrigation needs. The following is a description of the various surface water supplies held and managed by the district.

Quail Creek Diversion

The primary source of water in Washington County is the Virgin River. The district operates a large diversion structure on the river south of the town of Virgin. This robust structure has adjustable gates that can either divert water from the river or allow the total flow of the river to pass through. Water diverted off the river passes through a mechanical screen that removes large debris before entering a 66-inch steel pipeline capable of conveying approximately 250 cubic feet per second (cfs). The pipeline runs along the river to the west and continues to Quail Creek and Sand Hollow reservoirs.

Water is diverted from this location on the river to avoid water quality degradation downstream caused by the La Verkin Hot Springs, also known as Pah Tempe Hot Springs. Downstream of the diversion, this series of natural hot springs produce water high in sulfur and other dissolved minerals. These minerals increase the total dissolved solids (TDS) of the river, making water downstream of this point much harder and more expensive to use and treat.

Crystal Creek Diversion

The Crystal Creek Diversion is about 8 miles north of Kolob Reservoir. Flow is diverted from the creek into the 13-mile Crystal Creek Pipeline, a 30- and 36-inch pipeline which conveys water from the diversion to Kolob Reservoir.

Ash Creek Diversion

The Ash Creek Diversion is in Toquerville City near Toquerville Springs. This small diversion redirects flow from Ash Creek to an irrigation pond that is part of the TSWS.

Wet Sandy/South Ash/Leap Creek Diversions

Wet Sandy, South Ash, and Leap Creek are drainages from the west side of the Pine Valley Mountains used for irrigation purposes in the community of Pintura and nearby Anderson Junction.

La Verkin Creek Diversion

The diversion structure on La Verkin Creek can divert and pump up to 900 gallons per minute (gpm) into the Quail Creek Pipeline. Operation of this diversion is limited by water availability and high sediment loading from the creek during high flows.

Washington Fields Diversion

The Washington Fields Diversion is located on the Virgin River near Washington Dam Road. The diversion supplies water to irrigation and canal companies in the Washington Fields and St. George area.

GROUNDWATER SUPPLIES

Sand Hollow Well Field/West Dam Springs

Water stored in the Sand Hollow aquifer can be recovered from West Dam Springs and the Sand Hollow Well Field. The existing facilities that produce groundwater around the reservoir are shown in Figure 3-3. The pumping capacity of each well and the approximate production capacity of West Dam Springs is shown in Table 3-2.

FIGURE 3-3

SENSITIVE INFORMATION HAS BEEN REDACTED FOR SECURITY PURPOSES

Table 3-2
Sand Hollow Groundwater System Sustainable Production Capacity

Sand Hollow Well Field Production Facility	Current Sustainable Production Capacity (gpm)	Estimated Future Sustainable Production Capacity (gpm)	Well Status	Current Effective Production Capacity (gpm)
SH Well 1	750	750	active	750
SH Well 2	400	400	inactive	0
SH Well 4	310	310	active	310
SH Well 5	210	210	active	210
SH Well 6	230	230	active	230
SH Well 7	0	400[1]	future	0
SH Well 8	450	450	active	450
SH Well 9[2]	800	800	inactive	0
SH Well 10	535	535	active	535
SH Well 11	375	375	active	375
SH Well 12	305	305	active	305
SH Well 13	475	475	active	475
SH Well 15	0	400[1]	future	0
SH Well 17	200	200	inactive	0
SH Well 18	800	800	active	800
SH Well 19	630	630	active	630
SH Well 20	800	800	inactive	0
SH Well 21	1,000	1,000	inactive	0
SH Well 22	420	420	inactive	0
SH Well 23	680	680	active	680
West Dam Springs[2]	1,600	1,600	inactive	1,600
Total	**10,970[3]**	**11,770[3]**		**7,350**

[1] Estimated production capacity of future well.
[2] West Dam Springs and Well No. 9 are currently inactive due to water quality issues. The district is working on a solution to bring these sources back into service. West Dam Springs is expected to be brought back into service in the near future, so its capacity is included in the current total production capacity.
[3] Values represent the summation of the individual source production capacities. While the extent to which the wells are hydraulically connected is not fully understood, the district is likely unable to operate all of the Sand Hollow production facilities simultaneously. This master plan assumes that the maximum potential sustained production rate from the springs and wells is 10,000 gpm.

As summarized in the table, currently active wells only produce about 73% (7,350 gpm) of the potential cumulative sustained production rate of the well field (10,000 gpm). Completing planned future wells will bring the effective capacity to 8,150 gpm. To utilize the remaining 1,850 gpm of potential capacity, the district will need to reactivate currently inactive wells. The wells/spring that are currently inactive either require a pump replacement or have an issue with water quality. The district is actively working to bring these inactive supplies back into service.

Cottam Wells

The Cottam Wells are located just south of Anderson Junction on the west side of I-15. The two wells produce water primarily for communities on the east side of the service area, including Hurricane, Toquerville, La Verkin, and the town of Virgin. The sustainable pumping capacity for the Cottam Wells is shown in Table 3-3.

Table 3-3
Sustainable Production Capacity of Cottam Well System

Source	Sustainable Production Capacity (gpm)
Cottam Well 1	815
Cottam Well 2	365
Total	**1,180**

Ence Wells

The Ence Wells are located along the Santa Clara River near Ivins City. The wells were previously used as the primary potable water source for the KWU system but are now used as a backup supply. Though the water produced from the wells meets drinking water standards, it has elevated sulfate levels. Given these qualities, the wells may ultimately be used for secondary irrigation. The sustainable production capacity of the Ence Wells is shown in Table 3-4.

Table 3-4
Sustainable Production Capacity of Ence Well System

Source	Sustainable Production Capacity (gpm)
Ence Well 1	400
Ence Well 2	60
Total	**460**

Toquerville Springs

Toquerville Springs is a natural spring that produces an average flow of approximately 4,000 gpm located in Toquerville City adjacent to Ash Creek. The spring produces high quality water that is used in the Hurricane, La Verkin, and Toquerville potable water systems and TSWS. A future district project (Ash Creek Pipeline/Toquer Reservoir) is planned to bring additional secondary irrigation water into the Toquerville area to preserve the spring for potable uses.

Santa Clara Supplemental Irrigation Wells

The four irrigation wells in Santa Clara City are utilized to provide supplemental flow to irrigators on the Gunlock system when natural stream flows into Gunlock Reservoir are low. Table 3-5 provides the pumping capacity for each of these wells.

Table 3-5
Sustainable Production Capacity of Santa Clara Supplemental Wells

Source	Sustainable Production Capacity (gpm)
Gubler Well	150
Gates Well	170
Chapel Street Well	250
Old Farm Well	480
Total	**1,050**

Kolob Well, Whispering Pines Well, and Woodland Springs

The Kolob Retail Water System is supplied water from two wells (Kolob Well 1 & Whispering Pines Well 1) and a small spring (Woodland Spring). This system is not connected to the facilities that serve the RWSA partners or other district retail customers. The production capacity of these water supplies is shown in Table 3-6.

Table 3-6
Sustainable Production Capacity Kolob Retail Water System Sources

Source	Sustainable Production Capacity (gpm)
Kolob Well 1	30
Whispering Pines Well 1	20
Woodland Springs	7
Total	**57**

WATER TREATMENT FACILITIES

Quail Creek Water Treatment Plant

The QCWTP is located next to Quail Creek Reservoir. The treatment plant uses a coagulation, clarification, filtration, and disinfection process to treat surface water to drinking water standards. The plant is currently capable of treating up to 60 million gallons per day (MGD).

Sand Hollow Groundwater Treatment Plant

The Sand Hollow Groundwater Treatment Plant (SHGTP), located near Sand Hollow Reservoir, removes contaminants in the water extracted from the Sand Hollow wells. The plant is currently capable of treating up to 3 MGD.

STORAGE FACILITIES

The district's existing finished water storage tanks are summarized in Table 3-7. The following sections provide a brief description of each storage facility.

Quail Creek Water Treatment Plant Finished Water Tanks

Water treated at the QCWTP is stored in 3 tanks on the treatment plant site. The site has a 10 million gallon (MG), 9 MG, and 5 MG tank, for a total combined storage capacity of 24 MG at the QCWTP.

Sand Hollow 1 MG Tank

The Sand Hollow 1 MG Tank is located on the north end of Sand Hollow Reservoir. The tank stores water from the Sand Hollow Wells/West Dam Springs and feeds into Hurricane City and the Regional Pipeline.

Sand Hollow 2 MG Tank

The Sand Hollow 2 MG Tank is located on the east side of the reservoir and stores water produced from the Sand Hollow Wells/West Dam Springs. The tank feeds into Hurricane City and the Sand Hollow Regional Pipeline.

Cottam Tank

The Cottam Tank is a 360,000-gallon steel tank located next to the Cottam Wells, storing groundwater produced from the wells.

Warner Valley Tank

The recently constructed Warner Valley Tank is located off Warner Valley Road to the east of the Southern Parkway. The 3 MG tank is connected to the Sand Hollow Regional Pipeline.

Sky Ranch/Cliff Dwellers Tanks

These two 130,000-gallon tanks provide service to the HVWS.

Kolob Storage Tank

The 0.5 MG Kolob Tank provides water storage exclusively for the Kolob Retail Water System. The tank sits near Kolob Reservoir and is fed by the local wells and spring.

Table 3-7
Summary of District Finished Water Storage Facilities

Water Storage Facility	Storage Volume (MG)
Quail Creek Water Treatment Plant Finished Water Tanks	24
Warner Valley Tank	3
Sand Hollow 2 MG Tank	2
Sand Hollow 1 MG Tank	1
Cottam Tank	0.36
Sky Ranch/Cliff Dwellers Tanks	0.26
Kolob Tank[1]	0.5
Total	**31.62**

[1] Kolob Tank services the Kolob Retail Water System and does not provide service to RWSA partners or other district retail customers.

HYDROPOWER GENERATION FACILITIES

The district operates two hydropower plants that were constructed with the Quail Creek Pipeline. The first, Hurricane Hydropower Plant, takes water from the Quail Creek Pipeline and discharges it back into the Virgin River near the La Verkin Hot Springs to satisfy water rights at the Washington Dam Diversion. The plant generates up to 600 kilowatts of power, which is sold to Hurricane City. The second facility, Quail Creek Hydropower Plant, is inline on the main Quail Creek Pipeline upstream of Quail Creek Reservoir. Power generated from the plant, up to 2.4 megawatts, is sold to Dixie Power.

MAJOR CONVEYANCE SYSTEM NETWORK

The district's existing pipeline network is shown in Figure 3-1. The major components of the system include:

Quail Creek Pipeline

Water is conveyed from the Quail Creek Diversion to Quail Creek and Sand Hollow reservoirs via an extensive network of over 23 miles of 48-inch, 60-inch, and 66-inch pipe.

Regional Pipeline

The Regional Pipeline delivers water treated at the QCWTP and water from the Sand Hollow Wells to customers through a 21-mile pipeline network that ranges in diameter from 24 to 72 inches. This pipeline allows the district to move water seamlessly between its RWSA partner customers from Washington to Ivins.

Sand Hollow Regional Pipeline (SHRP)

The Sand Hollow Regional Pipeline is a 12-mile, 36-inch line that delivers water from the Sand Hollow Well Field/West Dam Springs to the southern regions of St. George and Washington cities. Water delivered through the pipeline can also be routed to the Regional Pipeline for delivery to Ivins and Santa Clara.

Sand Hollow Wells to Regional Pipeline

This 18-inch line connects the 1 MG Sand Hollow Tank to the Regional Pipeline.

Cottam Wells to Virgin Pipeline

The Cottam Well Pipeline is a 9-mile, 12-inch line that provides water for Toquerville, La Verkin, and Hurricane and is the sole source of water for the town of Virgin.

Cottam Wells to Harrisburg Pipeline

Water produced from the Cottam Wells can also be sent through a 12, 14, and 24-inch pipeline that runs along I-15 through Leeds to Harrisburg.

Santa Clara Pipeline

The Santa Clara Pipeline is a 15-mile, raw water (untreated) pipeline from Gunlock Reservoir to the St. George City reuse water pipeline. The 24-inch and 30-inch pipeline provides water to irrigation companies, RWSA partners, and other users in Santa Clara, Ivins, and St. George. The pipeline is also used to fill/draw water from Ivins Reservoir. The district's supplemental irrigation wells supply water into this pipeline during low water years on the Santa Clara River.

CHAPTER 4
WATER SUPPLY EVALUATION

INTRODUCTION

Water supplies are the foundation of the district's water system. Maintaining and developing reliable water sources is critical for Washington County. The purpose of this chapter is to evaluate the reliable annual yield and peak production capacity of local water supplies. These annual yield and peak production values are compared against existing and projected future water demands within the district's service area. Based on this analysis, this chapter also provides recommendations for the development of new sources of water and water production facilities.

DISTRICT AND RWSA PARTNER WATER RIGHTS

BC&A reviewed the water rights held by the district and RWSA partners for this Master Plan. Appendix A contains a list of all known water rights held by the district, and Appendix B contains a technical memorandum developed collectively with the RWSA partners documenting their individually owned water rights. The UDWRi administers the appropriation and distribution of water resources in the state. Every water source that is operated by the district or a RWSA partner is associated with one or more water rights. Water rights represent the volume of water that the district or RWSA partners have legal claim to (often referred to as the "paper" water right). Each water right may be subject to limitations in diversions, depletion, and time of use. The amount of water that is available for use (often referred to as "wet water") may vary significantly from what is allowed under the water right. For this reason, it is important to consider historical source production as well as potential impacts of climate change to determine the reliable yield of water sources.

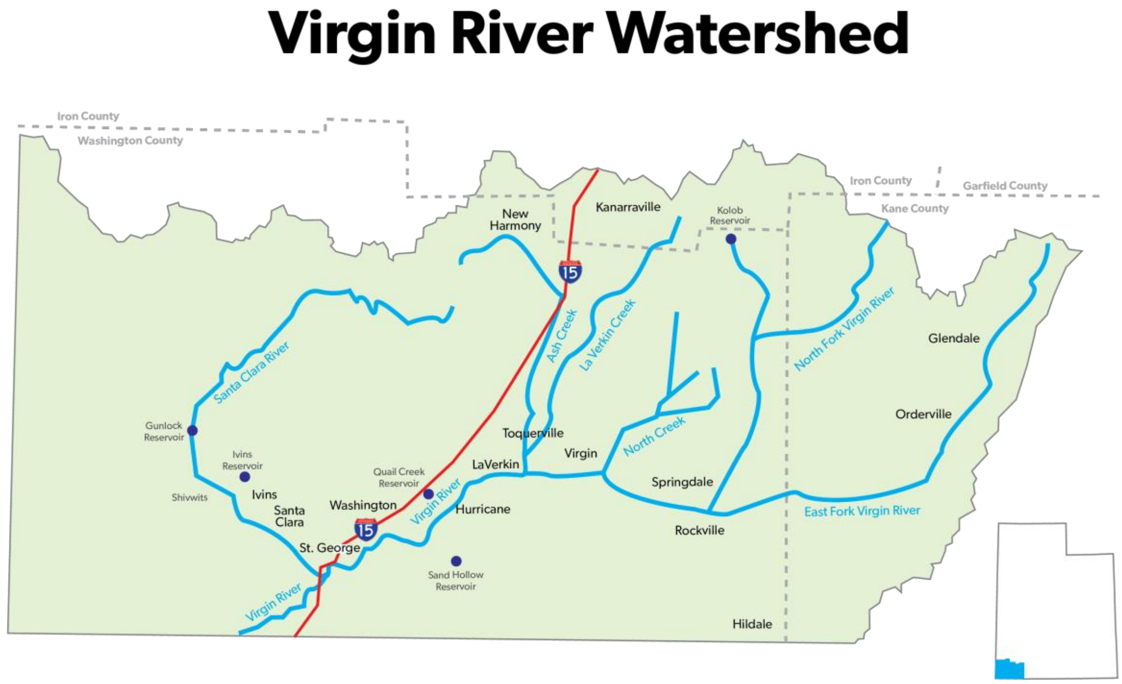
DETERMINING THE RELIABLE ANNUAL YIELD OF DISTRICT AND RWSA PARTNER SUPPLIES

Reliable annual supply, or reliable yield, refers to the volume of water that can be *reliably* produced from a source from year to year. UAC R309-510 requires that public water systems, like those serviced by the district, possess adequate water supply capacity to meet demands throughout the course of the year. This section covers the estimated reliable annual supply of the sources operated by the district and RWSA partners.

The reliable yields presented in this report were established after extensive evaluation of previously completed water supply analyses and through collaboration with the district and RWSA partners. The following sections describe how the reliable yield of district and RWSA partner owned water sources were determined for this master plan.

Evaluation Methodology for District Potable Surface Water Supplies

All water supplied by the district comes from the Virgin River watershed. The Virgin River is a desert river with highly variable annual, monthly, and daily flows. River flows are dictated by several different factors, such as precipitation, temperature, snowpack, and soil moisture. Figure 4-1 shown below displays the overall watershed of the Virgin River.



Source: Virgin River Program

Figure 4-1: Virgin River Watershed

To better understand the flow characteristics of the Virgin River and to evaluate the potential effects of future climate change on the overall flow and timing of flow in the river, the Bureau of Reclamation (Reclamation) performed a statistical analysis[1] using historical and projected flow data at the USGS stream gage at Littlefield, AZ (downstream of the confluence of the Virgin River and Beaver Dam Wash). The analysis evaluated the impact of 112 potential climate change scenarios (i.e., changes in temperature and precipitation) on flows in the Virgin River. This analysis produced a statistical range of projected changes in future flows in the Virgin River. Table 4-1 contains a summary of the results of this study. The values in the table were used to calculate percent changes of average historical flows in the Virgin River under future climate change scenarios. For example, if the 50th percentile flow changes are considered to be a single future climate change scenario, then future June streamflow would be 66% of historical June flows.

The projected climate change scenarios indicate that the average stream flow in the Virgin River may increase in the future (the mean river flow is estimated to be 104% of historical averages). However, this increase in average stream flow is accompanied by the following affects:

- **Change in Average Seasonal Flows**: As indicated by the mean values in Table 4-1, future climate change is expected to cause higher river flows in the late winter/early spring and lower flows the rest of the year. This is attributed to a reduction in snowpack as precipitation comes more in the form of rain than snow. This effectively increases the intensity of the spring runoff season but shortens the overall duration. From a water supply standpoint, this

[1] United States Bureau of Reclamation (Reclamation). 2014. *Virgin River Climate Change Analysis Statistical Analysis of Streamflow Projections.* Katrina Grantz. March 26.

introduces operational challenges. High flows in the Virgin River typically carry large quantities of debris (logs, branches, leaves, sediment loads, refuse, etc.). Excessive debris can block flow and damage diversion structures and pipelines. Under high flow conditions, the district may need to raise its diversion gates and allow flow to pass through. Although more water may be flowing in the river, it cannot realistically be captured and used.

- **Greater Disparity Between Wet and Dry Years**: Under the predicted climate change scenarios, wet years become wetter and dry years become drier. While extremely wet years will produce high river flows, the district will not be able to divert and utilize all the available water. Therefore, despite the predicted slight increase in the overall average river flow, the amount that the district can practically divert and utilize will almost certainly decrease.

Table 4-1
Projected Percentages of Future Virgin River Flows Relative to Historical Flows Based on Climate Change Scenarios

Month	10th Percentile	30th Percentile	50th Percentile	70th Percentile	90th Percentile	Mean
January	88%	98%	104%	117%	136%	110%
February	83%	98%	109%	139%	167%	123%
March	80%	103%	126%	161%	226%	141%
April	58%	79%	100%	124%	158%	107%
May	41%	59%	72%	91%	119%	77%
June	51%	59%	66%	75%	98%	70%
July	75%	83%	90%	95%	104%	90%
August	79%	86%	93%	98%	119%	95%
September	84%	92%	97%	105%	123%	100%
October	88%	93%	97%	104%	118%	101%
November	90%	94%	98%	102%	111%	100%
December	89%	94%	99%	104%	114%	101%
Annual Total	**72%**	**86%**	**97%**	**114%**	**141%**	**104%**

For the purposes of this master plan, three supply yield scenarios were considered:

1. **Baseline Reliable Yield:** Estimated reliable annual yield based on historical flows from the “base period” of 1950 – 1999.
2. **50^{th} Percentile Climate Change Reliable Yield:** Estimated reliable annual yield from a source under a 50^{th} percentile climate change scenario, based on the future period of 2025 – 2054.
3. **10^{th} Percentile Climate Change Reliable Yield**: Estimated reliable annual yield from a source under the 10^{th} percentile climate change scenario, based on the future period of 2025-2054.

Figure 4-2 shows a comparison of historical stream flow data at the Littlefield, AZ stream gage with the projected river flows under the 50^{th} and 10^{th} percentile climate change scenarios evaluated by Reclamation. As shown, flows within recent history (last 20 years) have been less than the predicted flow under the 50^{th} percentile yield scenario. Because recent historical stream flows in the Virgin

River are trending between the 50th and the 10th percentile climate change scenarios, district and RWSA partner water supplies will be quantified and evaluated under these two climate change conditions.

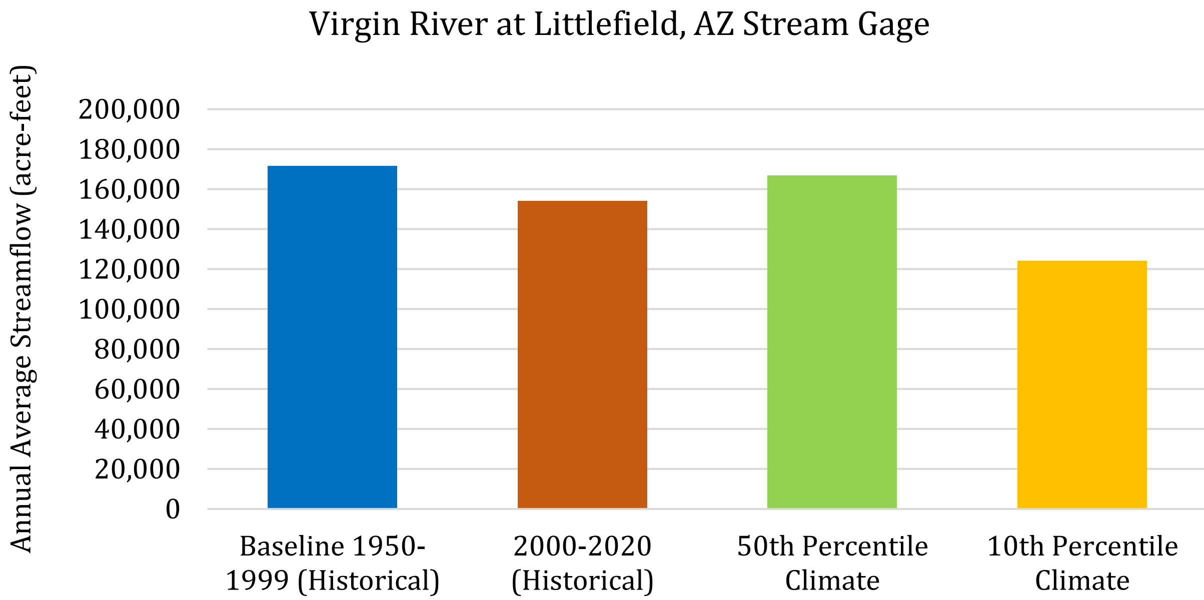


Figure 4-2: Historical Virgin River Flow at Littlefield, AZ Stream Gage

In 2014, the Utah Division of Water Resources (UDWRe) utilized the Virgin River Daily Simulation Model[2] (VRDSM) to evaluate the reliable yield of the Virgin River with respect to availability of water for M&I use in the greater St. George area. The model simulated the daily operation of the river from water years 1941 to 2013, accounting for the various diversions, reservoirs, and return flows on the river.

Based on historical flows, the VRDSM identified the estimated reliable yield of the river that allowed for up to a 10% shortage to occur in any given year (i.e., communities would need to be able to withstand a 10% water shortage). Wet years will result in higher yields, but the reliable yield is based on dry years. If the reliable yield were to be based on average years, then communities would need to be able to withstand shortages greater than 10%. Reclamation's climate change factors were then applied to the VDRSM to observe impacts to the reliable yield of the Quail Creek and Sand Hollow system (that is fed by the Quail Creek Diversion). The results of this VRDSM model simulation were also applied to other supplies directly tied to the availability of water at the Quail Creek Diversion.

Evaluation Methodology for District Potable Groundwater Supplies

Aquifers in Washington County have been studied for many years, and the general characteristics of local groundwater supplies are well understood. However, potential climate change impacts on availability, reliability, and sustainability of local groundwater sources have not been as well studied. From the information that is available, which includes work by the USGS[3,4], the Utah Geological

[2] Memorandum. "Virgin River Model including Climate change 50 percentile." October 2, 2014.
[3] Heilweil, V.M., et al. Geohydrology and Numerical Simulation of Ground-Water Flow in the Central Virgin River Basin of Iron and Washington Counties, Utah. U.S. Geological Survey (2000).
[4] Gardner, Philip M. & Heilweil, Victor M. Evaluation of the Effects of Precipitation on Ground-Water Levels from Wells in Selected Alluvial Aquifers in Utah and Arizona, 1936-2005. U.S. Geological Survey (2009).

Survey[5], and *Scientific Reports*[6], the general findings are that local aquifers are recharged by snowpack, rainfall, and flows from both perennial and ephemeral streams. Based on these findings, UDWRe[7] inferred that, under predicted future climate change conditions, overall recharge and availability of groundwater supplies will decrease. For planning purposes, the climate change reductions applied to surface water sources were also applied to the district's local groundwater supplies. The only exception is the groundwater recharge component of Sand Hollow Reservoir which is more directly tied to the yield of the Quail Creek/Sand Hollow system determined by the VRDSM.

Evaluation Methodology for RWSA Partner Potable Surface and Groundwater Supplies

The RWSA partners each maintain and operate their own potable water supplies and are required to utilize all their available sources under the Regional Water Supply Agreement. BC&A carried out an extensive evaluation of local water supplies to determine the RWSA partner reliable yield values to be used in this master plan and other district planning documents. BC&A worked with the RWSA partners to compile an inventory of their existing and planned water supplies. This process involved a thorough review of their existing water rights, an evaluation of historical yields, and numerous meetings with the individual RWSA partners. The RWSA partners provided feedback on the likelihood of their full water right portfolio being reliably available for use in the foreseeable future, or if reductions were pragmatic to arrive at a reliable yield. Ultimately, the goal of this effort was to establish a baseline reliable yield of the RWSA partner supplies based on their individual input. The complete results of this evaluation are documented in a technical memorandum found in Appendix B.

After determining the baseline reliable yields, 50^{th} and 10^{th} percentile climate change yield scenarios were applied to each of the RWSA partner supplies. If the baseline reliable yield established for a given source was deemed sufficiently conservative, no reductions were made from the baseline reliable yield to the 50^{th} percentile yield. For all other cases, the percent reductions identified by Reclamation's climate change scenarios were applied to the RWSA partner supplies to determine a respective 50^{th} and 10^{th} percentile yield estimate.

Some RWSA partners possess water rights for undeveloped water sources (see Appendix B). There is a high level of uncertainty regarding the availability, reliability, and quality of the water tied to these rights. The priority date of a water right establishes the order in which water is legally allowed to be diverted. Users with water rights that have early priority dates are more likely to continue receiving water when supplies are limited. Other water rights would be best utilized by changing the current point of diversion or type or time of use. Such changes may result in significant reductions of the right. Considering these factors, it has been conservatively assumed that these undeveloped water rights will not increase the overall reliable yield of the RWSA partner water supplies. If the RWSA partners are ultimately able to develop new, reliable sources of water, the district will account for these supplies in a future master plan update.

[5] Burden, Carole B and others. Groundwater Conditions in Utah, Spring of 2015. U.S. Geological Survey (2015).
[6] Tillman, F. D., Gangopadhyay, S. & Pruitt, T. Recent and projected precipitation and temperature changes in the Grand Canyon area with implications for groundwater resources. *Sci Rep* **10,** 19740 (2020).
[7] Khatri, Krishma B. & Strong, Courtenay. Climate Change, Water Resources, and Potential Adaptation Strategies in Utah. Division of Water Resources, Utah Department of Natural Resources. (Mar 2020).

POTABLE WATER SUPPLIES - AVERAGE ANNUAL RELIABLE YIELD

District Potable Water Supplies

Chapter 3 presented an overview of the district's existing water supply facilities. The estimated reliable annual yields of the district's potable water supplies are summarized in Table 4-2.

Table 4-2
Reliable Annual Yields from District Potable Water Supplies

	Source Yield Scenario		
District Potable Supply	**Baseline Reliable Yield (AF)**	**50th Percentile Yield (AF)**	**10th Percentile Yield (AF)**
Quail Creek/Sand Hollow	27,400	24,920	7,000
Crystal Creek	2,000	1,819	510.9
Sand Hollow Natural Recharge/Recharge and Recovery[1]	7,800	7,256	3,235
Toquerville Springs	1,640	1,590.8	1,180.8
Cottam Well Field	85	82.5	61.2
Total	**38,925**	**35,668.1**	**11,987.8**

[1]This amount includes both natural recharge and surface water recharge from Sand Hollow Reservoir which are anticipated to be impacted differently by climate change.

RWSA Partner Potable Water Supplies

Table 4-3 provides a summary of the estimated reliable annual yields for the potable water supplies held by the RWSA partners.

Table 4-3
Reliable Annual Yields from RWSA Partners' Potable Water Supplies

	Source Yield Scenario		
St. George City Potable Water Supply	**Baseline Reliable Annual Yield[1] (AF)**	**50th Percentile Annual Yield (AF)**	**10th Percentile Annual Yield (AF)**
Mountain Springs	1,230.0	1,230.0	885.6
City Creek Wells, Millcreek Wells, Ledges Wells, Tolman Wells	3,716.0	3,716.0	3,344.5
Gunlock Wells	9,811.0	9,811.0	8,830.0
Snow Canyon Wells	1,152.0	1,152.0	1,036.8
West City Springs	564.0	547.1	406.1
Subtotal	**16,473.0**	**16,456.1**	**14,503.0**
Washington City Potable Water Supplies[2]			
Well #2, Well #3, Well #4, Well #5, Well #6, Grapevine Well #1, Grapevine Well #2	2,666.0	2,585.6	1,919.2
Subtotal	**2,666.0**	**2,585.6**	**1,919.2**
Hurricane City Potable Water Supplies			
Stratton Well #1, Stratton Well #2, West Well	2,100.0[3]	2,100.0[3]	1,512.0
Toquerville Springs & Ash Creek Springs	1,420.4	1,378.0	1,023.0
Subtotal	**3,520.4**	**3,478.0**	**2,535.0**
Ivins City Potable Water Supplies			
Snow Canyon Wells (Snow Canyon Compact)	392.6	380.8	282.6
Gunlock Well Agreement with St. George	614	614	552.6
Subtotal	**1,006.6**	**994.8**	**835.2**
Santa Clara City Potable Water Supplies			
Snow Canyon Wells (Snow Canyon Compact)	1,071.5	1,039.3	771.5
Snow Canyon Wells (Well #6 and #7)	1,479.1	1,434.7	1,065.0
Sheep Spring, Miller Spring, Beecham Spring, Gray Springs	95.2	92.3	68.5
Subtotal	**2,645.8**	**2,566.3**	**1,905.0**
La Verkin City Potable Water Source			
Ash Creek Springs & Upper Ash Creek Springs	473.4	459.1	340.8
Toquerville Springs	241.1	233.8	173.6
Subtotal	**714.5**	**692.9**	**514.4**
Toquerville City Potable Water Supplies			
Toquerville Springs	538.8	522.6	387.9
Ash Creek	18.6	18	13.4
Subtotal	**557.4**	**540.6**	**401.3**
TOTAL	**27,583.7**	**27,314.3**	**22,613.1**

1Baseline reliable yields as determined by coordination with each RWSA partner.
[2] Washington City is planning to drill additional wells in the near future to maximize the reliable yield of their supplies. The new wells will potentially increase the city's baseline reliable yield up to 3,807.9 AFY.
[3] Groundwater availability in the Hurricane area has been the topic of study for over two decades, especially after the construction of Sand Hollow Reservoir. Studies have shown that the average natural recharge to the local aquifer (not including recharge from Sand Hollow Reservoir) is likely much less than the total water rights existing in the basin. The district is continuing to evaluate the reliable annual yield of groundwater in the Hurricane area. For this study, the reliable annual yield of Hurricane City's wells was assumed to be equal to the approximate, annual average amount of water that Hurricane has pumped from the West Well, Stratton Well #1, and Stratton Well #2 over the last 4 years.

SECONDARY WATER SUPPLIES - AVERAGE ANNUAL RELIABLE YIELD

Evaluation Methodology

Secondary irrigation water supplied in Washington County comes from surface water sources, such as the Virgin River, as well as local springs and wells. Water used for secondary irrigation is typically of lower quality with higher levels of TDS or other constituents that make it difficult to treat to drinking water standards. Like local potable water supplies, it is assumed that climate change will have an impact on local secondary irrigation supplies. This considered, the reliable yield of secondary irrigation supplies has been determined using Reclamation's climate change analysis for the Virgin River.

While potable water supplies are used year-round to meet both drinking water and irrigation needs, secondary irrigation sources are only used during the irrigation season. The irrigation season for Washington County has been assumed to run from March through November. For surface and spring water sources, it has been assumed that the climate change factors will only impact the irrigation season in which water is being diverted and used (i.e., reduced flow during off-season months will not increase or decrease the overall reliable yield of surface and spring sources used for secondary irrigation). For secondary irrigation wells, which draw from water stored in an aquifer, the 12-month average climate change reductions shown in Table 4-1 have been applied to future climate change scenarios (assuming that water not used in the winter months is not "lost" but is stored in the aquifer). Table 4-4 shows how the climate change scenarios developed by Reclamation have been applied to local surface and spring water sources used for secondary irrigation. As shown in the table, the assumed annual percent reduction is based on the 9-month irrigation season.

Table 4-4
Climate Change Scenarios Applied to Secondary Irrigation Supplies[1]

Month	10th Percentile	30th Percentile	50th Percentile	70th Percentile	90th Percentile	Mean
January	88%	98%	104%	117%	136%	110%
February	83%	98%	109%	139%	167%	123%
March	80%	103%	126%	161%	226%	141%
April	58%	79%	100%	124%	158%	107%
May	41%	59%	72%	91%	119%	77%
June	51%	59%	66%	75%	98%	70%
July	75%	83%	90%	95%	104%	90%
August	79%	86%	93%	98%	119%	95%
September	84%	92%	97%	105%	123%	100%
October	88%	93%	97%	104%	118%	101%
November	90%	94%	98%	102%	111%	100%
December	89%	94%	99%	104%	114%	101%
Annual Total from Irrigation Season	**72%**	**83%**	**93%**	**106%**	**131%**	**98%**

[1] If a given supply is used in both a potable and secondary irrigation system, the climate change reductions in reliable supply shown in Table 4-1 have been applied to the portion used as a potable water supply and the values shown in this table have been applied to the portion used as a secondary irrigation supply.

District Secondary Irrigation Supplies

Chapter 3 provides a summary of the district's existing secondary irrigation supplies. The estimated reliable yield of the supplies is summarized in Table 4-5.

Table 4-5
Reliable Annual Yield of District Secondary Irrigation Supplies

	Source Yield Scenario		
District Secondary Irrigation Supply	**Baseline Reliable Yield (AF)**	**50th Percentile Yield (AF)**	**10th Percentile Yield (AF)**
Ence Wells	370.0	359.0	266.0
Toquerville Springs[1]	678.0	632.0	487.0
Total	**1,048.0**	**991.0**	**753.0**

[1]Represents the value available for M&I secondary demand, excluding water used for agriculture or potable use.

RWSA Partner Secondary Irrigation Supplies

Most of the RWSA partners hold their own secondary irrigation water rights or canal company shares that consist of well, spring, and surface water sources. As with the potable water supplies, BC&A worked with each RWSA partner to determine the reliable yield of their existing secondary irrigation supplies. Table 4-6 contains a summary of these values. The same 50th percentile and 10th percentile yield assumptions applied to the district supplies have been applied to the RWSA partner water supplies. As done with potable water supplies, if a RWSA partner assumed a conservative reduction in reliable yield below the water right for a given source, no reduction was applied to the source from the baseline yield scenario to the 50th percentile yield scenario.

Table 4-6
Reliable Annual Yield of RWSA Partner Secondary Irrigation Supplies

	Source Yield Scenario		
St. George City Secondary Irrigation Supplies	**Reliable Annual Yield (ac-ft)**	**50th Percentile Yield (ac-ft)**	**10th Percentile Yield (ac-ft)**
Sunbrook Wells, Mathis Well, Moores Well, Sunset Well	2,873.3	2,873.3	2,586.0
West City Springs	550.0	512.7	394.8
East City Springs	480.0	447.5	344.5
SGWRF Reuse Facility[1]	4,400.0	4,400.0	4,400.0
St. George Clara Fields Canal Company	712.0	663.7	511.1
New Santa Clara Water Company	5.0	4.7	3.6
St. George Valley Irrigation Company	1,768.0	1,648.2	1,269.0
Bloomington Water Company	1,247.0	1,162.5	895.1
St. George Washington Fields Canal Company	1,932.0	1,801.1	1,386.7
Millcreek Water Company	670.0	624.6	480.9
Subtotal	**14,637.3**	**14,138.2**	**12,271.7**
Washington City Secondary Irrigation Supplies			
Mill Creek (Tanner Ditch)	306.5	285.8	220.0
Price/Pierce Springs	11.3	10.5	8.1
Prisbrey/Westover/Sproul Spring	206.2	192.2	148.0
Adair Spring, Warm Spring, Unnamed Spring	384.6	358.6	276.1
Green Spring, Calvin Hall Spring	126.5	118.0	90.8
Mascrew, Iron Bush, Cottonwood Spring	4.1	3.9	3.0
Green Stream	2.5	2.3	1.8
Sullivan Well	119.0	115.4	85.7
Well #1[2]	0.0	0.0	0.0
Subtotal	**1,160.8**	**1,086.6**	**833.5**
Hurricane City Secondary Irrigation Supplies			
Virgin River	193.4	180.3	138.8
Hurricane Canal Company	1,561.5	1,455.6	1,120.8
Subtotal	**1,754.8**	**1,635.9**	**1,259.6**
Ivins City Secondary Irrigation Supplies			
St. George Clara Irrigation Company	96.9	90.3	69.6
Ivins Irrigation Company	51.8	48.3	37.2
Santa Clara Irrigation Company	24.8	23.1	17.8
Subtotal	**173.5**	**161.7**	**124.5**
Santa Clara City Secondary Irrigation Supplies			
Rex Jackson Sunbrook Well	95.0	92.2	68.4
Crystal Lakes Sunbrook Well	120.0	116.4	86.4
Ralph Hafen Well	7.6	7.3	5.4
McDermitt Well	150.0	145.5	108.0
J. Ross Hurst Entrada Well	26.2	25.4	18.9
Irrigation Company Shares	53.1	49.5	38.1
Subtotal	**451.9**	**436.3**	**325.2**
La Verkin Secondary Irrigation Supplies			
Virgin River (via Quail Creek Pipeline Diversion)	2,630.2	2,451.9	1,887.9
Subtotal	**2,630.2**	**2,451.9**	**1,887.9**
TOTAL	**20,808.6**	**19,910.8**	**16,702.5**

[1] Availability of wastewater reuse water assumed to be unaffected by climate change scenarios.
[2] Washington City's Well #1 operates under a water right that has already been accounted for in its potable supply in Table 4-3.

PEAK PRODUCTION CAPACITY OF DISTRICT AND RWSA PARTNER SUPPLIES

Water sources must be capable of producing enough water to meet peak day demands, as discussed in Chapter 2. BC&A met with district personnel and the RWSA partners to organize an inventory of existing peak source production capacity. The following sections provide a summary of existing water production facilities and their assumed reliable peak production rates.

POTABLE WATER SUPPLIES - PEAK PRODUCTION CAPACITY

District Potable Water Production Facilities

Table 4-7 provides a summary of the estimated reliable peak production capacity from each district facility.

Table 4-7
District Existing Peak Potable Water Production Capacity

District Potable Water Production Facilities	Peak Production Capacity (gpm)
Quail Creek Water Treatment Plant	41,667
Sand Hollow Wells/West Dam Springs	7,350
Cottam Well Field	1,180
Toquerville Springs	0[1]
TOTAL	**49,347**

[1]The district's portion of Toquerville Springs used in potable water systems is available in the winter months/low irrigation period of the year. In most years, there is no production capacity available from Toquerville Springs for potable use during the summer when peak demands occur.

RWSA Partner Potable Water Production Facilities

The estimated reliable peak production capacity of the RWSA partner potable water supplies is summarized in Table 4-8.

Table 4-8
RWSA Partner Estimated Reliable Peak Potable Production Capacity

St. George City Potable Water Production Facilities	Reliable Peak Production Capacity (gpm)
Mountain Springs	2,000
City Creek Wells, Millcreek Wells, Ledges Wells, Tolman Wells	3,040
Gunlock Wells	6,620
Snow Canyon Wells	1,019
West City Springs	350
Subtotal	**13,029**
Washington City Potable Water Production Facilities	
Well #2, Well #3, Well #4, Well #5, Well #6, Grapevine Well #1, Grapevine Well #2	2,900
Subtotal	**2,900**
Hurricane City Potable Water Production Facilities	
Stratton Well #1, Stratton Well #2, West Well	2,790
Toquerville Springs & Ash Creek Springs	1,618
Subtotal	**4,398**
Ivins City Potable Water Production Facilities	
Snow Canyon Wells (Snow Canyon Compact)	244
Gunlock Well Agreement with St. George	380
Subtotal	**624**
Santa Clara City Potable Water Production Facilities	
Snow Canyon Wells (Snow Canyon Compact)	482
Snow Canyon Wells (Well #6 and #7)	1,500
Sheep Spring, Miller Spring, Beecham Spring, Gray Springs	59
Subtotal	**2,041**
La Verkin City Potable Water Production Facilities	
Ash Creek Springs & Upper Ash Creek Springs	803
Toquerville Springs	150
Subtotal	**953**
Toquerville City Potable Water Production Facilities	
Toquerville Springs	334
Ash Creek Springs	26
Subtotal	**360**
TOTAL	**24,305**

SECONDARY WATER SUPPLIES - PEAK PRODUCTION CAPACITY

District Secondary Irrigation Production Facilities

The estimated reliable peak production capacity of the district's existing secondary irrigation supplies is summarized in Table 4-9.

Table 4-9
District Estimated Reliable Peak Secondary Irrigation Production Capacity

District Secondary Irrigation Supply	Peak Production Capacity (gpm)
Ence Wells[1]	460
Toquerville Springs	1,907[2]
Total	**2,367**

[1] The sustainable pumping capacity of Ence Well 1 and Well 2 are 400 gpm and 60 gpm, respectively.
[2] Estimated peak production rate for district's stake in Toquerville Springs for secondary irrigation calculated by subtracting the allowable diversion rates from the RWSA partners deliveries from the total estimated production rate of the springs (4,000 gpm).

RWSA Partner Secondary Irrigation Production Facilities

The estimated reliable peak production capacity of the existing RWSA partner secondary irrigation supplies is summarized in Table 4-10.

Table 4-10
RWSA Partner Estimated Reliable Peak Secondary Irrigation Production Capacity

St. George City Secondary Irrigation Production Facility	Reliable Peak Production Capacity (gpm)
Sunbrook Wells, Mathis Well, Moores Well, Sunset Well	2,400
West City Springs	341
East City Springs	300
SGWRF Reuse Facility	4,800
St. George Clara Fields Canal Company	1,000
New Santa Clara Water Company	20
St. George Valley Irrigation Company	2,700
Bloomington Water Company	900
St. George Washington Fields Canal Company	2,700
Millcreek Water Company	1,000
Subtotal	**16,161**
Washington City Secondary Irrigation Production Facility	**Reliable Peak Production Capacity (gpm)**
Mill Creek (Tanner Ditch)	273
Price/Pierce Springs	0
Prisbrey/Westover/Sproul Spring	0
Adair Spring, Warm Spring, Unnamed Spring	265
Green Spring, Calvin Hall Spring	79
Mascrew, Iron Bush, Cottonwood Spring	0
Green Stream	4
Sullivan Well	224
Well #1	1,000
Subtotal	**1,845**
Hurricane City Secondary Irrigation Production Facility	**Reliable Peak Production Capacity (gpm)**
Virgin River	160
Hurricane Canal Company	1,310
Subtotal	**1,470**
Ivins City Secondary Irrigation Production Facility	**Reliable Peak Production Capacity (gpm)**
St. George Clara Irrigation Company	60
Ivins Irrigation Company	32
Santa Clara Irrigation Company	15
Subtotal	**107**
Santa Clara City Secondary Irrigation Production Facility	**Reliable Peak Production Capacity (gpm)**
Rex Jackson Sunbrook Well	59
Crystal Lakes Sunbrook Well	74
Ralph Hafen Well	5
McDermitt Well	93
J. Ross Hurst Entrada Well	16
Irrigation Company Shares	33
Subtotal	**280**
La Verkin City Secondary Irrigation Production Facility	**Reliable Peak Production Capacity (gpm)**
Virgin River (via Quail Creek Pipeline Diversion)	3,577
Subtotal	**3,577**
TOTAL	**23,440**

SUPPLY AND DEMAND FORECAST – POTABLE WATER, AVERAGE ANNUAL DEMAND

Chapter 2 establishes projections for average annual and peak day source capacity requirements for the district service area through the year 2070. Having documented all existing potable and secondary water supplies held by the district and RWSA partners, projected future demands can be compared against existing sources and proposed future source development projects. The district's source production and conveyance network is interconnected, providing versatility in where water can be moved. Planned projects will enhance the district's ability to effectively transport water where it is needed. Although not all the district's sources are directly connected to all RWSA end users, water can effectively be shifted/offset around the system through exchanges between supplies. This considered, the water supply and demand analysis presented in the section is for the service area as a whole, pooling together all of the district's supplies to meet overall water needs. However, in order to identify the most beneficial location of future supply, storage, and water conveyance projects, the system was also evaluated in more detail by dividing the service area into smaller regions. These regions are:

- **East Region**: Toquerville, La Verkin, Virgin
- **Central Region**: Hurricane City, HVWS, Casa De Oro/Homespun
- **West Region**: Washington, St. George, Ivins/Kayenta, Santa Clara

Because of the overall interconnectivity of the district water system, it is important to reiterate that any new supplies of water, wherever they are located, directly benefit the system as a whole.

As presented previously in this chapter, three different source yield scenarios have been considered in this study. The "baseline" yield, 50th percentile yield, and 10th percentile yield scenarios all represent possible supply yield scenarios. Of these three yield scenarios, historical source yields over the last 20 years have aligned most closely with the 50th percentile yield scenario, and for the purposes of this Master Plan, it has been assumed that local sources will reliably produce the 50th percentile yield into the future. However, climate change introduces a significant amount of uncertainty regarding the long-term sustainability of water supplies in Washington County. For comparison and informational purposes, an additional scenario has been included in this Master Plan that assumes a gradual decline in supply reliability over time as a result of climate change (50th percentile yield scenario gradually decreasing to the 10th percentile yield scenario by the year 2070).

Proposed Potable Water Supply Projects

Before comparing projected future water needs against future water availability, it is necessary to review the future water development projects that the district has identified within its previous water system planning efforts. The following are summary descriptions of each future water supply project identified by the district:

- **Ash Creek Pipeline/ Toquer Reservoir**: Ash Creek Reservoir is located near the town of New Harmony and was created when I-15 was constructed through Southern Utah. The reservoir, which collects runoff from North Ask Creek, is prone to leaks and is difficult to utilize effectively as a water supply in its current condition and as currently configured. The district is planning to construct a new pipeline from the outlet of Ash Creek Reservoir that will convey water to the new Toquer Reservoir (to be constructed on the north end of Toquerville City south of I-15 near Anderson Junction). The pipeline will also pick up additional water for drainages to the east of Pine Valley Mountain, including Leap Creek, Wet

Sandy Creek, and South Ash Creek. Based on the hydrologic analysis[8] performed for the project, the estimated baseline reliable yield from the system is **1,739 acre-feet per year (AFY)** (excluding the water that will be used for secondary irrigation in Pintura). The project is considered a potable water project because it will free up capacity in Toquerville Springs that is currently being used to supply water to TSWS. It is estimated that the project will be in operation in the year 2024.

- **Sullivan Well Field**: The district owns **1,448 acre-feet** of water rights located between Toquerville City and the town of Leeds. Three pilot wells were drilled in this location several years ago, but preliminary pump testing showed some interference in the groundwater level between the wells. Once the wells are equipped, the district will need to develop an operational plan to fully utilize the water from this source and limit well interference. The estimated baseline reliable yield from the Sullivan Well Field is equal to the water right (1448 AFY). It is estimated that the project will be in operation by the year 2026.
- **Cove Reservoir**: The Cove Reservoir is a proposed off-stream reservoir near Orderville. The reservoir will store water from the East Fork of the Virgin River. Releases will travel to the Quail Creek Diversion and will be timed to provide an increased supply. The reservoir will initially be used to firm up local agricultural yields but will eventually be used to augment the Quail Creek/Sand Hollow system for M&I use. Preliminary hydraulic analyses indicate that the reservoir will add a baseline reliable yield of **600 AFY** to the Quail Creek/Sand Hollow System. It is estimated that the project will be in operation by the year 2033.
- **Diamond Valley Well:** The Diamond Valley Well Project is a conceptual water development project for the west side of the county. While the location is not certain at this time, the district is planning to construct a new well in the Diamond Valley area to help meet future system demands on the west side of the county. The district's intent is to acquire water rights in the Diamond Valley area and to construct a well with a baseline reliable yield of **400 AFY**.
- **Lake Powell Pipeline**: The Lake Powell Pipeline Project involves the construction of approximately 140 miles of 69-inch pipe, five pump stations, six hydropower facilities, and other features to deliver water from the Colorado River to Washington County. The Utah State Legislature passed the Lake Powell Pipeline Development Act in 2006 which authorized the Utah Board of Water Resources to pursue the project to meet future water needs in Southern Utah. The project is currently in the planning and permitting phase. While the construction date of the project is not certain at this time, it is estimated that the pipeline will be in operation by the year 2035. The project will deliver up to **83,756 AFY** to Washington County.

As done with existing supplies, future water supplies have been evaluated using the same climate change factors to determine the 50th percentile and 10th percentile reliable yield. These reliable yield estimates for proposed future potable water supply projects are shown in Table 4-11.

[8] "Ash Creek Project Hydrology". Prepared by Alpha Engineering. April 23, 2019.

Table 4-11
Estimated Reliable Yield of Proposed Potable Water Development Projects

Project Name	Baseline Reliable Yield (AFY)	50th Percentile Yield (AFY)	10th Percentile Yield (AFY)
Ash Creek Pipeline/Toquer Reservoir	1,739	1,582	444
Sullivan Wells	1,448	1,405	1,043
Cove Reservoir	600	546	153
Diamond Valley Well	400	388	288
Lake Powell Pipeline[1]	Up to 83,756	Up to 83,756	Up to 83,756
Total	**Up to 87,943**	**Up to 87,677**	**Up to 85,684**

[1]Current planning documents for the Lake Powell Pipeline have identified a water need from the project of up to 83,756 AFY. Once the project is constructed, water deliveries are anticipated to increase gradually over time, up to the total amount of 83,756 AFY. No climate change reductions have been applied to the potential deliveries from the Lake Powell Pipeline.

The projected potable water supplies and service area source sizing requirements (average annual supply) are shown in Figure 4-3 (50th percentile yield scenario) and Figure 4-4 (50th percentile yield scenario declining to the 10th percentile yield scenario by the year 2070). Each figure provides two forecasted source sizing requirements. One line represents the projected source sizing requirement assuming that the current source sizing standard identified in Chapter 2 remains the same into the future (i.e., no reduction in water use per ERC from conservation or reduction of non-revenue water), while the other portrays the target conservation/non-revenue water reduction scenario for the service area that includes a new source sizing standard for new construction (see Chapter 2 for more information). It should be noted that the combined block of RWSA partner water supply is assumed to increase in the future as the effective service area of the district expands to include new communities and their local supplies become part of the collective pool. The following are key takeaways from these supply forecasts:

- Water conservation is vital to meeting the growing water needs of the community. As shown in Figure 4-3, achieving the district's water conservation goal significantly extends existing and future supplies' ability to meet demand. Without this conservation, the service area may exceed its reliable supplies in 2023. With this conservation, supplies should meet demand until 2028.
- Under all scenarios, the district is anticipated to run into a supply deficit where all available reliable supplies have been allocated to users in the system. At that point, the district will need to assess how this gap will be met. If the Lake Powell Pipeline project is progressing and will be operational within a reasonable time frame, the district may elect to utilize banked groundwater storage to bridge this gap, knowing that a sustainable, reliable supply is forthcoming and that the water taken from the aquifer storage can be replenished. The volume that will need to be withdrawn from the aquifer storage varies dramatically depending on future demand patterns and availability of other supplies, with the largest gap occurring under the "no-conservation" scenario in Figure 4-4 (50th percentile to 10th percentile yield scenario). It should be noted that the district will continue to evaluate its source sizing standards in the future, and if overall average water use continues to decline, the source sizing standard will be reduced accordingly. Such reductions in the source sizing standard may delay the forecasted gap in water supply.
- The Lake Powell Pipeline will deliver up to 83,756 AF of water per year into Washington County. The actual amount that will be needed by the year 2070 will depend heavily on the

long-term yield of existing supplies and the demand characteristics of the community. Assuming existing and future sources maintain a reliable yield consistent with the 50th percentile climate change scenario and that the community meets the long-term water conservation goals, only about 41,200 AFY will be needed from LPP by 2070. On the flip side, if demand patterns do not change as expected and supply yields are diminished in the future due to climate change, the full 83,756 AFY will not be sufficient to meet projected water needs in 50 years.

- Both projections show a distinct dip in potable water demand at the year 2040. As discussed in Chapter 2, many cities have required and are continuing to require new development to install secondary irrigation infrastructure. It has been assumed that by the year 2040, a large, regional, secondary irrigation storage facility will be online that will be able to supply secondary water into a significant portion of the community, effectively reducing demands on the potable water system. Secondary irrigation will play a critical role in meeting the growing demands of Washington County. If a regional secondary irrigation system is developed sooner, both existing and future potable water supplies can be extended further into the future. In such a case, the "dip" in potable demand would shift to an earlier point in time.

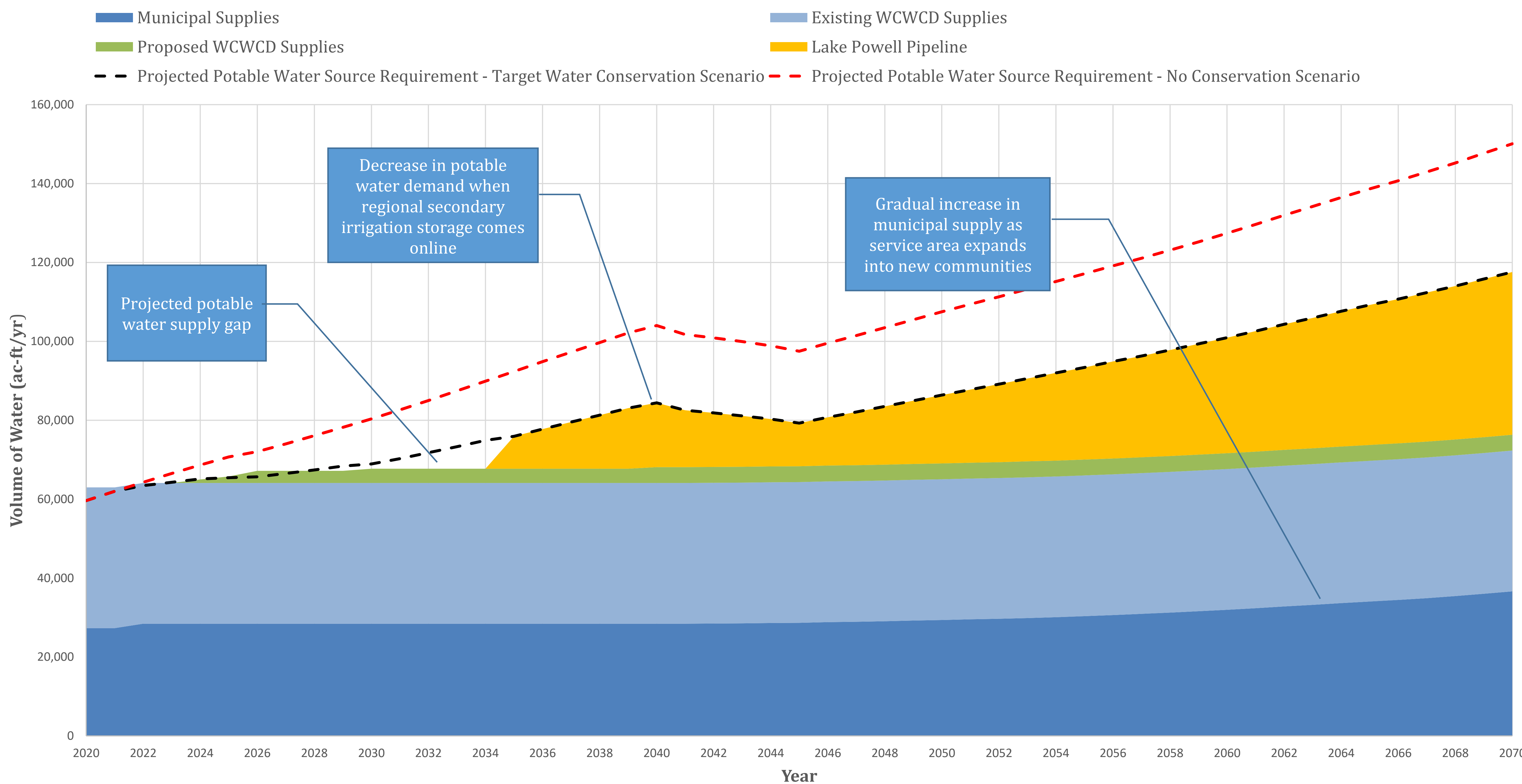


Figure 4-3 - Potable Water Supplies vs Projected Potable Water Source Sizing Requirement 50th Percentile Yield Scenario

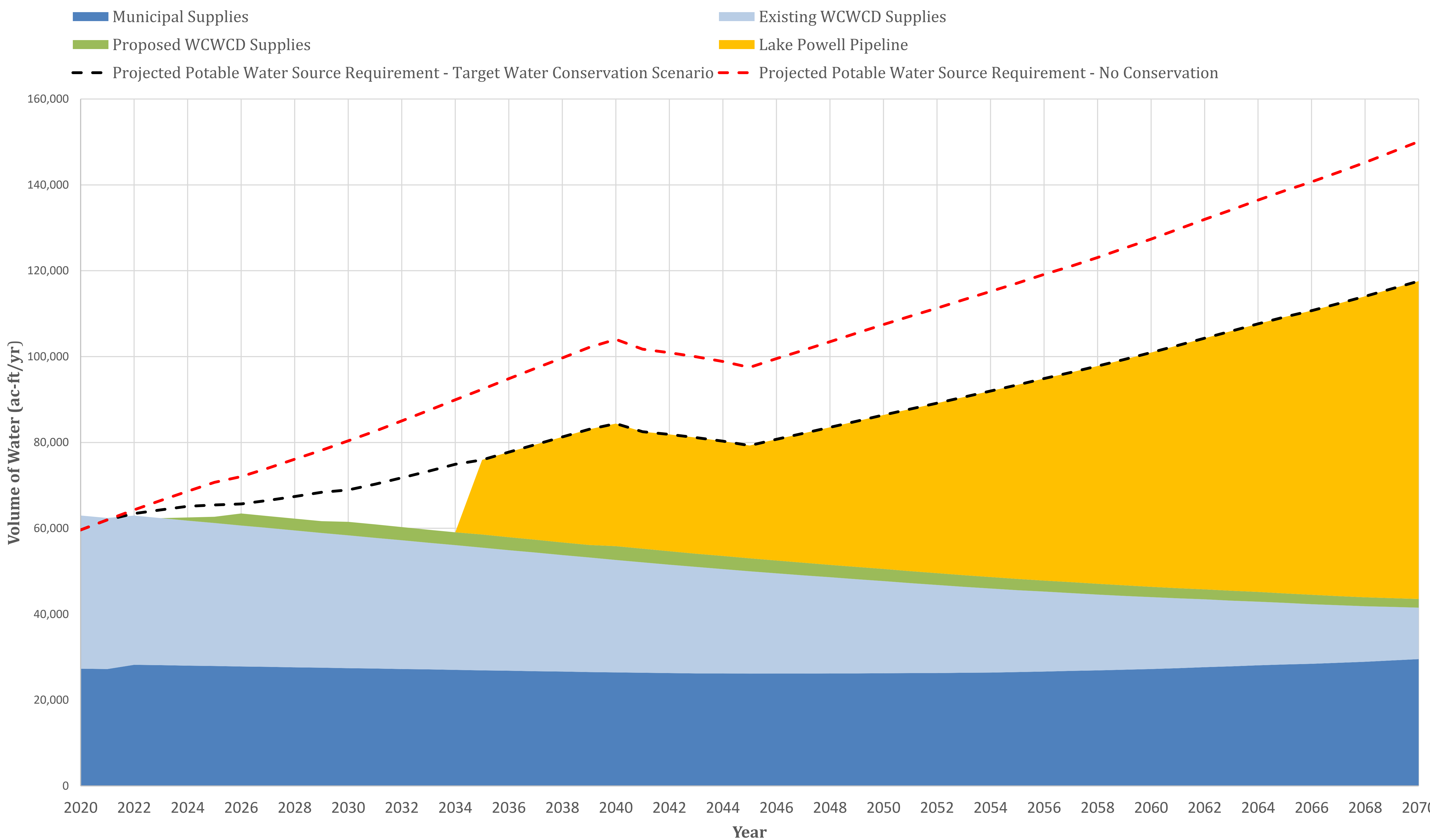


Figure 4-4 - Potable Water Supplies vs Projected Potable Water Source Sizing Requirement 50th Percentile to 10 Percentile Yield Scenario

SUPPLY AND DEMAND FORECAST – POTABLE WATER, PEAK DAY DEMAND

Figure 4-5 compares the projected peak day production requirement for the district service area with existing and proposed future water production facilities. As shown in the figure, there are a number of recommended improvement projects aimed at maintaining adequate peak water production facilities in the system. The following is a summary description of each recommended project.

- **Ash Creek Pipeline/Toquer Reservoir Project**: Since the Ash Creek Pipeline Project effectively replaces Toquervile Springs in the TSWS system, the peak production capacity of the project has been assumed to be equal to the district's production capacity from Toquerville Springs, which is estimated at 1,907 gpm.
- **Sand Hollow Well Field Expansion:** The maximum sustainable pumping rate from the aquifer around Sand Hollow Reservoir is estimated to be 10,000 gpm (including flow from the West Dam Springs). To increase the overall production capacity of the well field to meet growing demands as well as provide redundancy within the system, two additional wells will be drilled. The new wells have an estimated production capacity of 400 gpm each.
- **Sand Hollow Groundwater Treatment Plant Expansion:** The SHGTP has a current treatment capacity of 3 MGD. The facility was designed to be expanded to 6 MGD. At a sustained production rate of 10,000 gpm, the well field could produce over 14 MGD. Increasing the capacity of the treatment plant to 6 MGD will provide greater redundancy and versatility for the system, allowing the district to fully utilize the available wells, including those that may have higher concentrations of arsenic. The expansion will require an additional treatment vessel along with some additional piping and appurtenances.
- **Quail Creek WTP Expansion Project:** The increasing peak demands on the Regional Pipeline will require an upgrade to the QCWTP. The plant has a current treatment capacity of 60 MGD and is expandable up to 80 MGD. The expansion will include a new filters, an ozone treatment facility, and new settling ponds, adding 20 MGD of treatment capacity to the facility.
- **Cottam Well 3**: Cottam Well 3 is a proposed third well at the Cottam Well site. This proposed well will increase the production capacity from the well field and will provide system redundancy in the case that one of the other two wells needs to be taken offline for service, cleaning, etc. The estimated production capacity of Cottam Well 3 is 600 gpm.
- **Sullivan Well Field:** The Sullivan Well Field Project is expected to include up to three production wells, all of which have already been drilled but are not yet equipped. The water right allows for a diversion of up to 4 cubic feet per second (roughly 1,800 gpm). At that pumping rate, the full 1,448 AF water right would be fully used within a period of about 6 months. When the first two wells were originally drilled and pump tested, some interference was observed between the wells (pumping one of the wells would result in a drop in the static water level of the other well). Knowing that the aquifer may have a high transmissivity, it is recommended that the wells be operated at a lower pumping rate for a longer period of the year rather than a high pump rate for a shorter period of the year. The estimated reliable production rate for the Sullivan Well Field is 1,200 gpm.
- **Diamond Valley Well:** The Diamond Valley Well Project is a conceptual water development project for the west side of the county. The district is planning to acquire water rights and develop a new well in the Diamond Valley area. It has been assumed that this new well will produce 500 gpm of potable water.

- **Sand Hollow Surface Water Treatment**: Once constructed, Lake Powell Pipeline will deliver water from Lake Powell to Sand Hollow Reservoir. Currently, water from Sand Hollow Reservoir is piped to Quail Creek Reservoir to be treated to drinking water standards. With the QCWTP approaching its ultimate design capacity, it will become necessary in the future to construct an additional surface water treatment plant. Rather than continuing to convey all water to Quail Creek Reservoir for treatment, it will become advantageous to construct a new surface water treatment plant near Sand Hollow Reservoir. In addition to providing new water treatment capacity, constructing the plant near Sand Hollow Reservoir will eliminate the need for expensive conveyance system upgrades that may otherwise be needed to move Lake Powell water from Sand Hollow Reservoir to Quail Creek Reservoir. Like the QCWTP, the Sand Hollow Surface Water Treatment Plant will be built in phases, adding additional capacity as needed. Based on the projections in this Master Plan, up to 50 MGD (approximately 35,000 gpm) of treatment capacity will be needed by the year 2070.

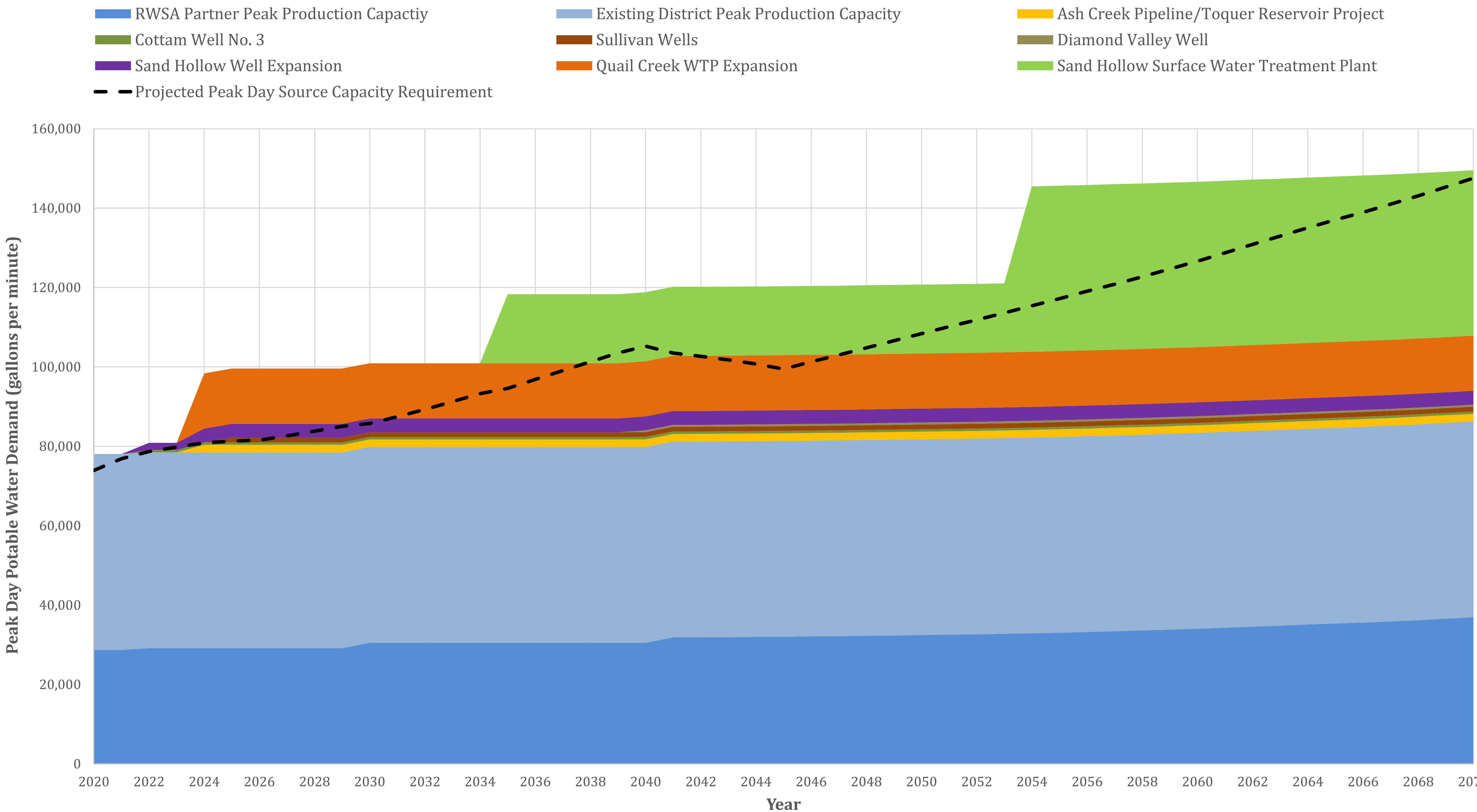


Figure 4-5 - Peak Day Potable Water Production Capacity vs Projected Peak Day Production Capacity

SUPPLY AND DEMAND FORECAST – SECONDARY IRRIGATION

Secondary irrigation water currently plays an important role in meeting water demands in Washington County. Most RWSA partner secondary irrigation systems are pressurized systems. Some systems individually meter each customer while others do not. Many cities have an extensive network of dry (not currently in use) secondary irrigation lines that have been installed over the last several decades with the intent to one day supply customers with secondary water.

Secondary irrigation water, particularly in residential irrigation applications, will play a pivotal role in meeting future water demands in Washington County. Currently, the district provides a relatively limited amount of secondary water for M&I purposes. Most cities that currently operate a secondary irrigation system do so using their own water supplies or shares in local irrigation or canal companies, except for the TSWS system in Toquerville that uses the district's water from Toquerville Springs and Ash Creek.

To effectively provide secondary irrigation water to the RWSA partners across the county, the district will need to expand its secondary irrigation system to capture and deliver water from various sources, including Type 1 wastewater effluent (reuse water), water from agricultural conversion and other local sources of water. To fully utilize these sources of water, regional storage reservoirs will need to be constructed. These reservoirs will allow water to be stockpiled year-round, providing a reliable supply of water during the irrigation season.

While there is still a significant amount of planning and design that needs to be considered to implement a regional secondary irrigation system, BC&A has evaluated future secondary irrigation supply needs based on the future demands for each RWSA partner (these assumptions are documented in Chapter 2). For the purposes of this master plan, secondary irrigation supplies have been evaluated from an annual supply basis only. It has been assumed that the facilities needed to meet peak day secondary irrigation demands would be the responsibility of each individual RWSA partner. The district would take on the responsibility of developing sources of water, storage reservoirs, and the transmission infrastructure to connect sources to reservoirs. The RWSA partners would then be responsible to construct the infrastructure to bring water from district reservoirs or transmission lines into their respective systems.

Figures 4-6 and 4-7 compare available secondary irrigation supplies and projected source sizing requirements (average annual) for the 50th percentile yield scenario and the 50th to 10th percentile yield scenarios, respectively. Similar to the potable water projections, each figure shows a "no conservation" scenario and a "target conservation" scenario. As shown in the figures, there is an expected gradual increase in secondary demand over the next 18 years, followed by a large uptick in demand. This large increase is associated with the estimated time frame for the completion of a large, regional storage reservoir in a central location in the county that could allow a significant portion of dry irrigation systems to be brought into service.

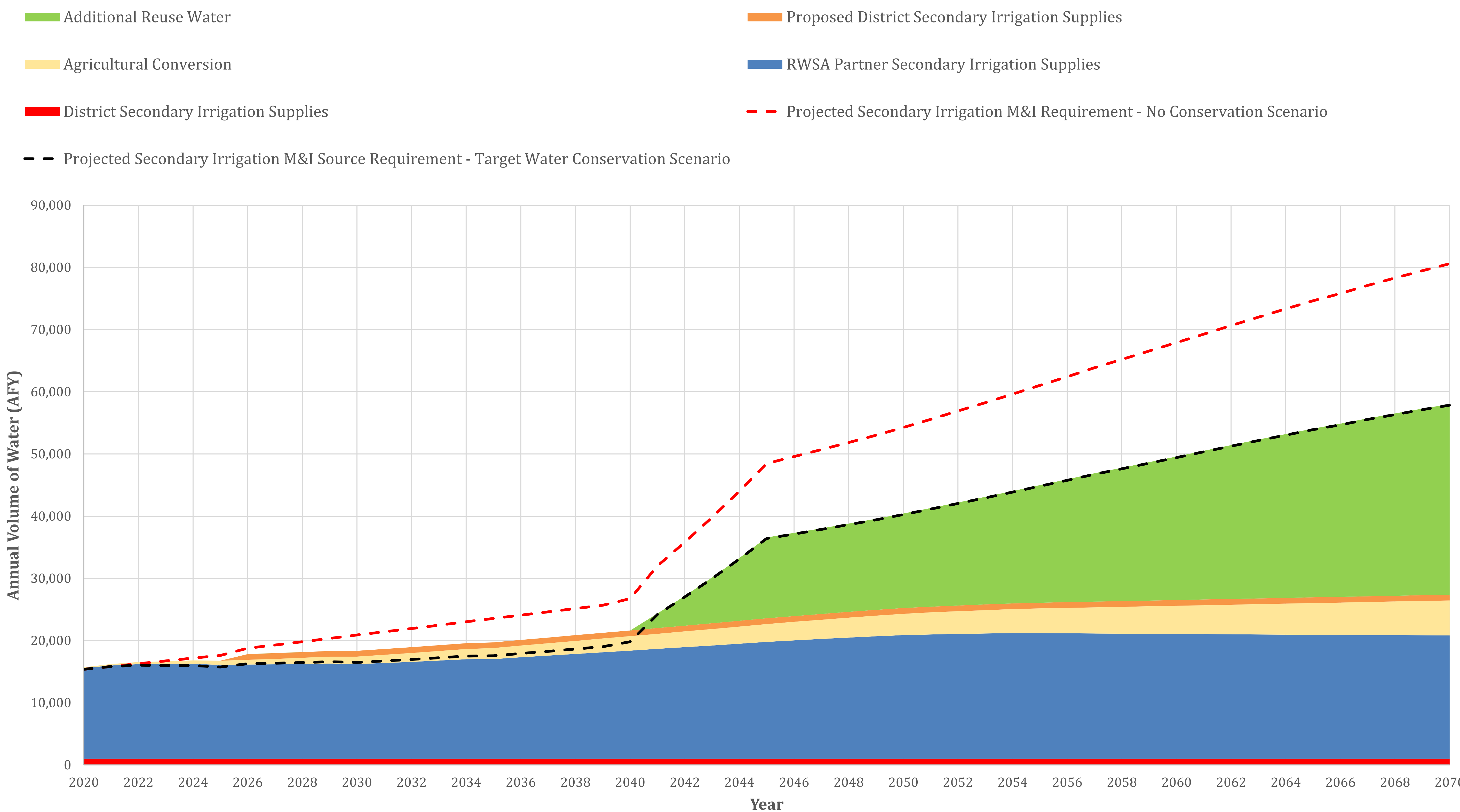


Figure 4-6 - Secondary Irrigation Supplies vs. Projected Secondary M&I Source Sizing Requirement 50th Percentile Yield Scenario

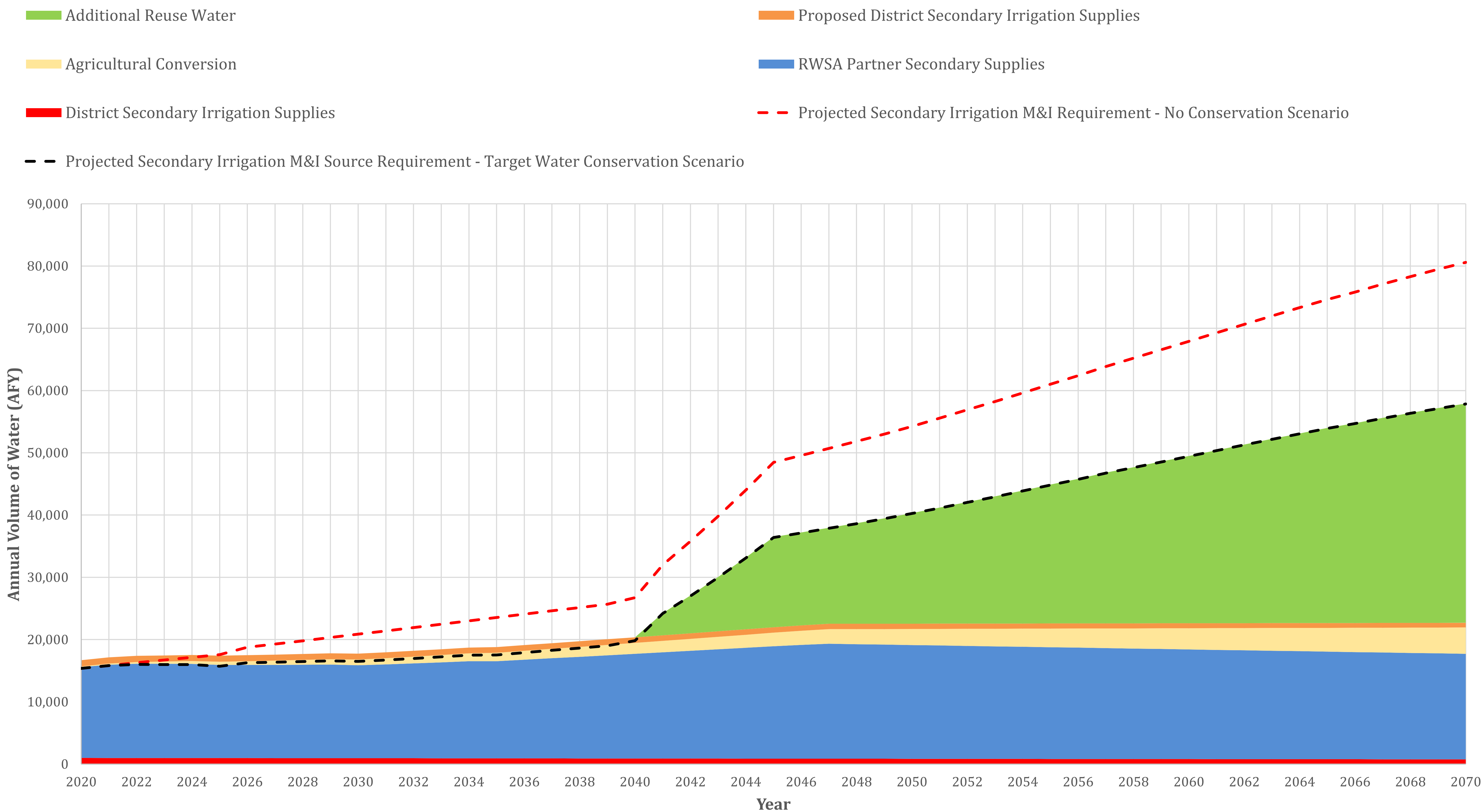


Figure 4-7 - Secondary Irrigation Supplies vs. Projected Secondary M&I Source Sizing Requirement 50th Percentile to 10th Percentile Yield Scenario

Projected future secondary irrigation demands will be met through a combination of the following water supplies:

- **Reuse Water:** Wastewater treated to Type 1 effluent standards can be used for a variety of irrigation applications, including residential landscaping, vegetable gardens, and commercial landscaping. The City of St. George Water Reclamation Facility, which treats wastewater from St. George, Washington, Ivins, and Santa Clara, operates a reuse water facility capable of producing up to 7 MGD of Type 1 effluent. Ash Creek Special Service District (ACSSD), which provides wastewater collection and treatment services to Hurricane, La Verkin, and Toquerville, is planning to implement reuse water facilities within its system as well. Reuse water provides a drought resilient, reliable supply of water that will be a key component of future water supplies in the county. Today, if all wastewater treated by St. George and ACSSD was recycled and reused for secondary irrigation, it could provide over **16,000 AFY** for Washington County. This number is projected to increase to over **60,000 AFY** within the next 50 years (assuming potable water supplies are capable of meeting future demands).
- **Agricultural Conversion:** As agricultural land in Washington County is sold and developed, water rights and irrigation company shares may become available for use within the RWSA partner water systems. A recent report[9] completed by the UDWRe estimates that up to **6,900 AFY** of water from agricultural conversion will become available by the year 2065. When extrapolated to the year 2070, agricultural conversion is expected to reach a total of **7,650 AFY**. Applying Reclamation's climate change factors, a 50th percentile yield scenario and 10th percentile yield scenario would, respectively, result in a **7,132 AFY** and **5,491 AFY** of agricultural conversion available for M&I use by 2070. The timing of where and when agricultural water will become available for M&I use in the future is uncertain.
- **District Water Rights at the Washington Dam Diversion:** The district holds water rights and irrigation company shares at the Washington Dam Diversion. The availability of water at the Washington Dam Diversion is predicated on a number of different factors, including natural flow in the river and priority of water rights. Water quality may also limit the amount of water that can be diverted and used for secondary irrigation.
- **Ence Wells:** The Ence Wells could be pumped directly into the Gunlock system or into one of the proposed reservoirs near Ivins and Santa Clara (Dry Wash Reservoir and Graveyard Wash Reservoir). As shown in Table 4-5, the 50th percentile yield from the Ence Wells is estimated at **359 AFY** and the 10th percentile yield is estimated at **266 AFY.** With the construction of additional wells, the estimated reliable yield under the 50th percentile and 10th percentile climate change scenarios, respectively, is **1,277 AFY** and **948 AFY.**
- **Ash Creek Pipeline/Toquer Reservoir:** The Ash Creek Pipeline/Toquer Reservoir project will provide a new source of secondary irrigation water for the east side of the county, freeing up capacity in Toquerville Springs for use in potable water systems. The estimated reliable yield for this project is shown in Table 4-11.

Proposed and Potential Future Secondary Irrigation Reservoirs

The following locations have been identified as potential sites for regional secondary irrigation reservoirs:

[9] "Water Resources Plan". Utah Division of Water Resources. December 2021.

- **Graveyard Wash Reservoir:** Graveyard Wash is located west of Santa Clara City south of Old Highway 91. A reservoir at this location could hold approximately 1,500 AF of water to be supplied from the SGWRF reuse facility, the Gunlock irrigation system, or Ence Wells.
- **Dry Wash Reservoir:** Located about 2 miles northwest of Graveyard Wash, Dry Wash is an additional site identified for a secondary irrigation reservoir. The reservoir could hold about the same volume as Graveyard Wash Reservoir (1,500 AF) and would receive water from the same potential sources. This reservoir would operate in tandem with Graveyard Wash Reservoir to store and supply secondary irrigation water for the west side of the service area.
- **Warner Valley Reservoir (potential):** Warner Valley Reservoir is a long-term project with an uncertain timeline. The site has been considered as a potential reservoir location for over 50 years, but there are no specific plans for its construction at this time. It has been assumed that Warner Valley Reservoir, or another large-scale reservoir project, will be constructed and operational by the year 2040. Preliminary analyses of the Warner Valley site indicate that the reservoir could safely store between 30,000 and 60,000 AF of water.

Need for Continued Evaluation

The district is currently in the process of completing a Reuse Feasibility Study to seek Title XVI grant funding from the Bureau of Reclamation for reuse projects in Washington County. The study will propose a regional reuse system, identifying the treatment facilities, conveyance infrastructure, and storage reservoirs needed to produce and deliver reuse water to RWSA partners across the county. It is recommended that the district continue to evaluate and pursue the development of reuse water and other sources of secondary irrigation water in Washington County. As plans for a regional secondary irrigation system are refined, the assumptions contained in this Master Plan should be revisited and revised as needed.

Recommended Source Development Projects

Table 4-12 provides a summary of the recommended source development projects for the district. The table includes planning level cost estimates for each project.

Table 4-12
Recommended Source Development Projects

Project ID	Project Name	Project Completion Year	Total Project Cost Estimate
S-1	Cottam Well 3	2023	$1,997,000
S-2	Sand Hollow Well 7	2023	$1,815,000
S-3	Sand Hollow Well 15	2024	$1,815,000
S-4	Ash Creek Pipeline/Toquer Reservoir	2024	$85,816,000
S-5	Sullivan Wells Project (Wells, Pipelines)	2026	$14,663,000
S-6	Cove Reservoir Project[1]	2033	$9,000,000
S-7	Lake Powell Pipeline	2035	$1,705,200,000
S-8	Diamond Valley Well	2040	$2,877,000
S-9	Quail Creek WTP 80 MGD Expansion	2025	$130,000,000
S-10	Sand Hollow Surface Water Treatment Plant (Phase 1, Treatment and Pipelines)	2035	$300,850,000
S-11	Sand Hollow Surface Water Treatment Plant (Phase 2, Treatment and Pipelines)	2054	$173,250,000
S-12	Dry Wash/Graveyard Wash Reservoirs	2025	$33,259,000
	Total		**$2,460,542,000**

[1] Project cost shown represents the estimated portion to be paid by the district. The project will be funded in part by the Natural Resources Conservation Service (NRCS).

CHAPTER 5
FINISHED WATER STORAGE CAPACITY EVALUATION

Storage facilities play a vital role in the operation of the district water system. They provide a buffer between sources and the transmission/distribution system, as well as store water for emergencies and fire suppression. This chapter evaluates the district's existing water storage facilities and determines future storage needs that will arise due to growth within the service area. The storage facilities evaluated in this chapter refer to enclosed, finished water storage tanks and not open storage reservoirs. The district's open reservoir capacity is considered part of the reliable yield of a source and does not provide the same function as an enclosed, finished water storage tank.

STORAGE EVALUATION CRITERIA

UDDW establishes storage sizing criteria for facilities that service public water systems in Utah. The district is primarily a wholesale water provider for local municipalities, but also services a small number of retail customers (communities of Casa de Oro, Homespun Village, and HVWS). The district's various storage facilities provide different functions within the system; some provide service directly to retail customers, while others act as "operational storage", providing an intermediate buffer between sources and wholesale connections. These two types of facilities are operated differently and will be evaluated in their own manner.

For the district's storage facilities servicing a retail water system, each facility must meet the requirements set forth in Utah Administrative Code R309-510-8 and the 2018 legislative modifications made to the Utah Safe Drinking Water Act (Utah Code 19-4-101). The State regulations require the consideration of the following storage components for a facility servicing retail water connections:

1. ***Equalization Storage***: This is the storage volume needed to meet system demands when they exceed the production capacity of sources. System demands do not remain constant throughout the day, and sources are not generally sized to meet peak hour demands. Equalization storage makes up the difference during these times.

   As part of the 2018 legislative modifications to the Utah Safe Drinking Water Act (Utah Code 19-4-101), public water systems are now, or will be, required to establish system specific equalization storage sizing standards similar to those required for source capacity for retail systems that serve more than 500 people. Therefore, the sizing requirements established in Utah Administrative Code R309-510-8 will be used to evaluate and determine equalization storage requirements. R309-510-8 requires public water systems to provide equalization storage to "satisfy average day demands for indoor use and irrigation use".

2. ***Emergency Storage***: This is the storage volume needed (as deemed necessary by the water supplier) to satisfy system demand in an emergency situation, such as a power outage or other event that may affect the ability of a water source to produce water. Emergency storage is not dedicated fire flow storage. Emergency storage requirements are defined as follows in R309-510-8:

   > *"Emergency storage shall be considered during the design process. The amount of emergency storage shall be based upon an assessment of risk and the desired degree of system dependability. The Director (of UDDW) may require emergency storage when it is warranted to protect public health and welfare"*

As described, there are no specific requirements for emergency storage. Since the district is a wholesale water provider, emergency storage has not been deemed necessary. If the communities serviced by the district desire a higher level of dependability, they are entitled to build additional storage capacity within their own systems.

3. ***Fire Flow Storage***: This is the storage volume needed to provide fire suppression as required by the local fire authority. R309-510-8 says the following regarding fire flow storage:

    a. *Fire flow storage shall be provided if fire flow is required by the local fire code official or if fire hydrants intended for fire flow are installed.*

    b. *Water system shall consult with the local fire code official regarding needed fire flows.*

    c. *When direction from the local fire code official is not available, the water system shall use Appendix B of the International Fire Code, 2015 edition, for guidance. Unless otherwise approved by the local fire code official the fire flow and fire flow duration shall not be less than 1,000 gallons per minute for 60 minutes.*

Not all the storage tanks operated by the district need to provide fire flow for the system. Some storage facilities only provide operational storage between a source and a wholesale customer connection; fire flow and/or emergency storage are not needed because they are provided by the individual wholesale customer's system. Operational storage is beneficial because it is typically most economical to operate sources at a relatively constant rate. This is especially true for major surface water treatment facilities such as the QCWTP that have a difficult time changing production rates rapidly. Allowing sources to operate at a relatively constant rate and using storage facilities to meet the variation in demand from wholesale customers is the preferred method of system operation.

For tanks that provide only operational storage, it is recommended that tanks be sized to provide 100% of the source sizing standard for average day demand *for the volume of water supplied by the district.* As described in Chapter 4, demand throughout the district service area is met through the combination of city-owned sources and district sources. For the water produced by the individual cities themselves, it is assumed that the cities will cover their own internal storage needs. Hence, the district's storage requirement pertains only to the water that the district provides.

A summary of the district's existing storage facilities is shown in Table 5-1. The table also indicates the required fire flow storage capacity for each tank.

Table 5-1
Existing District Storage Tanks

Storage Facility	Total Storage Volume (gallons)	Fire Flow Storage Requirement (gallons)	Total Equalization Storage Available (gallons)
Quail Creek WTP[1]	24,000,000	180,000	23,820,000
Cottam Tank[2]	360,000	180,000	180,000
Sand Hollow 1 MG Tank	1,000,000	0	1,000,000
Sand Hollow 2 MG Tank	2,000,000	0	2,000,000
Warner Valley Tank	3,000,000	180,000	2,820,000
Sky Ranch Tank[3]	130,000	120,000	10,000[4]
Cliff Dwellers Tank[3]	130,000	0	130,000
Total	**30,620,000**	**660,000**	**29,960,000**

[1]Storage at QCWTP consists of 3 separate tanks (10 MG, 9 MG, and 5 MG). The City of St. George utilizes fire flow storage in these storage facilities.
[2]The Cottam Tank provides fire flow storage for Casa de Oro/Homespun Village developments.
[3]The Sky Ranch and Cliff Dwellers tanks service the Hurricane Valley Water System. The Sky Ranch Tank is located at a higher elevation than the Cliff Dwellers Tank, and the fire flow stored in the higher tank can cover the lower Cliff Dwellers pressure zone.
[4]The Hurricane Valley Water System was constructed under previous county standards and has a backup connection to the Hurricane City water system.

EVALUATION OF EXISTING AND FUTURE STORAGE REQUIREMENTS

Similar to the evaluation of local water supplies, the district's storage facilities have been evaluated under existing and future demand conditions. While the district's storage tanks collectively provide service to the system as a whole, for the purpose of this analysis, storage tanks were divided into three different regions of the service area: West, Central and East. These regions connect different areas of the county to their primary storage tank or group of tanks (i.e. the tanks that they typically utilize). This process helps to identify not only the total volume needed in the future, but where the new storage volume is best suited geographically within the system.

Table 5-2 provides a summary of the regions used for this analysis with the associated primary storage facilities.

Table 5-2
District Storage Regions[1]

Region	Cities Included	Primary Storage Tanks
West[1]	St. George, Washington, Ivins, Santa Clara, KWU	QCWTP, Warner Valley
Central[1]	Hurricane City, HVWS	Sand Hollow 1 MG, Sand Hollow 2 MG
East	La Verkin, Toquerville, Virgin, Casa de Oro, Homespun	Cottam Tank

[1]West and Central regions are capable of drawing upon the combined storage of both regions as necessary.

Using the demand projections presented in Chapter 4, Table 5-3 provides a summary comparison of storage needs under existing conditions, projected 10-year growth, and projected growth by the year 2070. The following paragraphs provide additional discussion on each storage scenario.

Table 5-3
WCWCD Storage Analysis

Existing Conditions (2022)								
Tank Service Regions	**Primary Systems Serviced**	**Existing Source Capacity Supplied by the District (acre-feet)**	**Primary Storage Facilities**	**Equalization Storage Required (gallons)**	**Fire Flow Storage Required (gallons)**	**Total Storage Required (gallons)**	**Available Storage (gallons)**	**Total Storage Surplus/(Deficit) by Service Region (gallons)**
West	St. George, Washington, Ivins, Santa Clara, KWU	28,086	QCWTP, Warner Valley	25,073,329	360,000	25,433,329	27,000,000	1,566,671
Central	Hurricane , HVWS	6,355	Sand Hollow, Dixie Springs, Cliff Dwellers, Sky Ranch	5,673,230	120,000	5,793,230	3,260,000	(2,533,230)
East	La Verkin, Toquerville, Virgin, Casa de Oro, Homespun	566	Cottam	505,218	180,000	685,218	360,000	(325,218)
Project 10-Year Growth Conditions (2032)								
Tank Service Regions	**Primary Systems Serviced**	**Projected 10-Year Source Capacity Supplied by the District (acre-feet)**	**Primary Storage Facilities**	**Equalization Storage Required (gallons)**	**Fire Flow Storage Required (gallons)**	**Total Storage Required (gallons)**	**Available Storage (gallons)**	**Total Storage Surplus/(Deficit) by Service Region (gallons)**
West	St. George, Washington, Ivins, Santa Clara, KWU	34,164	QCWTP, Warner Valley	30,499,741	360,000	30,859,741	27,000,000	(3,859,741)
Central	Hurricane , HVWS	7,770	Sand Hollow, Dixie Springs, Cliff Dwellers, Sky Ranch	6,937,037	120,000	7,057,037	3,260,000	(3,797,037)
East	La Verkin, Toquerville, Virgin, Casa de Oro, Homespun	1,407	Cottam	1,255,843	180,000	1,435,843	360,000	(1,075,843)
Projected Long-Term Growth Conditions (2070)								
Tank Service Regions	**Primary Systems Serviced**	**Projected 2070 Source Capacity Supplied by the District (acre-feet)**	**Primary Storage Facilities**	**Equalization Storage Required (gallons)**	**Fire Flow Storage Required (gallons)**	**Total Storage Required (gallons)**	**Available Storage (gallons)**	**Total Storage Surplus/(Deficit) by Service Region (gallons)**
West	St. George, Washington, Ivins, Santa Clara, KWU	60,277	QCWTP, Warner Valley	53,811,409	360,000	54,171,409	27,000,000	(27,171,409)
Central	Hurricane , HVWS	12,376	Sand Hollow, Dixie Springs, Cliff Dwellers, Sky Ranch	11,048,502	120,000	11,168,502	3,260,000	(7,908,502)
East	La Verkin, Toquerville, Virgin, Casa de Oro, Homespun	6,871	Cottam	6,134,365	180,000	6,314,365	360,000	(5,954,365)

[1]This storage analysis encompasses the district's current effective service area, which includes the RWSA partners and district retail systems. It is anticipated that the district will gradually expand its service area over time to provide water to additional communities in the county. This system expansion will likely require additional storage facilities not discussed in this report.
[2]The Central region has access to storage within the Quail Creek WTP tanks, so this deficiency is covered by the excess capacity shown within the West region. Sky Ranch/Cliff Dwellers can also draw on storage within the Hurricane culinary water system.
[3]The Cottam Tank is the sole source of district storage for the East region. Hence, a storage deficiency exists within this region that cannot be made up from excess storage in other regions.

Storage Evaluation – Existing Conditions

Table 5-3 indicates that there are capacity deficiencies within the Central and East regions of the service area under existing conditions. However, the Central region can also draw on the storage tanks at the QCWTP. This considered, the excess capacity available in the West region can be used to cover a portion of the deficiency shown in the Central region. On the other hand, the deficiency shown within the East region cannot be currently made up by excess storage in other regions. The Cottam Tank is the only storage facility that currently services the East region.

Storage Evaluation – Future Conditions

As the system continues to grow, the district will need to continue constructing additional water storage facilities. As shown in Table 5-3, storage needs are anticipated within all storage regions in the future.

RECOMMENDED STORAGE FACILITIES

The recommended storage improvements for the district service area through the year 2070 are shown in Table 5-4 on the following page. The table provides the anticipated project construction year and the estimated total project cost in 2022 dollars. Construction costs estimates include the cost for land acquisition and tank construction. Additional costs associated with planning, engineering, legal, and other administrative costs have been included in the overall project cost. Figure 5-1 displays the location of the proposed storage tank projects. It is important to reiterate that, while most proposed storage facilities are located in the central and east region of the service area, these storage facilities provide benefit to the entire service area as a whole. The following is a detailed description of each recommended project.

Project ST1: Cottam Well Tank 2
Construction Year: 2022

The existing 360,000 gallon storage tank on the Cottam Well site is not sufficient for existing and future needs in the Toquerville, La Verkin, and Virgin area. To meet the demands on this region of the service area, it is recommended that a new 3 MG storage facility be constructed on the Cottam Well site adjacent to the existing 360,000 gallon tank. The tank should be constructed at the same base/overflow elevation as the existing tank to optimize the capacity of the two facilities.

Project ST2: Sand Hollow 2 MG Tank B
Construction Year: 2023

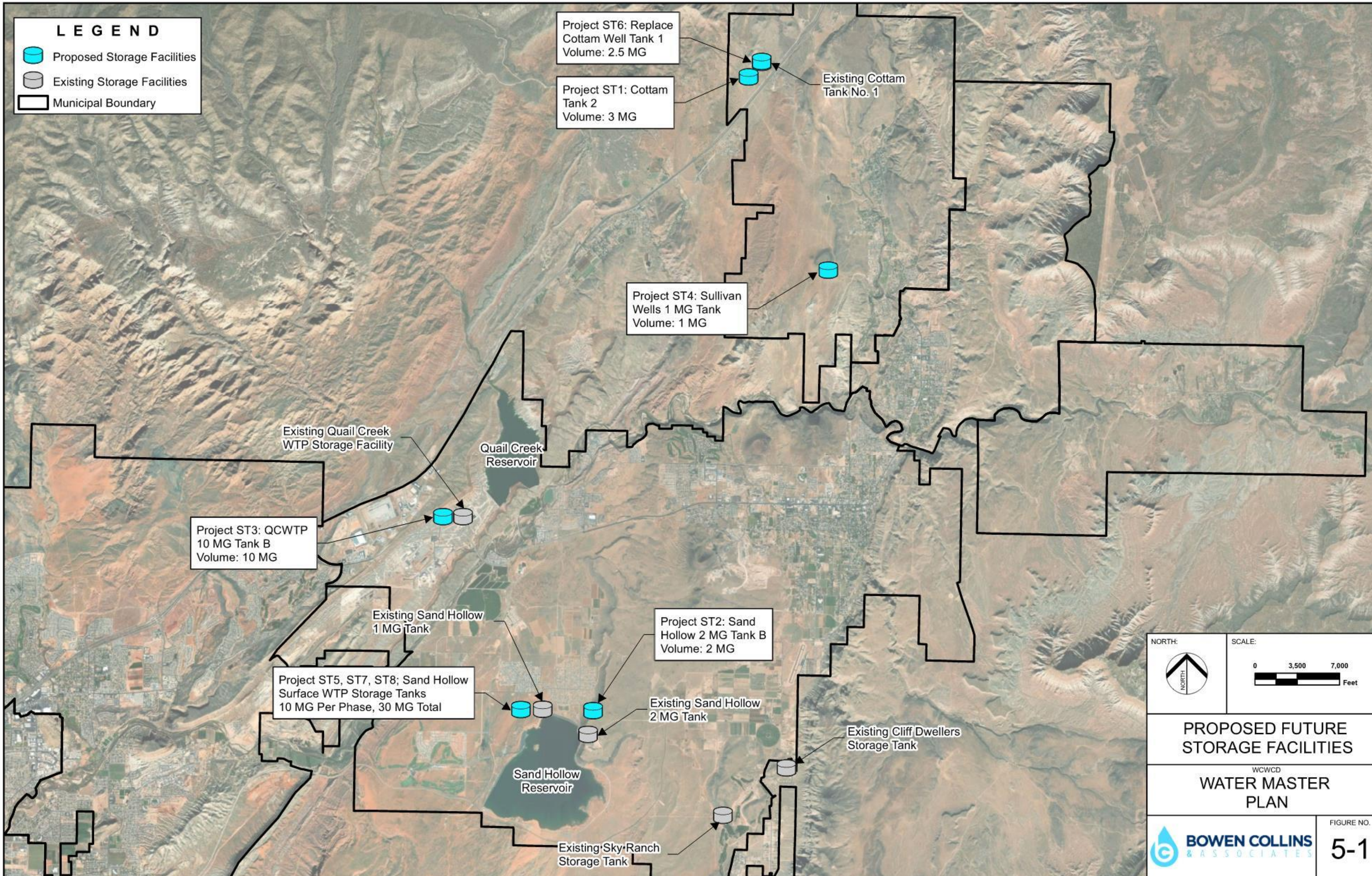
As demands on the Sand Hollow Wells increase so will the need for additional storage capacity. Water produced from the wells is currently stored in the Sand Hollow 2 MG Tank and the Sand Hollow 1 MG Tank. It is recommended that an additional 2 MG tank be constructed next to the existing Sand Hollow 2 MG tank at the same elevation.

Project ST3: QCWTP 10 MG Tank B
Construction Year: 2025

The QCWTP has a current total treatment capacity of 60 MGD. To meet increasing system demands, the treatment plant will ultimately be upgraded to a capacity of 80 MGD. The increased demand from the district's customers will also require an upgrade to the storage facilities located on the treatment plant site. It is recommended that a new 10 MG storage facility be constructed adjacent to the existing finished water storage tanks at the treatment plant.

Table 5-4
Recommended Storage Improvements

Project ID	Project Description	Proposed Construction Year	Storage Tank Volume (gallons)	Total Estimated Project Cost (2022 Dollars)
ST1	Cottam Well Tank 2	2022	3,000,000	$6,330,000
ST2	Sand Hollow 2 MG Tank B	2023	2,000,000	$6,050,000
ST3	Quail Creek 10 MG Tank B	2025	10,000,000	$25,988,000
ST4	Sullivan Well 1 MG Tank	2026	1,000,000	$3,307,000
ST5	Sand Hollow WTP Storage - Phase 1	2034	10,000,000	$25,000,000
ST6	Replace Cottam Well Tank 1	2045	2,500,000	$6,100,000
ST7	Sand Hollow WTP Storage - Phase 2	2052	10,000,000	$25,000,000
ST8	Sand Hollow WTP Storage - Phase 3	2068	10,000,000	$25,000,000
		Total	**48,500,000**	**$122,775,000**



S:\WCWCD\285-19-03 Water Master Plan - Phase 2\4.0 GIS\4.4 Figures\Figure 5-1 - WCWCD Existing Storage Tanks.mxd aanderson 1/6/2023

Project ST4: Sullivan Wells 1 MG Tank
Construction Year: 2026

A new 1 MG storage tank is planned as part of the Sullivan Wells Project. The new tank will store water produced from the wells prior to delivery to the district wholesale customers. The tank will allow the wells to operate more consistently rather than needing to adjust flow to match daily demands. A potential location of the new tank is in the Toquerville west fields area.

Project ST5: Sand Hollow Surface Water Treatment Plant Storage Facility – Phase 1
Construction Year: 2034

Storage capacity will be needed at the proposed Sand Hollow Surface Water Treatment Plant to hold finished water from the plant and facilitate plant operations. Based on the growth projections presented in this study, it is recommended that this storage facility be constructed in phases, with the initial phase including a 10 MG facility.

The exact location of the water treatment facility and storage tanks is undetermined at this time, but a likely location is within the district's property along the north dam of Sand Hollow Reservoir where the depth of the reservoir is greatest. It is recommended that the storage facility be constructed below grade on the north end of the reservoir so that finished water from the treatment plant can be gravity fed into the tank.

Project ST6: Replace & Upsize Cottam Well Tank 1
Construction Year: 2045

Long-term water demand on the east side of the service area will ultimately require additional storage capacity at the Cottam Well site. It is recommended that the existing 360,000-gallon steel tank be replaced with a new 2.5 MG storage tank.

Project ST7 & ST8: Sand Hollow Surface Water Treatment Plant Storage Facility – Phase 2 & Phase 3
Construction Year: 2052 & 2068

Increased future demands will require additional storage capacity at Sand Hollow Reservoir. Phase 2 and Phase 3 will each add 10 MG of storage to the facility, bringing the total combined storage capacity to 30 MG. Care should be taken during the Phase 1 improvement to accommodate and facilitate these future expansion phases.

CHAPTER 6
CONVEYANCE SYSTEM EVALUATION

INTRODUCTION

A hydraulic computer model is a valuable tool for simulating the operation and evaluating performance of water transmission and distribution networks. Information such as system pressure and pipeline flow velocities can be accurately estimated using a hydraulic computer model. As part of this Master Plan, portions of the district's water transmission system were modeled under existing and projected future demand conditions. The hydraulic model was developed using Innovyze's InfoWater software, which is integrated with Geographic Information System (GIS) technology. The purpose of this chapter is to describe the methodology used to model the district's system, present results of the evaluation, and provide recommendations for improvements to the district's conveyance network.

WATER SYSTEM MODEL

A hydraulic computer model is a digital representation of physical features and characteristics of the water system, including pipes, valves, storage tanks and pumps. Key physical components of a water system are represented by a set of user-defined parameters that represent the characteristics of the system (such as pressure reducing valve (PRV) settings or pipe roughness coefficients). Computer model output includes information such as pressure at each model node, flow rate for each pipe in the water system, and more.

The hydraulic model of the district's major conveyance network was created by BC&A for this study. This was accomplished by using available GIS data and historic demand and production data provided by the district. The model was set up to run a "steady state" simulation and is primarily intended to identify pressure and pipe size deficiencies in the conveyance system, such as undersized water lines and areas with excessively low/high pressure. For modeling purposes, pipelines were assigned a Hazen-Williams roughness coefficient of 120.

MAJOR CONVEYANCE FACILITIES EVALUATED

Hydraulic modeling efforts for this Master Plan focused on the district's major conveyance network that delivers treated potable water to wholesale and retail customers. These facilities are highlighted in Figure 6-1. The following is a summary description of each major conveyance component evaluated in this chapter:

Regional Pipeline

The Regional Pipeline is the largest and most heavily utilized finished water transmission line operated by the district. The Regional Pipeline is fed primarily by the QCWTP, but it is also linked to the Sand Hollow Well Field via an 18-inch pipeline from the Sand Hollow 1 MG Tank. The Regional Pipeline begins at the QCWTP and travels via an extensive pipeline network that ranges in size from 30 to 72 inches to Ivins.

FIGURE 6-1

SENSITIVE INFORMATION HAS BEEN REDACTED FOR SECURITY PURPOSES

Cottam Wells to Harrisburg Pipeline[1]

Water produced from the Cottam Wells flows into one of two pipelines that feed wholesale and retail customers on the east side of the county. The main pipeline diverts from the Cottam Wells and runs southwest along I-15 through Leeds and into the Harrisburg area of Hurricane. This connection provides water to Hurricane and serves retail customers in the Casa De Oro and Homespun Village developments within the unincorporated county area between Leeds and Toquerville. This line consists of 12-inch, 14-inch, and 24-inch sections of pipe.

Cottam Wells to Virgin Pipeline

The Cottam Wells to Virgin Pipeline is a 12-inch pipe that runs through Toquerville and La Verkin and ends on the west end of Virgin. Toquerville, La Verkin, Hurricane, and Virgin all maintain connections to this pipeline.

Sand Hollow Regional Pipeline (SHRP)

The recently constructed Sand Hollow Regional Pipeline is a 36-inch line that runs from Sand Hollow Reservoir to the southern regions of St. George and Washington City. The pipeline runs through the undeveloped areas of Sand Mountain and Warner Valley, and into the new 3 MG Warner Valley Tank. From the tank, the 36-inch line continues into Washington City and St. George City. The pipeline currently relies on head pressure from the Sand Hollow 2 MG Tank to drive flow, but a pump station will be necessary to move flow through the line in the future.

Sand Hollow Wells to Regional Pipeline

An 18-inch line connects the Sand Hollow 1 MG Tank to the Regional Pipeline (tying into the 36-inch pipe that runs parallel to the 60-inch pipe). This pipe conveys excess water produced from the Sand Hollow Wells to the Regional Pipeline system and into the west side of the service area. Hurricane City also receives water directly from this line.

Sand Hollow Reservoir West Dam to North Dam Pipeline

The Sand Hollow Well Field has numerous pipes connecting the wells and spring to the treatment plant, storage tanks, and Hurricane Valley Water System. Among this network of piping, a 24-inch line serves as the backbone of water conveyance from the west side of the reservoir to the northeast side of the reservoir. Water produced from the west wells or West Dam Springs is often moved to the Sand Hollow 2 MG Tank that resides on the northeast side of the reservoir. Under certain scenarios, this is done to blend with water from the north wells to improve water quality. Water from the 2 MG tank can also flow west through this pipeline and into the SHRP. Since water in this pipeline can only flow one direction at a time, the district is currently limited in how its system operates.

[1] Cottam to Harrisburg Pipeline was named "Anderson Junction to Harrisburg Pipeline" in original project documents.

EVALUATION RESULTS FOR EXISTING MAJOR CONVEYANCE FACILITIES

Regional Pipeline

The QCWTP is capable of being expanded to a treatment capacity of 80 MGD, or up to 55,556 gpm (124 cfs). The Regional Pipeline was designed to convey water at a velocity of up to 5 feet per second (fps). As shown in Table 6-1, the Regional Pipeline is adequately sized to convey the future 80 MGD maximum flow from the QCWTP. Therefore, BC&A does not recommend any capacity related improvements, such as pipeline upsizes, to the Regional Pipeline.

Table 6-1
Future Flow Capacity of Regional Pipeline

Regional Pipeline Reach	Diameter (in)	Combined Pipe Area (ft^2)	Maximum Flow (cfs)	Maximum Flow Velocity (fps)
Reach 1	36, 60	26.7	123.8	**4.64**
Reach 2	72	28.3	123.8	**4.38**

Phase 2 and 3 of the Regional Pipeline are used to deliver water into the northern area of St. George as well as Santa Clara and Ivins City. Most of the new growth to be serviced in these areas is planned to utilize secondary irrigation for outdoor water demands, and an upsize to these phases of the Regional Pipeline is not recommended at this time.

Cottam Wells to Harrisburg Pipeline

The Cottam Wells to Harrisburg Pipeline is currently utilized to deliver water from the Cottam Wells into the district's retail water systems east of Leeds and into the west side of Hurricane City. The district is not currently planning to service any additional users in the Leeds area, and the areas of Hurricane serviced by this pipe are small and have relatively limited growth potential. However, to meet future water demands on the east side of the county, a new series of pump stations, described in a subsequent section, will be constructed along this pipeline to allow the conveyance of treated water from the QCWTP into the Cottam system. To meet these future needs, the existing 10, 12, and 14-inch sections of pipe will ultimately need to be upsized to a 24-inch line. The 24-inch line should then be extended from Harrisburg to the QCWTP along SR-318 (5300 W) to complete the connection.

Cottam Well to Virgin Pipeline

The large growth potential on the east side of the county will increase peak water demands on the district's infrastructure, particularly the Cottam Pipeline. Under future demand conditions, the existing 12-inch pipeline will require an upsize to 20-inch and 24-inch pipe to maintain adequate pressures while meeting demands.

Sand Hollow Regional Pipeline

The recently constructed SHRP will serve as the primary potable water feed into the rapidly growing southern areas of St. George and Washington City. After the construction of the Lake Powell Pipeline, a new surface water treatment plant will be built at Sand Hollow Reservoir. The treatment plant will include finished water storage and a pump station to send water through the SHRP. At 5 fps, the existing 36-inch pipe can convey approximately 16,000 gpm. The projected peak day demand on the SHRP by the year 2070 is estimated to be 36,000 gpm. If a second, parallel 36-inch pipe were constructed along the same SHRP alignment, and operating velocities were increased to up to 6 fps, each pipeline could convey over 19,000 gpm for a total capacity of 38,000 gpm. If the district desires to maintain peak pipe velocities at 5 fps, a 42-inch parallel pipeline will be needed. At this time, a 36-inch pipeline has been assumed as the appropriate diameter for the future parallel line.

Sand Hollow Reservoir to Regional Pipeline

In addition to the SHRP, water produced from the wells and spring around Sand Hollow Reservoir can also be conveyed to customers via an 18-inch pipeline that runs from the Sand Hollow 1 MG Tank to the 36-inch Regional Pipeline just downstream of the QCWTP. As demands increase on the SHRP and in Hurricane City, less water will be available to send down the 18-inch line to the Regional Pipeline. Ultimately, water will need to be moved back from the Regional Pipeline into the Sand Hollow area to feed into Hurricane and the SHRP.

This considered, it is recommended that the pipeline be repurposed, under most conditions, to move water from the Regional Pipeline back to the Sand Hollow area. To do this, a pump station will need be constructed on the line to boost water from the Regional Pipeline to the energy grade line of the Sand Hollow 2 MG Tank, allowing the water to flow into the SHRP. The 18-inch pipeline should be connected to the proposed North Dam to West Dam pipeline (described below) and disconnected from the Sand Hollow 1 MG Tank. Due to the elevation of the 1 MG Tank, it will need to be taken out of service (the 1 MG Tank does not provide adequate head to drive flow into the SHRP). However, the facility should not be abandoned entirely. In the future, the district will construct a surface water treatment facility at Sand Hollow Reservoir, reducing or eliminating the need to bring water from the Regional Pipeline back into the Sand Hollow area. Under future conditions, it may be advantageous to bring the 1 MG Tank back into service and deliver water produced at Sand Hollow to the Regional Pipeline.

Sand Hollow Reservoir West Dam to North Dam Pipeline

As demands in Hurricane City and on the SHRP continue to increase, the district will need increased capacity to move water between the different facilities around Sand Hollow Reservoir. The 24-inch line that currently connects the to the Sand Hollow 2 MG Tank is used to move water in both directions, creating an operational bottleneck. It is recommended that a dedicated line be constructed that will allow the district to freely move blended water from the Sand Hollow 2 MG Tank to the SHGWTP and into the SHRP. This will provide valuable operational flexibility and help ensure the district can satisfy demands while still meeting water quality requirements.

RECOMMENDED NEW CONVEYANCE IMPROVEMENT PROJECTS

This section includes a summary of the recommended improvements to the district conveyance system. The recommended improvements are shown in Figure 6-2. Table 6-2 provides a total project cost estimate for each recommended project. Additionally, this section includes other upgrades to enhance system flexibility, connectivity, and redundancy.

FIGURE 6-2

SENSITIVE INFORMATION HAS BEEN REDACTED FOR SECURITY PURPOSES

Project C-1: North Dam to West Dam Pipeline
Estimated Year of Completion: 2023

Project C-1 will bring a new 24-inch pipeline from the north side of Sand Hollow Reservoir to the SHGTP. This line will be dedicated to moving water from the Sand Hollow 2 MG Tank and the wells located on the north side of the reservoir to the SHRP. The project consists of installing approximately 13,400 feet of 24-inch pipe from the 20-inch outlet of the Sand Hollow 2 MG Tank to the SHGTP/SHRP.

Project C-2: HVWS Pump Station
Estimated Construction Year: 2023

HVWS is currently supplied water from Sand Hollow Well 4. To provide increased reliability to the HVWS, a new pump station is proposed on the east side of Sand Hollow Reservoir that will convey water from the Sand Hollow 2 MG Tank to the HVWS system. The pump station will have a design capacity of 500 gpm.

Project C-3, C-5, and C-9: Quail Creek to Cottam Wells Pipeline and Pump Stations
Estimated Year of Completion: 2024 – 2040+

This project includes the construction of two new booster pump stations, upsizing existing pipelines, and adding a new pipeline to convey water from the QCWTP to the Cottam Wells Tank. The project has been divided into 3 phases:

Phase 1. Phase 1 will utilize the existing pipeline from Cottam Wells to Harrisburg which consists of 10-inch, 14-inch, and 24-inch diameter pipelines. A new section of 24-inch pipe (approximately 15,000 feet) will be installed. Near the QCWTP tanks, a pump station will be constructed and will pump water up to a small, intermediate holding tank in Leeds located near a pressure reducing valve (PRV) on the Cottam Wells to Harrisburg pipeline. A second pump station will then draw water from the intermediate tank and pump it to be stored in the Cottam Tanks or used in the Cottam System. The first project phase will be designed to pump up to 2,000 gpm.

The Cottam Wells to Harrisburg pipeline currently feeds into the Hurricane City water system, filling a storage tank located off of 6300 W. Flow into the Hurricane tank is currently regulated by the PRV in Leeds. The new pump station at the QCWTP will create new hydraulic conditions within the Cottam Wells to Harrisburg line as well as Hurricane City's line; when the pump station is operating, pressure in these lines will increase. To prevent water from being able to overflow out of the Hurricane City tank, a flow regulating valve will need to be installed somewhere between the tank and Hurricane's connection to the Cottam Wells to Harrisburg pipeline.

Phase 2. Phase 2 includes upsizing any remaining sections of 10-inch and 14-inch pipe from the Cottam Wells to Harrisburg pipeline. Once complete, a 24-inch line will run from the Cottam Well Field to the QCWTP.

Phase 3. Phase 3 includes an upsize of the capacity of the pump stations from 2,000 gpm to 4,500 gpm.

Project C-4: Regional Pipeline to Sand Hollow Booster Pump Station
Estimated Year of Completion: 2025

This project includes the construction of a new booster station to pump water through the existing 18-inch pipeline running between the Regional Pipeline (36-inch pipe) and Sand Hollow 1 MG tank. As discussed previously, the 1 MG tank may need to be temporarily taken out of service when this pump station is operating (but could potentially be used seasonally). Based on the flow capacity of the 18-inch line, it is recommended that the pump station be capable of pumping approximately 4,500 gpm from the Regional Pipeline to Sand Hollow Reservoir. This project will also include some minor reconfigurations of existing piping to tie into the 18-inch line into the Sand Hollow 2 MG Tank.

Project C-6: Toquerville Springs to Cottam Pipeline Booster Pump Station
Estimated Construction Year: 2028

The Cottam Pipeline is currently the sole supply of water for the town of Virgin. If the pipeline from the Cottam Wells to Virgin were to experience a line break or other outage, Virgin would potentially be without water. To provide greater operational flexibility to meet growing demands on the east side of the county, construction of a small pump station (approximately 750 gpm) to boost water from the Toquerville Springs line into the Cottam Pipeline is recommended.

Project C-7: Cottam Well to Virgin Pipeline, Reach 1
Estimated Year of Completion: 2035+

Water produced from the Cottam Wells is currently delivered into Toquerville, La Verkin, Hurricane, and Virgin via a 12-inch pipeline. As demand on the system continues to increase in this region, so must the conveyance capacity of this pipeline. Based on the results of the hydraulic computer model, it is recommended that approximately 22,300 feet of pipe be upsized to 24-inches in diameter.

Project C-8: Cottam Well to Virgin Pipeline, Reach 2
Estimated Year of Completion: 2035+

This reach of pipe will extend the upsize from the end of Project C-7 to the La Verkin East Bench. The existing 12-inch line will be upsized to a 20-inch pipeline to the high point of the pipe alignment along SR-9 toward the town of Virgin. The project includes the replacement of approximately 16,000 feet of 12-inch pipe with 20-inch pipe.

Project C-10: SHRP Phase 2
Estimated Year of Completion: 2050+

The SHRP Phase 2 will include a parallel 36-inch pipeline from the SHGTP to the southern region of St. George and Washington, following the same alignment as the existing pipeline.

Table 6-2
Recommended Conveyance System Improvements

Project ID	Project Name	Project Year	Total Estimated Project Cost (2022 Dollars)
C-1	North Dam to West Dam Pipeline	2023	$3,660,000
C-2	Hurricane Valley Water System Pump Station	2023	$726,000
C-3	Quail Creek WTP to Cottam Wells Pipeline and Pump Stations, Phase 1	2024	$10,610,000
C-4	Regional Pipeline to Sand Hollow Booster Pump Station	2025	$2,904,000
C-5	Quail Creek WTP to Cottam Wells Pipeline and Pump Stations, Phase 2	2028	$11,922,000
C-6	Toquerville Springs to Cottam Pipeline Booster Pump Station	2028	$925,000
C-7	Cottam Well to Virgin Pipeline, Phase 1	2035+	$7,860,000
C-8	Cottam Well to Virgin Pipeline, Phase 2	2035+	$5,852,000
C-9	Quail Creek WTP to Cottam Wells Pipeline and Pump Stations, Phase 3	2040+	$1,139,000
C-10	Sand Hollow Regional Pipeline, Phase 2	2050+	$15,000,000
	Total		**$60,598,000**

CHAPTER 7
10-YEAR CAPITAL IMPROVEMENT AND SYSTEM REPLACEMENT RECOMMENDATIONS

INTRODUCTION

This chapter provides recommendations regarding reserve funds for the rehabilitation and renewal of the District's existing infrastructure and details the cost and timing of the facilities recommended to be constructed in the next 10 years.

RECOMMENDED BUDGET FOR SYSTEM REPLACEMENT

In addition to funding the recommended capital improvement projects needed to meet future growth in the district service area, it is also important to budget for the replacement of components of the existing system. As with all utilities, each component of a water system has a finite service life. Therefore, it is necessary to continually set aside and invest money toward the rehabilitation or replacement of these components. If adequate funds are not set aside for regular system renewal, the water system has the potential to fall into a state of disrepair and be incapable of providing the level of service that the district's customers have come to expect.

The district's water system is composed of a variety of facilities, including pipelines, pump stations, diversions, reservoirs, storage tanks, and treatment facilities. Each facility plays an important role in the overall system, and the failure of one facility component can impact the operation of the system as a whole. One of the best ways to identify a target level of funding for system replacement is to estimate the total replacement cost and service life of each facility. As a facility approaches the end of its service life, the district should be prepared to either replace or significantly rehabilitate said facility.

With help from district staff, BC&A compiled a list of all existing major water system components that are currently used to serve the RWSA partners[1]. Using the actual construction cost of existing projects escalated to today's dollars or by estimating the value of an existing project based on current construction estimates, a total "replacement cost" of the system has been estimated. The value represents the estimated cost, in today's dollars, to construct the entire district water system that is in place today. These estimates are shown in Table 7-1. As shown in the table, the total estimated cost to construct the district system is **$947 million dollars**.

[1] Excludes the facilities associated with the Kolob Retail Water System and the Pinion Hills Wastewater System.

Table 7-1
Estimated Water System Replacement Value

System Component	Quantity	Unit Replacement Value	Estimated Replacement Value
Reservoirs	***Storage Volume (AF)***	***$/AF***	
Sand Hollow Reservoir	51,360	$1,250	$64,200,000
Quail Creek Reservoir	40,325	$1,350	$54,439,000
Gunlock Reservoir	10,884	$750	$8,163,000
Ash Creek Reservoir	3,175	$750	$2,382,000
Kolob Reservoir	5,586	$750	$4,190,000
Ivins Reservoir	778	$1,500	$1,167,000
Meadow Hollow Reservoir	300	$3,000	$900,000
TSWS Upper Irrigation Pond	25	$20,000	$500,000
TSWS Lower Irrigation Pond	17.5	$15,000	$263,000
Grandpa's Pond	125	$10,000	$1,250,000
		Subtotal	**$137,454,000**
Diversions	***N/A***	***N/A***	
Quail Diversion			$15,000,000
Wet Sandy Diversion			$2,000,000
Leap Creek Diversion			$750,000
La Verkin Diversion			$2,000,000
Washington Dam Diversion[1]			$10,000,000
Crystal Creek Diversion			$16,000,000
Ash Creek Diversion			$2,000,000
		Subtotal	**$37,750,000**
Wells	***Capacity (gpm)***	***N/A***	
Cottam Well 1	815		$1,800,000
Cottam Well 2	365		$1,800,000
Toquerville Springs	1,907		$2,000,000
SH Well 1	750		$1,800,000
SH Well 2	400		$1,800,000
SH Well 4	310		$1,800,000
SH Well 5	210		$1,800,000
SH Well 6	230		$1,800,000
SH Well 8	450		$1,800,000
SH Well 9	800		$1,800,000
SH Well 10	535		$1,800,000
SH Well 12	305		$1,800,000
SH Well 17	200		$1,800,000
SH Well 18	800		$1,800,000
SH Well 19	630		$1,800,000
SH Well 20	800		$1,800,000
SH Well 21	1000		$1,800,000
SH Well 22	420		$1,800,000
SH Well 23	680		$1,800,000
SH West Dam Springs	1600		$2,500,000
Ence Well (Well 1)	400		$800,000
Lower Ence Well (Well 2)	60		$800,000
Old Farm Road Well	1000		$800,000
Gates Well	200		$800,000
Chapel Street Well	350		$800,000
Gubler Well	300		$800,000
		Subtotal	**$41,700,000**
Pump Station	***Capacity (gpm)***	***$/gpm***	
Sand Hollow PS	44,883	$100	$4,489,000
Toquerville PS	3,500	$400	$1,400,000
Pump Back PS	4,488	$400	$1,796,000
Skyline Drive PS	10,000	$300	$3,000,000
Mall Drive PS	10,000	$300	$3,000,000
La Verkin PS	1,500	$400	$600,000
Kayenta PS	500	$500	$250,000
		Subtotal	**$14,535,000**

Table 7-1 (continued)
Estimated Water System Replacement Value

Storage Tanks	*Volume (gal)*	*$/gal of storage*	
QCWTP 10 MG Tank	10,000,000	$2.25	$22,500,000.00
QCWTP 5 MG Tank	5,000,000	$2.50	$12,500,000.00
QCWTP 9 MG Tank	9,000,000	$2.25	$20,250,000.00
Sand Hollow 1 MG Tank	1,000,000	$3.00	$3,000,000.00
Sand Hollow 2 MG Tank	2,000,000	$2.75	$5,500,000.00
Cottam Tank	360,000	$3.00	$1,080,000.00
Sky Ranch Tank	130,000	$3.00	$390,000.00
Cliff Dwellers Tank	130,000	$3.00	$390,000.00
Warner Valley Tank	3,000,000	$2.50	$7,500,000.00
		Subtotal	**$73,110,000**
Pipe Diameter (inch)	*Length (ft)*	*$/ft*	
1.5	21,683	$100.00	$2,169,000
3	2,367	$120.00	$285,000
4	21,221	$140.00	$2,971,000
6	59,412	$170.00	$10,101,000
8	85,618	$200.00	$17,124,000
10	52,504	$210.00	$11,026,000
12	81,217	$225.00	$18,274,000
14	60,247	$240.00	$14,460,000
15	7,761	$250.00	$1,941,000
16	13,945	$275.00	$3,835,000
18	42,581	$300.00	$12,775,000
20	34,000	$350.00	$11,901,000
24	87,061	$375.00	$32,648,000
27	10,174	$400.00	$4,070,000
28.5	154	$425.00	$66,000
30	133,124	$450.00	$59,907,000
36	144,486	$500.00	$72,243,000
48	34,272	$600.00	$20,564,000
54	7,498	$700.00	$5,249,000
60	71,840	$750.00	$53,881,000
65	1,570	$800.00	$1,256,000
66	23,461	$800.00	$18,769,000
72	2,989	$1,000.00	$2,989,000
		Subtotal	**$378,504,000**
Hydropower Plants	*N/A*	*N/A*	
Hurricane Hydro			$4,100,000
Quail Hydro			$8,600,000
		Subtotal	**$12,700,000**
Treatment Facilities	*Capacity (MGD)*	**$/gallon treated**	
Quail Creek Water Treatment Plant	60	$4.00	$240,000,000
Sand Hollow Groundwater Treatment Plant	3	$3.75	$11,250,000
		Subtotal	**$251,250,000**
		TOTAL	**$947,003,000**

[1]Washington Dam Diversion is owned and operated by the St. George Washington Fields Canal Company. It's replacement value is not included in the totals shown in the table.

In reality, it will not be necessary to completely replace each and every component within the system. Rehabilitation technologies such as slip lining, well swaging, etc. can extend the life of system components without the need for full replacement. However, not all system components are suited for rehabilitation and will require a full replacement. Of the district's water system components, pipelines are typically the best suited for cost-saving rehabilitation technologies. It has been assumed that 50% of the district's pipeline network could be rehabilitated at a cost of approximately 50% of total replacement cost. Under these assumptions, Table 7-2 shows the recommended annual replacement budget for the district's water system.

Table 7-2
Recommended Annual Water System Replacement Budget

System Component	Estimated Service Life (Years)	Estimated Cost – Complete Replacement	Estimated Cost – Rehabilitation and Replacement	Recommended Annual Budget for Major System Replacement and Renewal
Reservoirs	100	$137,454,000	$137,454,000	$1,375,000
Diversions	100	$37,750,000	$37,750,000	$378,000
Wells	50	$41,700,000	$41,700,000	$834,000
Pump Stations	75	$14,535,000	$14,535,000	$194,000
Storage Tanks	50	$73,110,000	$73,110,000	$1,462,000
Pipe Network	75	$378,504,000	$283,878,000	$3,785,000
Hydropower Plant	75	$12,700,000	$12,700,000	$169,000
Water Treatment Plants	75	$251,250,000	$251,250,000	$3,350,000
Total		**$947,003,000**	**$852,377,000**	**$11,547,000**

As shown in Table 7-2, the ideal annual budget for system replacement is $11.5 million per year. However, because the majority of the district's system is relatively new and on the front end of its service life, budgeting this full amount for annual system replacement may not be necessary at this time. However, the district should plan to gradually increase its annual budget for system replacement up to the recommended level of $11.5 million per year. As the system is expanded and becomes larger, this annual system replacement budget should be increased accordingly.

10-YEAR CAPITAL IMPROVEMENT PLAN

The previous chapters of this report have presented a series of recommended improvement projects that increase capacity and redundancy of sources, storage, conveyance, and treatment facilities. The recommended projects to be included in the 10-year capital improvement plan for the district are shown in Table 7-3. Summary descriptions of each project can be found in Appendix A of this report.

Table 7-3
Recommended 10-Year Capital Improvement Projects

Project	Description	Estimated Cost (2022 Dollars)	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total (Inflated Cost)
S-1	Cottam Well 3	$1,977,000		$2,036,000										$2,036,000
S-2	Sand Hollow Well 7	$1,815,000		$1,869,000										$1,869,000
S-3	Sand Hollow Well 15	$1,815,000			$1,926,000									$1,926,000
S-4	Ash Creek Pipeline/Toquer Reservoir Project	$92,395,000	$14,000,000	$27,056,000	$27,056,000	$27,056,000								$95,168,000
S-5	Sullivan Wells Project (Wells, Pipelines)	$14,663,000					$16,503,000							$16,503,000
S-9	Quail Creek WTP 80 MGD Expansion	$130,000,000				$142,055,000								$142,055,000
S-12	Dry Wash Reservoir	$15,465,000			$16,407,000									$16,407,000
S-13	Graveyard Wash Reservoir	$17,794,000			$18,878,000									$18,878,000
ST-1	Cottam Well 3 MG Tank	$6,330,000		$6,520,000										$6,520,000
ST-2	Sand Hollow 2 MG Tank B	$6,050,000			$6,418,000									$6,418,000
ST-3	Quail Creek 10 MG Tank B	$25,988,000				$28,398,000								$28,398,000
ST-4	Sullivan Wells 1 MG Tank	$3,307,000					$3,722,000							$3,722,000
C-1	Sand Hollow North Dam to West Dam Pipeline	$3,660,000		$3,770,000										$3,770,000
C-2	Quail Creek to Cottam Pump Stations and Pipeline, Phase 1	$10,610,000			$11,256,000									$11,256,000
C-3	Quail Creek to Cottam Pump Stations and Pipeline, Phase 2	$11,922,000							$14,235,000					$14,235,000
C-5	Regional Pipeline to Sand Hollow Booster Pump	$2,904,000				$3,173,000								$3,173,000
C-6	Hurricane Valley Booster Pump Station	$2,306,000		$2,375,000										$2,375,000
C-7	Toquerville Springs to Cottam Pipeline Pump Station	$926,000							$1,106,000					$1,106,000
	Total Improvements	**$349,927,000**	**$14,000,000**	**$43,626,000**	**$81,941,000**	**$200,682,000**	**$20,225,000**	**$0**	**$15,341,000**	**$0**	**$0**	**$0**	**$0**	**$375,815,000**

[1]A 3% inflation rate has been applied to future project costs.

APPENDICES

APPENDIX A

RECOMMENDED CAPITAL PROJECT SUMMARIES

SENSITIVE INFORMATION HAS BEEN REDACTED

FOR SECURITY PURPOSES

APPENDIX B

INVENTORY OF DISTRICT WATER RIGHTS

Water Right	Change Application Number	cfs	AND_OR	ac-ft	Priority Year	Water System
81-351		0		10000	1956	Ash Creek/Ash Creek Reservoir
81-5348		1.0005	OR	85.537	1917	Ash Creek/Leap Creek
81-4902	a37588	0.5712	OR	170.7912	1885	Ash Creek/Wet Sandy
81-4800		0		36.704	1885	Cottam Wells
81-2935		0		6.4796	1925	Cottam Wells
81-3813		0		1	1925	Cottam Wells
81-3890		0		22.44	1925	Cottam Wells
81-4199	a42542	0		0.45	1925	Cottam Wells
81-4202	a42542	0		0.5	1925	Cottam Wells
81-4203	a42542	0		0.95	1925	Cottam Wells
81-4204		0		0.5	1925	Cottam Wells
81-4205		0		1.5	1925	Cottam Wells
81-4206		0		0.5	1925	Cottam Wells
81-4232		0		0.45	1925	Cottam Wells
81-4233		0		0.5	1925	Cottam Wells
81-4378		0		0.45	1925	Cottam Wells
81-4439		0		0.7885	1925	Cottam Wells
81-4440		0		0.05	1925	Cottam Wells
81-4441		0		1	1925	Cottam Wells
81-4445		0		0.55	1925	Cottam Wells
81-4446		0		0.41	1925	Cottam Wells
81-4452		0		0.143	1925	Cottam Wells
81-4454		0		0.167	1925	Cottam Wells
81-4492	a42542	0		0.45	1925	Cottam Wells
81-4494	a42542	0		0.45	1925	Cottam Wells
81-4495		0		0.45	1925	Cottam Wells
81-4572		0		0.45	1925	Cottam Wells
81-4695		0		1.8	1925	Cottam Wells
81-4731		0		0.1	1925	Cottam Wells
81-4901	a42542	0		2.778	1934	Cottam Wells
81-4900	a42542	0		0.57	1955	Cottam Wells
81-4140		0		0.25	1961	Cottam Wells
81-4143		0		0.5	1971	Cottam Wells
81-4241		0		0.5	1971	Cottam Wells
81-4379		0		0.25	1971	Cottam Wells
81-4493	a42542	0		0.5	1971	Cottam Wells
81-4732		0		0.25	1971	Cottam Wells
81-4200	a42542	0		0.45	1981	Cottam Wells
81-4201	a42542	0		0.45	1981	Cottam Wells
81-529	a40391	0		71.75	1978	Dixie Deer/Central
81-4002	a33450	0.95378	OR	156	1961	Ence Wells
81-574	a18837	1	OR	288.6	1963	Ence Wells
81-1671		0.1488	OR	30.152	1964	Ence Wells
81-1303	a21555	0.167		30	1975	Ence Wells
81-1559		0.0064	OR	1.54	1975	Ence Wells
81-1732		0.0841	OR	25.2	1975	Ence Wells
81-2713	a21555	0.2471		0	1975	Ence Wells
81-2714		0.2471	OR	58.74	1975	Ence Wells
81-4173	a21555	0.0341	OR	10.23	1975	Ence Wells
81-1669		0.3512	OR	223.62	1978	Ence Wells
81-70	a38081	0.46	OR	11.28	1917	Ence Wells/Santa Clara Wells
81-4679	a45937	0.4275	OR	108	1958	Ence Wells/Santa Clara Wells
81-671	a38693	1	OR	318.936	1965	Ence Wells/Santa Clara Wells
81-1280		0		0.5	1903	Kolob Irrigation
81-4847	a36635	0		1	1951	Kolob Irrigation
81-3879	a36770	0.09	OR	5	1858	Kolob Retail Water System
81-3907	a34602	0		6	1858	Kolob Retail Water System
81-4103	a36770	0		3	1858	Kolob Retail Water System
81-4288	a36770	0		1.5	1858	Kolob Retail Water System

81-4363	a36770	0	0.66	1858	Kolob Retail Water System
81-4364	a36770	0	2.25	1858	Kolob Retail Water System
81-4854	a36770	0	0.25	1858	Kolob Retail Water System
81-4873	a36989	0 OR	0.25	1858	Kolob Retail Water System
81-990	a36770	0.1 OR	3.78	1858	Kolob Retail Water System
81-993	a36770	0.02	0	1858	Kolob Retail Water System
81-994	a36770	0.04 OR	1.4	1858	Kolob Retail Water System
81-5051	a40358	0 OR	0.25	1860	Kolob Retail Water System
81-5181	a43098	0	0.4	1880	Kolob Retail Water System
81-4360	a24774	0	0.5	1900	Kolob Retail Water System
81-4539	a29176	0	0.25	1900	Kolob Retail Water System
81-2152		0.0047	0	1900	Kolob Retail Water System
81-2153		0.0094	0	1900	Kolob Retail Water System
81-4989		0	1	1903	Kolob Retail Water System
81-4547		0	3.52	1951	Kolob Retail Water System
81-4855	a36770	0	0.5	1951	Kolob Retail Water System
81-4856	a36770	0	2.11	1951	Kolob Retail Water System
81-4874	a36989	0 OR	0.25	1951	Kolob Retail Water System
81-490	a34602	0.025 OR	2.5	1961	Kolob Retail Water System
81-583	a34602	0.1 OR	12.86	1963	Kolob Retail Water System
81-862		0	0.5	1966	Kolob Retail Water System
81-976	a36770	0	1.3	1968	Kolob Retail Water System
81-3776	a66387	0.025 OR	18	1992	Unapproved
81-48		2.5	0	1914	La Verkin Hot Springs
81-69		2.5	0	1917	La Verkin Hot Springs
81-3701		5	0	1991	La Verkin Hot Springs
89-1525	a16775	0	100000	1996	Lake Powell Pipeline
81-2816	a21554	2.64	0	1895	Virgin/Meadow Hollow, La Verkin Creek & Washington Diversion
81-180	a21554	5 OR	104.68	1947	Virgin/Meadow Hollow, La Verkin Creek & Washington Diversion
81-179	a21554	0	104.68	1949	Virgin/Meadow Hollow, La Verkin Creek & Washington Diversion
81-283	a21554	0	104.68	1952	Virgin/Meadow Hollow, La Verkin Creek & Washington Diversion
81-4428		0	15000	2001	Renumbered
81-4436		0	15000	2002	Renumbered
81-4231		0	0		Renumbered
81-4400	a44965	0	8	1958	Sand Hollow Wells
81-4816	144965	0	3	1958	Sand Hollow Wells
81-4976	a44965	0 OR	0.882	1958	Sand Hollow Wells
81-4978	a44965	0	2.1	1958	Sand Hollow Wells
81-4596	a44965	1.71881	0	1959	Sand Hollow Wells
81-4974	a44965	0 OR	25.6875	1959	Sand Hollow Wells
81-4977	a44965	0 OR	77.0625	1959	Sand Hollow Wells
81-5006	a44965	0	18.79	1959	Sand Hollow Wells
81-3629	a44965	0	80	1967	Sand Hollow Wells
81-3956	a44965	0	12.78	1967	Sand Hollow Wells
81-5000	a44965	0	27	1967	Sand Hollow Wells
81-3630	a44965	0	130	1967	Sand Hollow Wells
81-2187	a44965	0.238 OR	45	1968	Sand Hollow Wells
81-2432	a44965	0.143 OR	54	1968	Sand Hollow Wells
81-3799	a44965	0	6.84	1968	Sand Hollow Wells
81-3920	a44965	0	45	1968	Sand Hollow Wells
81-4250	a44965	0	59.7869	1968	Sand Hollow Wells
81-4594	a44965	1.30031 OR	260.6305	1968	Sand Hollow Wells
81-3706	a44965	0	36.3	1968	Sand Hollow Wells
81-2424	a44965	1.37 OR	288.672	1971	Sand Hollow Wells
81-3819	a44965	0	274.08	1971	Sand Hollow Wells
81-4595	a44965	0.65372		1971	Sand Hollow Wells
81-4975	a44965	0 OR	19.83	1975	Sand Hollow Wells
81-3809	a44965	0.1345 OR	42	1977	Sand Hollow Wells
81-3618	a44965	0	80	1980	Sand Hollow Wells
81-3925	a44965	0	121.996	1980	Sand Hollow Wells
81-3955	a44965	0	12.81	1980	Sand Hollow Wells
81-3957	a44965	0	8	1980	Sand Hollow Wells
81-4243	a44965	0	70.73	1980	Sand Hollow Wells

81-4647	a44965	0		15	1980	Sand Hollow Wells
81-4648	a44965	0		36.61875	1980	Sand Hollow Wells
81-4999	a44965	0		27	1980	Sand Hollow Wells
81-1628	a44965	0		93.3	1981	Sand Hollow Wells
81-2158	a44965	0		7.5	1981	Sand Hollow Wells
81-3623	a44965	0		31.08	1981	Sand Hollow Wells
81-3625	a44965	0		62.25	1981	Sand Hollow Wells
81-3954	a44965	0		93.33	1981	Sand Hollow Wells
81-4193	a44965	0		69.33	1981	Sand Hollow Wells
81-4799	a44965	0		4.5	1981	Sand Hollow Wells
81-3547	a5327	0.1487		0	1890	St. George & Washington Canal Company
81-1127	a1520	0.44	OR	144	1890	St. George & Washington Canal Company
81-3542	a3905	1.07	OR	351.48	1890	St. George & Washington Canal Company
81-3544	a7129	29.8513	OR	8608.8	1890	St. George & Washington Canal Company
81-3548		56	OR	18480	1900	St. George & Washington Canal Company
81-174	a3704	9		0	1943	St. George & Washington Canal Company
81-484		6		0	1961	St. George Washington Canal Company
81-488	a11363	6		0	1976	St. George Washington Canal Company
81-486		6		0		Lapsed
81-5278	a45316	0		377.52		St. George Washington Canal Company
81-1112	a23532	4		1448	1970	Sullivan Wells
81-4863	a36908	0.4324	OR	142.416	1862	Toquerville Springs
81-4864	a36908	2.346	OR	775.56	1862	Toquerville Springs
81-4865	a36908	3.2384	OR	1070.88	1862	Toquerville Springs
81-4866	a36908	0.1472	OR	44.16	1912	Toquerville Springs
81-51	a18455	8		0	1914	Toquerville Springs
81-37	a26026	3		0	1912	Toquerville Springs/Ash Creek
81-334		2		0	1957	Unapproved
81-427		0		4000	1961	Unapproved
81-1178		4		0	1970	Unapproved
81-3693		500	OR	40000	1990	Unapproved
81-3699		0		20000	1991	Unapproved
81-3824		2		0	1993	Unapproved
81-3828		5		0	1993	Unapproved
81-3829		10		0	1993	Unapproved
81-3830		10		0	1993	Unapproved
81-3832		0		10000	1993	Unapproved
81-3833		0		10000	1993	Unapproved
81-3834		0		6000	1993	Unapproved
81-3927		1	OR	500	1900	Virgin River/Cottam Wells
81-4108		2.67857	OR	1500	1922	Virgin River/Cottam Wells
81-4367		0.89286	OR	500	1922	Virgin River/Cottam Wells
81-3928		5		0	1994	Virgin River/Cottam Wells
81-5060	a40710	1.0847	OR	358	1893	Virgin River/Crystal Creek, Kolob, Quail Diversion
81-355	a30888	50	OR	6000	1957	Virgin River/Crystal Creek, Kolob, Quail Diversion
81-2478		0.275	OR	95.85	1880	Virgin River/Quail & Washington Diversion
81-2476		1	OR	330	1900	Virgin River/Quail & Washington Diversions
81-3107	a14441	1	OR	160	1900	Virgin River/Quail & Washington Diversions
81-142		0		4000	1937	Virgin River/Quail & Washington Diversions
81-143		0		4000	1937	Virgin River/Quail & Washington Diversions
81-1382		0		12820	1962	Virgin River/Quail & Washington Diversions
81-2273		0		28891.45	1962	Virgin River/Quail & Washington Diversions
81-2547		0		40000	1962	Withdrawn
81-2548		0		10000	1962	Withdrawn
61-64		10	OR	5400	1966	Virgin River/Quail & Washington Diversions
81-2318		250		0	1983	Virgin River/Quail & Washington Diversions
81-5067	a40901	0	OR	1242	1890	Virgin River/Quail Diversion
81-1137		0.4558	OR	82.35	1900	Virgin River/Quail Diversion
81-1381		33.92857	OR	19000	1922	Virgin River/Quail Diversion
81-110	a13526	35		0	1928	Virgin River/Quail Diversion
81-124	a13527	65		0	1931	Virgin River/Quail Diversion
81-2948		0		190	1951	Virgin River/Quail Diversion
81-507		0		147600	1962	Virgin River/Quail Diversion

81-3996	a12603a	0		5108.55	1962	Virgin River/Quail Diversion
81-4211	a22832	0		50000	1962	Virgin River/Quail Diversion
81-93		37.5		0	2013	Virgin River/Quail Diversion
81-3561	a31451	0.3675	OR	88.2	1880	Virgin/La Verkin Creek, Quail & Washington Diversion
81-3576	a31451	0.1265	OR	63	1880	Virgin/La Verkin Creek, Quail & Washington Diversion
81-3578	a31451	0.0775	OR	18.6	1880	Virgin/La Verkin Creek, Quail & Washington Diversion
81-3589	a31451	0.2175	OR	52.2	1880	Virgin/La Verkin Creek, Quail & Washington Diversion
81-3931	a31451	0.025	OR	6	1880	Virgin/La Verkin Creek, Quail & Washington Diversion
81-3562	a31451	0.2325	OR	55.8	1902	Virgin/La Verkin Creek, Quail & Washington Diversion
81-3577	a31451	0.1125	OR	27	1902	Virgin/La Verkin Creek, Quail & Washington Diversion
81-3579	a31451	0.035	OR	8.4	1902	Virgin/La Verkin Creek, Quail & Washington Diversion
81-3590	a31451	0.1575	OR	37.8	1902	Virgin/La Verkin Creek, Quail & Washington Diversion
81-3932	a31451	0.225	OR	52.266	1902	Virgin/La Verkin Creek, Quail & Washington Diversion
81-4557		0.3119	AND	113	2004	Washington Diversion - Non-Consumptive
81-184		0.2432	OR	62.002	1944	Washington Diversion Spring
81-615	a34530	1	OR	61.2	1964	Washington Diversion/La Verkin Creek
89-426		0		0	1864	
89-435		0		0	1864	

APPENDIX C

RWSA PARTNER WATER SUPPLY INVENTORY

TECHNICAL MEMORANDUM

TO:	Zach Renstrom – General Manager Brie Thompson – Assistant General Manager Whit Bundy – District Engineer
COPIES:	File
FROM:	Aaron Anderson – Bowen Collins & Associates
DATE:	12/15/2020
SUBJECT:	Inventory of Existing Water Sources in Washington County
JOB NO.:	285-19-02

INTRODUCTION

Washington County Water Conservancy District (District) is developing a regional capital facilities plan to determine the infrastructure needed to meet the future culinary and secondary irrigation water demands of the county. A central component of this analysis is to update and verify the supply source capacity that the District will need to develop to meet the demands of the many growing communities in its region. The county's current water needs are met through a combination of wholesale and retail water provided by the District and individual cities or towns. In order to better understand the future water needs of the county and, more specifically, the source capacity that the District needs to acquire and develop, it is necessary to identify what each city, town, or water company is able to provide on their own.

The purpose of this technical memorandum (TM) is to document the supply source information that has been gathered and reviewed from individual communities in Washington County, focusing on the larger cities. The information in this report has been gathered from multiple sources, including master plan documents, the Utah Division of Water Rights (UDWRi), and personal communication with water managers. This study is not merely a water rights inventory for each community; it is intended to identify the *reliable* capacity of sources in Washington County.

The reader should refer to each city's respective master planning documents for more information regarding water sources. This TM is intended to provide a summary of the information gathered and evaluated and does not provide a comprehensive documentation of all source data. The supply source inventory has been organized by city and is not presented in any particular order.

CITY OF ST. GEORGE

Existing Culinary Water Sources

In terms of population, the City of St. George is the largest community in Washington County. In kind, St. George holds the largest portfolio of individually owned and operated culinary water sources. The city's culinary water sources include several wells and springs located throughout the county. The estimated reliable annual yield and reliable peak production capacity of St. George's culinary water supplies is shown in Table 1.

Table 1
Summary of Existing Culinary Water Sources – City of St. George

Culinary Water Supply	Water Right #	Water Right (AF)	Reliable Annual Yield (AF)	Reliable Peak Production Capacity (gpm)
Mountain Springs[1]	81-1131	304.8	1,230	2,000
	81-1132	2,218.55		
	Subtotal	***2,523.35***		
City Creek Wells, Millcreek Wells, Ledges Wells, Tolman Wells[2]	81-293	796.36	3,716	3,040
	81-319	960		
	81-481	5.58		
	81-528	153.48		
	81-627	300		
	81-1428	89.99		
	81-548	532.71		
	81-577	1,597.31		
	81-1777	6		
	81-626	122.8		
	81-646	19.9578		
	81-2229	30		
	81-3122	1.01		
	81-3929	30		
	Subtotal	***4,645.20***		
Gunlock Wells[3]	81-451	8,687.61	9,811	6,620
	81-4390	4,343.8		
	Subtotal	***13,031.41***		
Snow Canyon Wells[4]	81-845	1,440	1,152	1,019
West City Springs[5]	81-3753	1,114.9	564	350
Total		**22,754.86**	**16,473**	**13,029**

[1]Water rights 81-1131 and 81-1132 are tied to a series of mountain springs located at the base of the Pine Valley Mountains and an irrigation spring located within the city. The average annual production of the mountain springs over the past 10 years is 2,430 AFY, with a 10-year low of 1,230 AF. East City Springs is not metered, but its assumed average annual yield is approximately 480 AF. Therefore, the reliable yield of these sources is less than the water right. The reliable yield listed is equal to the 10-year low flow from the Mountain Springs (East City Springs are used for irrigation and are documented in Table 2).

[2]This group of wells operate under several different water rights that are essentially tied together with multiple points of diversion. The city can produce water from any of these wells under the listed water rights. The reliable annual yield and reliable peak production capacity of these wells has been assumed to be equal to 80% of the combined water rights and 80% of the design capacity of the wells, respectively. The city has evaluated the wells in this manner to account for long-term sustainability of the aquifers and to account for potential downtime for wells due to mechanical failure, power outages, pump replacement, etc.

[3]The Gunlock Well Field has a total water right of 13,031 AF. Like the other culinary well group, the reliable annual yield and reliable peak production capacity of these wells is estimated to be 80% of the combined water rights and well design capacities, respectively. The reliable annual yield and peak production capacity for St. George have also been reduced by 614 AFY and 380 gpm, respectively, to account for a water delivery agreement with Ivins City (see section on Ivins City for more information). Three of the Gunlock Wells are currently used in the secondary irrigation system, but St. George may utilize these wells for culinary demand in the future. St. George also has commitments to supply supplemental water to local irrigation companies during low water years, and has additional commitments to supply water to the Shivwits Indian Tribe.

[4]St. George entered into the Snow Canyon Compact with Santa Clara City and Ivins City to develop 5 wells in Snow Canyon. The ownership of these wells is as follows: St. George – 63.7%; Santa Clara – 24.1%; Ivins – 12.2%. The wells have a combined capacity of 2,000 gpm. The values shown in the table reflect the portion of the Snow Canyon Compact available to St. George, reduced by 20% (assuming 80% reliable annual yield and reliable pumping capacity).

[5]The West City Springs provide water for both the culinary water and secondary irrigation systems. The quantities shown represent the volume/flow rate typically produced for the culinary water system. Production from this source has historically been very consistent.

Existing Secondary Irrigation Water Sources

The City of St. George operates an extensive secondary irrigation system that delivers untreated water to many of the city's parks, golf courses, and schools. The City also provides pressurized secondary irrigation to a limited number of residential connections and is planning to continue expanding the system in the future, particularly in areas of new development. Water for the system is provided by a combination of city-owned sources and shares in local irrigation companies. Table 2 summarizes the estimated reliable annual yield and peak production capacity for the sources used in the St. George secondary irrigation system.

Table 2
Summary of Existing Irrigation Sources – City of St. George

Secondary Irrigation Supply	Water Right Number	Water Right (AF)	Reliable Annual Yield (AF)	Reliable Peak Production Capacity (gpm)
Sunbrook Wells, Mathis Well, Moores Well, Sunset Well[1]	81-2454	156	2,873	2,400
	81-2461	139.24		
	81-322	32.04		
	81-3420	10.758		
	81-321	28.68		
	81-4582	517.62		
	81-4583	217.38		
	81-498	168.54		
	81-612	279.864		
	81-622	200.04		
	81-4649	0.6		
	81-659	1,340		
	81-377	8.784		
	81-2289	24		
	81-1574	91.08		
	81-4486	55		
	81-4487	175.992		
	81-4488	31.56		
	81-2227	30		
	81-2466	77.65		
	81-1577	6.858		
	Subtotal	***3591.69***		
West City Springs[2]	81-3753	1,114.9	550	341
East City Springs[3]	81-3754	550.2	480	300
	81-1131	304.8		
	81-1132	2,218.55		
	Subtotal	***550.2***		
SGWRF Reuse Facility	See Note 4	See note 4	4,400	4,800
St. George Clara Fields Canal Company	NA[5]	NA	712	1,000
New Santa Clara Water Company	NA[5]	NA	5	20
St. George Valley Irrigation Company	NA[5]	NA	1,768	2,700
Bloomington Water Company	NA[5]	NA	1,247	900
St. George Washington Fields Canal Company	NA[5]	NA	1,932	2,700
Millcreek Water Company	NA[5]	NA	670	1,000
Total		**4,141.89**	**14,637**	**16,161**

[1]This group of wells operates under the pool of water rights listed. The reliable annual yield and peak reliable production capacity of these sources is estimated to be equal to 80% of the combined water rights and design well pumping capacities, respectively.
[2]West City Springs is used in both the culinary water system and secondary irrigation system. The source yields shown correspond to the amount used for irrigation. This water right is accounted for in the culinary water sources and is not included in the total listed in the table.
[3]East City Springs operates under the same water right as the city's Pine Valley Mountain springs in addition to water right #81-3754. The subtotal shown does not include water right #81-1131 and #81-1132 which have already been included in the culinary water source inventory.
[4]The reclaimed water that is treated and reused from the SGWRF comes from St. George City water rights. The combined water rights allow for up to 6,400 AF to be treated at the reuse facility. Of this 6,400 AF, 2,000 AF is dedicated to the Shivwits Indian Reservation, leaving 4,400 AF usable within St. George.
[5]St. George holds shares in multiple water companies, but does not hold the underlying water right. The reliable annual yields and peak production capacity are calculated based on the city's number of shares in each respective company, accounting for the cuts that occur during drought years.

Planned Future Source Development Projects

St. George holds undeveloped water rights in different areas of the county. Some of these rights are for lower quality water sources, such as groundwater around the Virgin River that is traditionally high in total dissolved solids (TDS) which may be difficult and expensive to develop. While the exact timing for developing these water rights is unknown, the city does plan to eventually develop all its water rights. Table 3 lists the city's existing water rights that are either in non-use or have not been developed. It is important to note that, until these water rights are actually developed, it is uncertain whether they represent reliable future sources of water for the city. Water quality, climate change, and other factors may have a significant impact on the yield and functionality of these future sources.

The city is planning at some point in the future to drill additional wells in the Gunlock Well Field to increase peak production capacity (this does not represent an increase in reliable annual yield). The city is also planning to continue expanding the capacity of its reuse water facility.

Table 3
Summary of Non-Use/Undeveloped Water Rights – City of St. George

Non-Use or Undeveloped Water Rights	Priority Date	Annual Volume[1] (AF)
81-1019	1870	14.931
81-1261	4/12/1974	106
81-1323	11/8/1972	1
81-1397	11/23/1960	240.09
81-1492	4/12/1965	15.44
81-1494	4/12/1965	52.172
81-1500	4/12/1965	40
81-1576	4/12/1965	27.06
81-1597	1890	1,098
81-1648	2/16/1968	20.928
81-1651	11/30/1973	1.08
81-1652	2/16/1968	21.192
81-1748	4/29/1969	360
81-2214	4/12/1965	37.08
81-2433	2/16/1968	1.9
81-2463	4/12/1965	40
81-2465	11/30/1978	126.18
81-2618	5/8/1964	1.4
81-285	3/21/1953	42.6
81-2950	9/17/1962	1.01
81-30	5/29/1911	580
81-302	1/31/1955	80.238
81-3159	1890	136.8
81-3421	4/12/1965	37.938
81-379	12/5/1958	204
81-3873	5/18/1966	97.825
81-4216	5/8/1964	60
81-445	9/28/1975	720
81-4592	4/11/1975	266
81-4593	11/30/1978	275
81-4598	4/11/1975	39
81-4613	2/16/1968	49
81-4631	4/12/1965	24.06
81-5340	1/31/1955	518.586
81-670	5/26/2020	2,257.4
Total		**7,593.91**

[1]Volumes shown do not necessarily equate to future reliable yields. Several factors may limit the actual amount of water that can be used from these undeveloped water rights.

IVINS CITY

Existing Culinary Water Sources

Ivins is a rapidly changing city that has quickly transformed from a small rural town into a growing residential community. Ivins City holds a portion of ownership in the Snow Canyon Compact with St. George and Santa Clara, and the remainder of source capacity comes through agreements with the District and the City of St. George. Ivins is unique in that the City is serviced by two different water systems. The Ivins City municipal water system services the majority of the city, while the Kayenta development on the west side of Ivins is serviced by the Kayenta Water Users (KWU) system. Previously, the sole source of water for the Kayenta Water Users system was the Ence Wells which are owned and operated by the District. However, a pending agreement between the District and the City of St. George will allow Kayenta to also be supplied water from the Gunlock Well system (via a new connection to the Gunlock pipeline on Old Highway 91). Table 4 shown below summarizes the culinary water sources owned by Ivins City as well as the Gunlock Well Agreement with the City of St. George. All additional culinary water needed in Ivins is provided by the District.

Table 4
Summary of Existing Culinary Water Sources – Ivins City

Culinary Water Supplies	Water Right #	Water Right (AF)	Reliable Annual Yield (AF)	Reliable Peak Production Capacity (gpm)
Snow Canyon Wells[1] (Snow Canyon Compact)	81-86	72.4	392.6	244
	81-1322	138		
	81-1427	138.72		
	81-2207	2		
	81-2328	19.22		
	81-2411	19.22		
	81-2457	3		
	Subtotal	***392.56***		
Gunlock Well Agreement with St. George	NA	NA	614[2]	380[3]
Total		**392.56**	**1,006.6**	**624**

[1]Ivins hold 12.2% ownership in the Snow Canyon Compact, which is reflected in the values shown. The reliable yield from the Snow Canyon Wells is assumed to be equal to 100% of Ivins City's water right.
[2]When available, the City of St. George allows Ivins City to use more water from the Gunlock Well Field than what is defined in the agreement. However, with the completion of the Gunlock Arsenic Treatment Plant and with the continued growth in St. George, Ivins City should only count on reliably receiving the volume specified in the agreement with St. George.
[3]The Gunlock Well Agreement does not specify an allowable flow rate from St. George into Ivins City. This is an estimated value based on the total annual volume available to Ivins, assuming that a constant flow is taken into Ivins over the course of the year.

Existing Secondary Irrigation Sources

The Ivins Irrigation Company provides irrigation water to many of the large agricultural users in Ivins as well as a handful of residential homes. As agricultural land is developed in the future, it is assumed that either Ivins City or the District will acquire the water shares for the proposed Ivins City secondary irrigation system, as outlined in the Ivins City Secondary Irrigation Master Plan[1]. Currently, Ivins City holds a small number of shares in the Ivins Irrigation Company and other local irrigation companies which are summarized in Table 5.

Table 5
Summary of Existing Irrigation Sources – Ivins City

Secondary Irrigation Supplies	Water Right #	Reliable Annual Yield[1] (AF)	Reliable Peak Production Capacity[2] (gpm)
St. George Clara Irrigation Company	NA[3]	96.9	60.1
Ivins Irrigation Company	NA[3]	51.8	32.1
Santa Clara Irrigation Company	NA[3]	24.8	15.4
Total		**173.5**	**107.6**

[1]The listed irrigation companies receive water primarily from Gunlock Reservoir. Depending on annual precipitation, yields from Gunlock Reservoir vary from year to year. During dry years, irrigation users may receive cuts, reducing the amount of water available for that given year. This considered, the reliable annual yield shown in the table is equal to 50% of the share volume held in the water companies.
[2]The irrigation shares do not have a restriction on peak production capacity, and the values shown are an estimate assuming a constant flow is used or stored year round.
[3]Ivins holds shares in the irrigation companies, but does not hold the underlying water rights.

Planned Future Source Development Projects

Ivins City does not have any other undeveloped water rights and will rely on the District to develop all additional water needed to meet future demands.

[1] "Secondary Irrigation Master Plan." Prepared for Ivins City by Bowen Collins & Associates. February 2019.

SANTA CLARA CITY

Existing Culinary Water Sources

Santa Clara is a primarily residential community that has seen significant growth over the last few years. The area north of the Santa Clara River is approaching full build-out, and new development is expanding on the south side of the river. Santa Clara's culinary water system is supplied by wells in Snow Canyon as well as water provided by the District and St. George. Santa Clara is a part owner in the Snow Canyon Compact (24.1%) and has 2 additional wells in Snow Canyon. The city also owns a number of small springs located in St. George along the north side of Snow Canyon Parkway. St. George currently uses these springs for irrigation through an exchange agreement with Santa Clara. Table 6 provides a summary of the water sources owned by the City of Santa Clara.

Table 6
Summary of Existing Culinary Water Sources – City of Santa Clara

Culinary Water Supplies	Water Right #	Water Right (AF)	Reliable Annual Yield[1] (AF)	Reliable Peak Production Capacity (gpm)
Snow Canyon Wells (Snow Canyon Compact)	81-782	361.98	1,071.47[2]	482
	81-973	709.49		
	Subtotal	***1,071.47***		
Snow Canyon Wells (Well #6 and #7)	81-893	1,447.9338	1,479.11	1,500[3]
	81-4123	2.74		
	81-4225	20.01		
	81-4226	8.43		
	Subtotal	***1,479.11***		
Sheep Spring, Miller Spring, Beecham Spring, Gray Springs[4]	81-149	13	95.2	59
	81-741	128.9		
	81-742	40.5		
	81-1061	8		
	Subtotal	***190.4***		
Total		**2,740.98**	**2,645.78**	**2,041**

[1]Reliable annual yield is estimated to be equal to 100% of the city's water rights.
[2]Santa Clara's total water right in the Snow Canyon Compact is 1,071 AF. Based on the 24.1% ownership in the project, Santa Clara has 482 gpm worth of production capacity in the 5 wells, which would produce 778 AFY (assuming constant well operation). However, Santa Clara has additional well capacity in Snow Canyon Well #6 and #7 that could be used to produce the remaining volume.
[3]The Santa Clara Culinary Water Master Plan[2] indicates that Snow Canyon Well #6 and #7 have a combined pumping capacity of 1,971 gpm. However, through recent communication with Santa Clara personnel, the reliable production capacity for the 2 wells is estimated to be 1,500 gpm.
[4]Spring sources are currently being used by the City of St. George for irrigation. The water is then exchanged with St. George through a culinary water system interconnection. The reliable annual yield and peak reliable production capacity have been estimated to be equal to 50% of the water right, assuming the spring produces consistent flow throughout the year.

[2] "Santa Clara City, Utah Water Impact Fee Facilities Plan & Culinary Water Master Plan". Prepared by Sunrise Engineering. June 2018.

Existing Secondary Irrigation Sources

Santa Clara does not currently have a city-managed pressurized secondary irrigation system. There are, however, a number of agricultural users that hold shares in the local irrigation companies. The City is planning to extend pressurized secondary irrigation to a limited number of future residential users (only where new homes are built within close proximity of existing irrigation infrastructure). Table 7 provides a summary of Santa Clara's secondary irrigation sources.

Table 7
Summary of Existing Secondary Irrigation Sources - City of Santa Clara

Secondary Irrigation Supplies	Water Right #	Water Right (AF)	Reliable Annual Yield[1] (AF)	Reliable Peak Production Capacity[1] (gpm)
Rex Jackson Sunbrook Well	81-4189	95	95	58.9
Crystal Lakes Sunbrook Well	81-497	120	120	74.4
Ralph Hafen Well	81-475	7.56	7.56	4.7
McDermitt Well	81-4184	150	150	93.0
J. Ross Hurst Entrada Well	81-1496	26.22	26.22	16.3
Irrigation Company Shares[2]	NA	NA	53.1	32.9[3]
Total		**398.78**	**451.88**	**280.2**

[1]Estimated reliable yield and reliable peak production capacity of the city's irrigation wells have been assumed to be equal to 100% of water right.
[2]Irrigation shares come primarily from Gunlock Reservoir. Depending on annual precipitation, yields from Gunlock Reservoir vary from year to year. During dry years, irrigation users may receive cuts, reducing the amount of water available for that given year. This considered, the reliable annual yield and peak production capacity shown in the table are equal to 50% of the amount held in the irrigation company shares.
[3]Estimated value based on annual allocation in water company shares.

Planned Future Source Development Projects

Santa Clara City does not have any other undeveloped water rights and will rely on the District to develop all additional water needed to meet future demands.

WASHINGTON CITY

Existing Culinary Water Sources

Washington City is another rapidly growing community in Washington County that has a mix of residential and non-residential (commercial, industrial, etc.) development. Source capacity for the Washington City culinary water system is provided in part by city-owned wells, with the majority of capacity being provided from the District via connections to the Regional Pipeline and a raw water connection to Quail Creek Reservoir that is treated at Washington's microfiltration plant. Table 8 provides a summary of the culinary water sources owned by Washington City. Most of the city's wells are tied to a common pool of water rights, providing flexibility in which wells are utilized in the system.

Table 8
Summary of Existing Culinary Water Sources – Washington City

Culinary Water Supplies	Water Right #	Water Right (AF)	Reliable Annual Yield[1] (AF)	Reliable Peak Production Capacity[2] (gpm)
Well #2, Well #3, Well #4, Well #5, Well #6, Grapevine Well #1, Grapevine Well #2	81-666	151.4	2,666	2,900
	81-1087	535.76		
	81-1674	724		
	81-1719	434.4		
	81-1747	11.786		
	81-2412	1,578.002		
	81-1610	53		
	81-4313	160		
	81-5075	159.55		
Total		**3,807.90**	**2,666**	**2,900**

[1]Through communication with Washington City personnel, the reliable annual yield from this well group is estimated to be equal to 70% of the combined water rights. The City is planning to drill additional wells in Grapevine Wash to increase the reliable annual yield from the combined well group to 100% of the water right.

[2]The Washington City Culinary Water Master Plan[3] documents the production capacity of the City's culinary wells. The report shows a combined wells capacity of 3,337 gpm. However, through recent discussions with Washington City personnel, the estimated reliable production capacity from the existing combined well group is 2,900 gpm. With the completion of the new wells in the Grapevine Wash area, the reliable production capacity of the wells will be increased to 3,337 gpm or greater.

Existing Secondary Irrigation Sources

Washington City supplies secondary irrigation water to a select number of areas throughout the city, but does not currently have a pressurized irrigation system. However, there is a significant amount of dry pressurized irrigation pipe in place in many of the newer developments, and the city is planning to eventually expand secondary irrigation throughout the majority of the service area. Currently, secondary irrigation in Washington is focused on golf courses, parks, and other large irrigable areas. Table 9 provides a summary of the City's existing secondary irrigation sources, which consist of both springs and wells.

[3] "Culinary Water Master Plan & Impact Fee Facilities Plan". Prepared for Washington City by Sunrise Engineering. October 2017.

Table 9
Summary of Existing Secondary Irrigation Sources – Washington City

Secondary Irrigation Supplies	Water Right #	Water Right (AF)	Reliable Annual Yield (AF)	Reliable Peak Production Capacity[7] (gpm)
Mill Creek (Tanner Ditch)	81-710	71.834	306.53[1]	273
	81-1150	213		
	81-1151	21.7		
	Subtotal	***306.53***		
Price/Pierce Springs	81-207	11.2941	11.29[2]	0
Prisby/Westover/Sproul Spring	81-222	4.8429	206.22[3]	0
	81-4076	249.6		
	81-4077	50.6786		
	Subtotal	***305.12***		
Adair Spring, Warm Spring, Unnamed Spring	81-4078	65.1582	384.62[4]	265
	81-4079	896.4		
	Subtotal	***961.56***		
Green Spring, Calvin Hall Spring	81-3667	199.8	126.53[4]	78.5
	81-3939	116.52		
	Subtotal	***316.32***		
Mascrew, Iron Bush, Cottonwood Spring	81-266	10.2081	4.08[4]	0
Green Stream	81-3665	6.3	2.52[4]	3.59
Sullivan Well	81-645	119	119[5]	224.4
Well #1	81-2412	1,578.002	NA[6]	1,000
Total		**3,614.34**	**1,160.79**	**1,844.49**

[1]The reliable annual yield and peak production capacity of Mill Creek has been estimated to be equal to 100% of the water right. The usage reported to the UDWRi shows that approximately 720 AFY is diverted from Mill Creek into Tanner Ditch, but not all of the water that is diverted is used by Washington. For this reason, the reliable yield shown in the table is equal to Washington City's water rights in the stream.
[2]The reliable annual yield of Price/Pierce Springs has been estimated to be equal to 100% of the water right. The usage reported to the UDWRi shows that approximately 60 acre-feet per year is produced from the springs, but Washington's water right is equal to 11.2941 AF.
[3]At the direction of Washington City personnel, the reliable annual yield of these sources has been estimated using recent recorded flow data as reported to UDWRi.
[4]At the direction of Washington City personnel, the reliable annual yield from these springs and surface water sources has been estimated to be equal to 40% of the water rights.
[5]The reliable annual yield and peak production capacity of Sullivan Well has been estimated to be equal to 100% of the water right.
[6]Well #1 operates under WR #81-2412 which is already accounted for in Washington's culinary well water right inventory.
[7]Peak production capacity of the Washington's secondary irrigation sources has been taken from the Draft Washington City Secondary Irrigation Master Plan, dated October 2020 or estimated based on the water right. It is believed that the City's groundwater springs and wells are interconnected, and that operating Well #1 will reduce the production from some of the springs. Springs that are expected to be affected by groundwater pumping have an assumed peak production rate of 0 gpm. However, this does not mean that these spring sources will produce no water over the course of the year. Assuming that Washington implements storage reservoirs in their future system, spring flow could be stored during the non-irrigation season to later be used during the summer months, but the spring yield is expected to be minimal during the irrigation season while Well #1 is under operation.

Planned Future Source Development Projects

According to the culinary water master plan, Washington is planning to develop additional small to medium sized wells within the Grapevine Pass Wash area. With the addition of these new wells, it is anticipated that Washington City will be able to produce the full groundwater right from their culinary wells (3,807.9 AF). Washington City has the option to upgrade/expand its surface water treatment plant, but does not have specific plans to do so in the near future. The city will continue to add new connections to the District's regional infrastructure to service developing areas.

HURRICANE CITY

Existing Culinary Water Sources

Hurricane City is geographically one of the largest cities in Washington County and, like most communities in the area, has seen significant growth in recent years. Hurricane operates both a culinary water and pressurized irrigation system (pressurized irrigation is currently only available on the east side of the city). The Hurricane Canal Company provides irrigation water for many of the agricultural users in the city.

Hurricane's culinary water system is supplied in part by city-owned wells and ownership in local springs, with the remaining demand being met by the District's sources. Table 10 provides a summary of Hurricane's existing culinary water sources.

Table 10
Summary of Existing Culinary Water Sources – Hurricane City

Culinary Water Supplies	Water Right #	Water Right (AF)	Reliable Annual Yield (AF)	Reliable Peak Production Capacity (gpm)
Hurricane Valley Wells (Stratton #1, Stratton #2, West Well)	81-281	80.00	2,100[1]	2,790[2]
	81-4678	8.20		
	81-4814	15.00		
	81-4162	24.00		
	81-4114	720.00		
	81-1338	102.72		
	81-1609	316.20		
	81-2224	15.00		
	81-3617	8.00		
	81-4124	8.33		
	81-3993	40.00		
	81-2215	28.38		
	81-1439	0.03		
	81-4112	139.64		
	81-1721	286.75		
	81-1722	258.25		
	81-975	79.26		
	81-1040	362.21		
	81-1588	210.00		
	81-1706	210.00		
	81-1723	96.14		
	81-1201	364.07		
	81-1279	153.53		
	81-1234	362.80		
	Subtotal	***3888.51***		
Toquerville Springs & Ash Creek Springs	81-1145	360.00	1,420.42[3]	1,608[4]
	81-1143	97.80		
	81-1144	367.62		
	81-3279	482.18		
	81-2743	3.00		
	81-2744	60.00		
	81-2745	36.00		
	81-4126	13.82		
	Subtotal	***1420.42***		
Total		**5308.93**	**3,520.42**	**4,398**

[1]Groundwater in the Hurricane area has been the topic of study for the past two decades, especially after the construction of Sand Hollow Reservoir. Studies have shown that the average natural recharge to the local aquifer (not including recharge from Sand Hollow Reservoir) is likely much less than the total water rights allocated for the basin. The District is continuing to evaluate the reliable annual yield of groundwater in the Hurricane area. For this study, the reliable annual yield of the Hurricane Valley Wells is assumed to be approximately equal to the amount of water that Hurricane has pumped annually from the West Well, Stratton Well #1, and Stratton Well #2 over the last 4 years.
[2]Value shown as reported in the Draft Hurricane City Culinary Water Master Plan (2022).
[3]Value assumed to be equal to 100% of combined water rights.
[4]Estimated value based on water rights.

Existing Secondary Irrigation Sources

Hurricane City holds a secondary irrigation water right in the Virgin River and also owns shares in the Hurricane Canal Company. This water from the Virgin River is diverted into the Hurricane City/Hurricane Canal Company irrigation systems from the Quail Creek Pipeline. The City also holds a water right in the Frog Hollow drainage basin.

According to the Hurricane Canal Company, there are a total of 2,000 primary shares and 772 secondary shares in the water company. Of these total shares, Hurricane City owns 279.50 primary shares and 33.65 secondary shares. During a lower water year, the Hurricane Canal Company receives a total of 12,000 AF of water. Primary shares receive 5.4 AF for a total of 10,800 AF. The secondary shares receive the remaining 1,200 AF at 1.55 AF per share. During an average or above average water year, the Hurricane Canal Company receives 15,000 AF of water. Primary shares in the company receives their 5.4 AF per share (for the same total of 10,800 AF), and the secondary shares receive 5.44 AF per share for a total of 4,200 AF. The city's existing secondary irrigation supply is summarized in Table 11.

Table 11
Summary of Existing Secondary Irrigation Sources – Hurricane City

Secondary Irrigation Supplies	Water Right #	Water Right (AF)	Reliable Annual Yield (AF)	Reliable Peak Production Capacity[3] (gpm)
Virgin River	81-2475	193.38	193.38	160
Frog Hollow[1]	81-279	1,000	0	0
Hurricane Canal Company[2]	NA	NA	1,561.46	1,310
Total		**1,193.38**	**1,754.84**	**1,087.9**

[1]This water right was previously used by the Hurricane Canal Company to divert water from Frog Hollow Wash into the canal system. The Hurricane Canal Company no longer uses this water right and turned it over to Hurricane City. At this point, no infrastructure is in place to use this water in the Hurricane secondary irrigation system, but the city is planning to ultimately utilize this water right. Due to the nature of Frog Hollow Wash, this is uncertain whether this source would provide a consistent, reliable source of irrigation water for Hurricane City. For this reason, no reliable yield has been assumed from this source at this time.
[2]Values shown for the Hurricane Canal Company correspond to the water that is available during a less than average water year.
[3]Estimated based on 9 months of operation over the course of the year at a sustained diversion rate.

Planned Future Source Development Projects

Hurricane holds additional groundwater rights that could be used to develop new sources in the future. These undeveloped water rights are summarized in Table 12. It is uncertain when Hurricane will develop these water rights, but it is assumed that they will at some point ultimately be developed into new sources of water. It is important to note that, until these water rights are actually developed, it is uncertain whether they represent reliable future sources of water for the city. Water quality, climate change, and other factors may have a significant impact on the yield and functionality of these future sources.

Table 12
Hurricane City Undeveloped Groundwater Rights

Water Right #	Priority Date	Annual Volume[1] (AF)
81-1490	11/22/1971	43.09
81-4197	11/22/1971	2
81-5092	5/28/1969	421.97
Total		**467.06**

[1]Volumes shown do not necessarily equate to future reliable yields. Several factors may limit the actual amount of water that can be used from these undeveloped water rights.

LA VERKIN CITY

Existing Culinary Water Sources

La Verkin City is a rural community that has also been experiencing a high growth rate in recent years. Its proximity to Zion National Park has made it an attractive location for new hotels and other tourism-based businesses. La Verkin's culinary water inventory consists of water rights in Ash Creek Springs and Toquerville Springs, with the remaining demand being met by the District's sources. Table 13 summarizes La Verkin's existing culinary water source capacity.

Table 13
Summary of Existing Culinary Water Sources – La Verkin City

Culinary Water Source	Water Right #	Water Right (AF)	Reliable Annual Yield[1] (AF)	Reliable Peak Production Capacity[1] (gpm)
Ash Creek Springs & Upper Ash Creek Springs	81-1073	72	473.35	803.8
	81-687	71.35		
	81-1602	330		
	Subtotal	***473.35***		
Toquerville Springs[2]	81-2287	241.1	241.1	149.5
Total		**714.45**	**714.45**	**953.3**

[1]Estimated reliable annual yield and peak reliable production is equal to 100% of the water right.

Existing Secondary Irrigation Sources

Alongside the culinary water system, La Verkin also operates an extensive pressurized secondary irrigation system that delivers untreated surface water to the majority of the city. Water for the secondary irrigation system in La Verkin is provided from water rights in the Virgin River via a connection to the District's Quail Creek Pipeline. Existing secondary irrigation source capacity for La Verkin is shown in Table 14.

Table 14
Summary of Existing Secondary Irrigation Sources – La Verkin City

Secondary Irrigation Source	Water Right #	Water Right (AF)	Reliable Annual Yield[1] (AF)	Reliable Peak Production Capacity[1] (gpm)
Virgin River (via Quail Creek Pipeline Diversion)	81-2477	1,640.22	2,630.22	3,577.3
	81-4334	990		
Total		**2,630.22**	**2,630.22**	**3,577.3**

[1]Estimated reliable annual yield and peak reliable production is equal to 100% of the water right.

Planned Future Source Development Projects

La Verkin City does not have any other undeveloped water rights that can be used in their water systems and will rely on the District to develop all additional water needed to meet future demands.

TOQUERVILLE CITY

Existing Culinary Water Sources

The City of Toquerville is a small rural community with the potential for significant growth in the coming years. A number of large development projects in the Toquerville West Fields are planned for the near future, all of which will place greater demands on the culinary water system. Toquerville holds several water rights in Toquerville Springs that are used for the culinary system, and also holds a small water right in Ash Creek. All additional water supply needs are provided by the District. Table 15 provides a summary of Toquerville's existing culinary water source capacity.

Table 15
Summary of Existing Culinary Water Sources – Toquerville City

Culinary Water Supplies	Water Right #	Water Right (AF)	Reliable Annual Yield[1] (AF)	Reliable Peak Production Capacity[1] (gpm)
Toquerville Springs	81-3474	12.384	538.76	334
	81-3475	67.44		
	81-3476	93.12		
	81-4063	3.84		
	81-3546	361.98		
	Subtotal	***538.76***		
Ash Creek	81-2739	18.57	18.57	25.7
Total		**557.33**	**557.33**	**359.7**

[1]Estimated reliable annual yield and peak reliable production is equal to 100% of the water right.

Existing Secondary Irrigation Sources

The Toquerville Secondary Water System (TSWS) provides secondary water to several customers in Toquerville. TSWS is governed by a board which includes two representatives from Toquerville City and two representatives from the District. Water for the TSWS system is provided by the District's shares in Toquerville Springs.

Planned Future Source Development Projects

Toquerville City does not have any other undeveloped water rights and will rely on the District to develop all additional water needed to meet future demands.

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