CARSON CITY
WATER RESOURCES REPORT

LAKE TAHOE AND MARLETTE LAKE

PUBLIC WORKS DEPARTMENT

FINAL JUNE 30, 2018

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OVERVIEW

The mission of this water planning and development effort is to develop a Sustainable Water Supply Plan based on four fundamental actions:

(1) Use water efficiently to get maximum utility from existing water resources;
(2) Protect water quality to safeguard the City's potable water supply;
(3) Plan for and secure the City's water supply for current and future populations; and
(4) Provide the above actions at the most optimal costs.

The Carson City Community Development Department does annual projections of population growth for the future for planning purposes. A high and low projection is done to provide a range of growth as it is difficult to predict increases since so many variables affect future change. The City Public Works Department then uses the rate of growth projections to plan for future water demands. For the purposes of this effort to determine future water resource demands the low and high projections, which were updated in March 2018, for the calendar year 2017 to 2067 were utilized.

The City has been following an Integrated Water Supply and Facilities Plan that was completed by Black and Veatch Consultants in 2011, which projected water demands, infrastructure needs, and future water supply considerations. This Integrated Water Supply and Facilities Plan recognizes that the City's groundwater and surface water supplies are finite, and, the use of the resources are faced with on-going changes influenced by our climate and more stringent regulatory and environmental requirements. Therefore, there is a need to sustainably manage the water resources to effectively respond to changing availability and constraints on the available water.

This report identifies that the base load water supply, that water supplied during the late fall through the winter months, is secure and will be adequate for build-out of the City as currently envisioned. It is the summer demand season, generally June through September that needs additional water production to meet future demands.

The City is not alone or unique in needing a sustainable water plan. In researching how other areas have approached and defined "sustainability", a Technical Advisory Committee consisting of staff and consultants to assist in the identification, review and planning for a sustainable system has adopted the following Goal Statement:

> *The City's water supply and distribution system will sustainably meet today's needs without harm to ecosystems and will not degrade water quality or compromise the ability to meet the needs of future generations.*

The City's water managers will monitor the progress toward the goal of becoming sustainable by developing operational measurements of how water quality, supply, and distribution meets the needs of the City as it moves forward towards build-out based on the City's adopted Master Plan.

WATER RESOURCES

The City's water supply originates from a portfolio of water resources that allows Carson City to utilize a mix of surface water and groundwater resources to meet demands. This portfolio includes the following:

Groundwater sources:

- The Eagle Valley Groundwater System.
- That portion of the Dayton Valley Groundwater System within the Carson City Boundaries.
- That portion of the Carson Valley Groundwater System within the Carson City Boundaries.

Imported Groundwater

- Carson City owned groundwater permits supplied by the Town of Minden through the Carson-Douglas Intertie Pipeline.
- Groundwater supplied through an Interlocal Agreement with Lyon County from the Lyon County Dayton Water Utility.

Surface Water

- Carson City owned Carson River Segment 7A Decreed Water Rights and stored water in Ambrosetti Pond accessed through induction wells located next to the Carson River within the Carson City Boundaries.
- Surface water owned by Carson City from Kings Canyon and Ash Canyon.
- Surface Water imported from the State-Owned Marlette-Hobart System.
- Leased Water from the Carson Subconservancy District for Mud Lake and Lost Lake accessed through induction wells located next to the Carson River within the Carson City Boundaries.

Wastewater Reuse

- Carson City re-use program that applies reuse water from the Water Reclamation Facility to the State Prison, City parks, golf courses, cemetery, and other greenbelt applications.

Carson City's total annual water consumption from all sources averaged 11,124 Acre Feet Annually (AFA) for the period 2014 through 2017. All groundwater resources including imported sources for the Period 2014 through 2017 provided 7,886 AFA, or approximately 71% of the Cities total supply. For this period, the imported groundwater through the Carson-Douglas Intertie Pipeline provided 35% (2,766 AFA) of the total groundwater supply and 46% (3,642 AFA) of the total groundwater supply is generated from the twenty groundwater wells within the Eagle Valley. That portion of the Dayton Valley Hydrographic basin within the Carson City boundaries supplied 17% (1,322 AFA) of the groundwater supply and that portion of the Carson Valley Hydrographic basin within the Carson City boundaries supplied 2% (155 AFA) of the total supply.

All groundwater basins are, in essence, storage reservoirs for groundwater. The storage levels in the groundwater basins are dependent on the amount of precipitation and snowfall,

generating runoff that can recharge the basins. This recharge is cyclic due to variations in the precipitation and snowfall, resulting in variable storage levels. Management of these cyclic characteristics is based on experience with the goal of maintaining a sustainable level of groundwater storage over a period of years.

The State Engineer has approved groundwater permits for a total of 21,674 AFA from the groundwater basins within the City Boundary and an additional 2,740 AFA from City owned groundwater rights in Minden for a total of 24,414 AFA

Eagle Valley has a total permitted use of 17,793 AFA. The current pumping from Eagle Valley for the period 2014 through 2017 averaged 3,642 AFA. Based on the management history for pumping in Eagle Valley, it is estimated that the sustainable level of pumping may be a maximum of about 6,000 AFA. The projections indicate that as the City progresses towards the buildout population the groundwater resource in Eagle Valley will become the dominate source of groundwater.

The challenge facing the Carson City water system is to find groundwater wells with acceptable quality that can provide wet water to reach the 6,000 AFA without adversely impacting the groundwater aquifers.

In the Eagle Valley Basin there are twenty producing wells with only five wells that can currently produce over 500 gallons per minute, and, all five of these wells are over twelve years old with two of the five being over thirty-three years old. Eleven of the twenty wells are adversely impacted by either Arsenic or Uranium levels which exceed the regulatory limits. The amount of supply generated from these eleven Arsenic and Uranium impacted wells is significantly reduced due to the NDEP approved Alternative Management Plans which requires a blending process applied to meet regulatory water quality requirements.

SUMMARY

This report recommends that the Eagle Valley groundwater well system should be improved for developing additional summer peaking supplies. The older wells are not able to produce the water that they have in the past. The loss in production is a mixture of the age of the wells and regulatory constraints due to the degradation of groundwater quality. The current groundwater production needs to be substantially increased during the summer peaking season. Otherwise, the City will need to develop a more efficient use of its Carson River surface water rights.

The investment in the groundwater system needs to be carefully planned to fit within the management structure for each of the groundwater basins and to produce groundwater at the most optimal cost. And, the water quality issues with Arsenic and Uranium need to be mitigated through treatment and/or blending. Well drilling technology today can assess the water quality profile of a well as it is being developed which will identify water production zones with higher water quality, blanking off those zones with higher levels of contaminants. If zones with higher levels of contaminants are blocked off this may reduce treatment and/or blending, but it can also reduce production.

To achieve sustainability for the Eagle Valley groundwater production and manage the well development program at the most optimal cost, this report recommends a 3-Dimensional hydro-geologic groundwater basin model be completed to assist the water system managers in

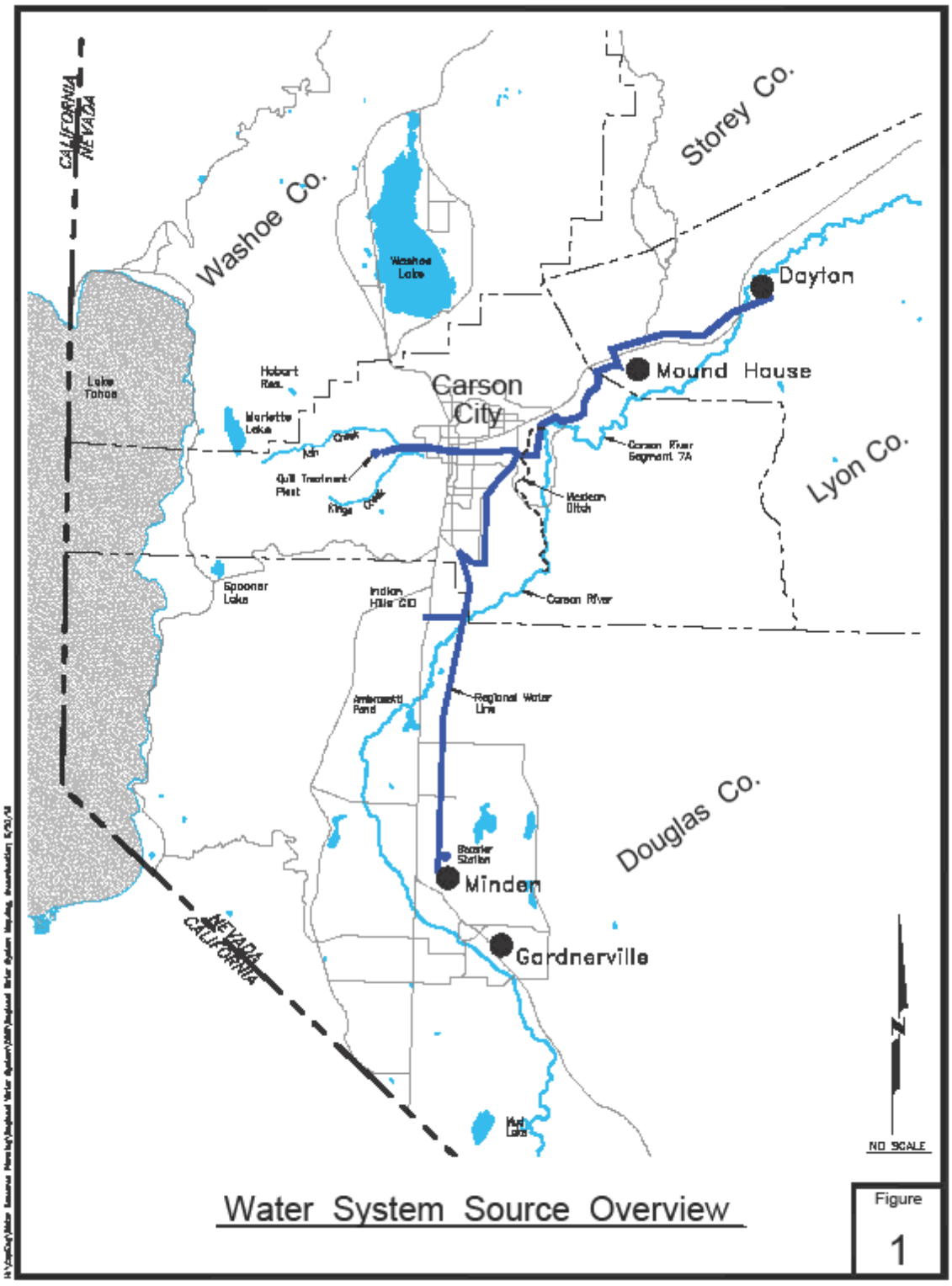
determining a viable and sustainable Eagle Valley groundwater production program. This program will include the groundwater well development and, if necessary, groundwater treatment/blending to augment the current summer water supply capabilities and to generate the needed future summer season supplies.

The Carson City owned surface water supplies are also evaluated in this report. The surface water sources servicing the West Side Water System which includes the Ash and Kings Canyons creeks and the State-owned Marlette-Hobart System are summarized in this report. These resources currently feed the Quill Water Treatment facility on the West side of the water supply system.

This report explains the water quality issues with the West side surface water sources, including Ash and Kings Canyon tributaries and the State-owned Marlette-Hobart water system. These water quality issues are impacting the production capabilities of the Quill Water Treatment facility. This report recommends a watershed management program be completed to protect the water quality and quantity for the West Side tributaries that supply surface water to the Quill Water Treatment facility.

The Central City Water System groundwater wells have a capability for high water production but are impacted by high Arsenic levels. This report compares blending opportunities and/or treatment of this cluster of wells to re-establish the diminished production due to the water quality issues.

The East side surface water supplies from the City owned Carson River Decreed rights and the management and production issues due to the use of the rights being subject to the irrigation priority system managed by the Federal Water Master are included in this report. The City owned Carson River Decreed rights are supplied through two induction wells adjacent to the Carson River. Recommendations are provided for the possible future expansion of these supplies.


CALIFORNIA
NEVADA
Washoe Co.
Storey Co.
Lyon Co.
Douglas Co.
Washoe Lake
Dayton
Mound House
Carson City
Hobart Res.
Marlette Lake
Lake Tahoe
Spooner Lake
Indian Hills GID
Carson River
Carson River Segment 7A
Western Ditch
Regional Water Line
Minden
Gardnerville
NEVADA
CALIFORNIA
NO SCALE
Water System Source Overview
Figure
1

INTRODUCTION

The Carson City Public Works Department supplies potable water to the Carson City community through the operation of water production facilities and the water distribution system. The City's water supply utilizes a mix of surface water and groundwater supplies.

The Carson City water delivery system draws from a mix of these various resources on a daily, weekly, monthly, quarterly and annual basis to meet the water systems demands. These resources have served the City well, but because of drought, declining water quality coupled with increased regulatory requirements, declining well production, and, as the City grows, additional resources will be required to meet future system demands.

The City Public Works Department has conducted this review of the water supply options with the goal of developing a robust and sustainable program utilizing the surface and groundwater resources to meet the Carson City Master Plan to the buildout population of the City, approximately 75,000 to 85,000+/- people.

This review provides recommended actions, which focus on water supply options that can be developed to satisfy the summer peaking season demands. The base water usage during the non-peaking season is not projected to be an issue as the current water use and the water supply model indicates the base production is adequate to meet base-load water supply to build-out conditions.

The current water supply model for the summer season, including a 20% reserve supply condition set by the State Engineer; has projected a buildout Maximum Day Demand of 33 million gallons per day; (MGD) with the 2017 supply providing 19 MGD. The model indicates there will be a need for additional water supply during the summer peaking season, which is generally from June through September, of approximately 4,500 Acre-Feet to meet the 33 MGD Maximum Day Demand.

A Technical Advisory Committee was established consisting of staff and consultants to assist in the identification, review and planning to meet the goal of identifying quantities of water to satisfy the demands at the City Land Use Master Plan buildout population. In addition, the effort has reviewed priorities, schedules and generalized costs for development of the supply options.

The Technical Advisory Committee (TAC) adopted the following guidelines:

- All options considered must include the 20% reserve supply condition set by the State Engineer.
- Provide the most reliable supply options at the lowest probable cost.
- Provide a water development program to meet the water supply demand for projected buildout of the City in an incremental approach.
- Coordinate water planning for Carson River Segments 7A, 7B and 7C with the Dayton Water Utility in Lyon County
- Consider options to develop additional groundwater supplies.
- Mitigate the water quality issues for the State of Nevada Marlette-Hobart water supply or determine options to replace portions of the Marlette-Hobart supply.

The TAC identified the following water resources being available to the City:

- Permits issued to Carson City through the State Engineer for Carson Valley, Basin 105; Eagle Valley, Basin 104; and the Dayton Valley, Basin 103, which is partially in Carson City and Lyon County (Dayton area).
- Surface water owned by Carson City from Kings Canyon and Ash Canyon.
- The Alpine Decree Segment 7A Carson River surface rights and other surface water rights owned by Carson City or other parties with consideration of off-stream storage with the water accessed through the Mexican Ditch.
- Water delivered through the State Marlette-Hobart Water System.
- Water delivered under interlocal agreements between Carson City and Douglas County/Town of Minden, Carson City and Lyon County (Dayton Water Utility), and existing agreements with other third parties.
- Continued utilization of wastewater reuse for open spaces including golf courses, State Prison Farm, parks, etc.

Chapters 2 through 7 include a description of the water available for the sources of water being discussed and water planning recommendations including potential options for using the water to meet the supply requirements for the buildout summer demand season. Chapter 8 includes the projected preliminary or planning level costs and possible schedule for improvements and includes the conclusions and recommendations for Chapters 1 through 7.

As this report is reviewed, it is important to note that the above sources of water are aggregated together in their use. A source of water is managed and used in concert with the other sources of water to meet the demands of the Carson City water supply system. The management of the supply needs to consider all the supply/pressure zones in the City as one system, drawing water as needed from the available sources of water supply. This becomes particularly important when the system must meet the summer supply demands. This management effort is complex, requiring management decisions by City staff on a daily, weekly, monthly, and annual basis to meet water system demands. To the degree the complexity can be reduced the better the system can be managed.

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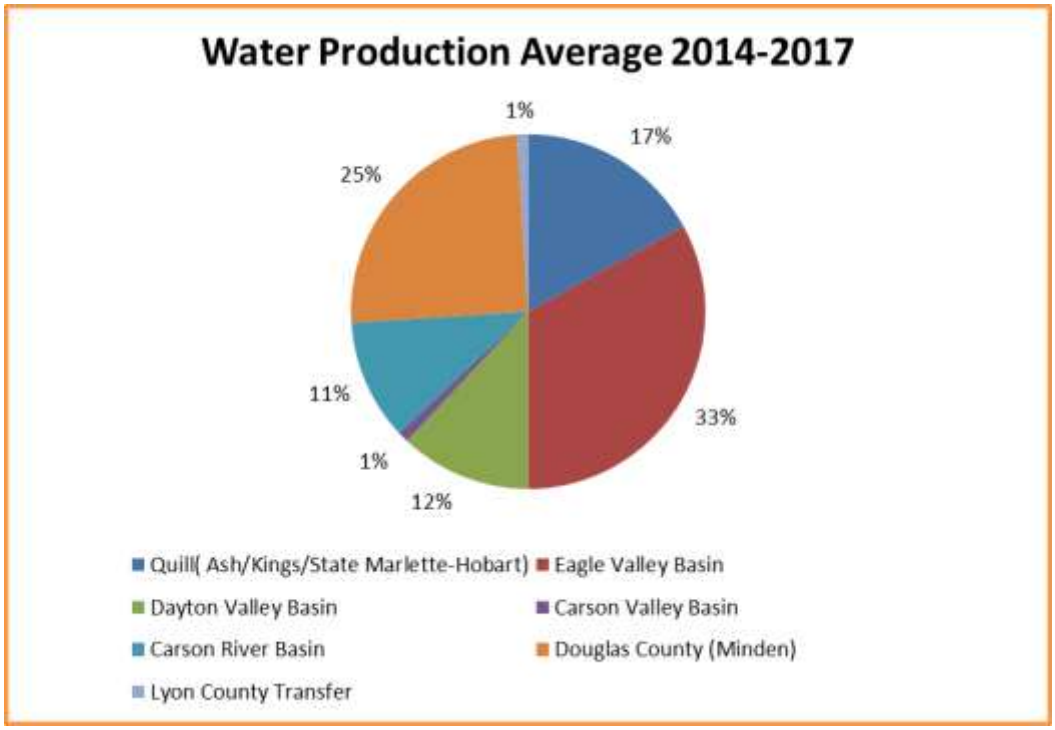
Wastewater Reuse

Carson City re-use program that applies reuse water from the Water Reclamation Facility to City parks, golf courses, cemetery, and other greenbelt applications.

Each source of water is accessed through a dedicated system of pumps, pipelines and reservoirs to meet the supply demands for residential, commercial, industrial and, in times of an emergency, such immediate demands as fire flows. Coupled with the management of demand flows, there is the requirement to manage the blending of groundwater pumping to meet water quality issues primarily from the high levels of Arsenic and Uranium. The City's robust portfolio of water resources are summarized in the Pie Chart following. The individual groundwater basins are represented by the Carson Valley, Dayton Valley, Eagle Valley and the Douglas County/Minden percentages. The Sierra West slope tributaries and the State-owned Marlette-Hobart system are included in the Quill percentage. The Carson River surface rights accessed through the induction wells are included in Carson River Basin percentage.

The 2017 total groundwater from all sources represents 72 percent of the total City Supply with the surface water sources providing the remaining 28 percent.

Figure 2 Water Production Averages 2014-2017



CHAPTER 1

Summer Season Water Demand

The Carson City Community Development Department does annual projections of population growth for the future for planning purposes. A high and low projection is done to provide a range of growth as it is difficult to predict increases since so many variables affect future change. For the purposes of this effort to determine future water resource demands the low and high projections, which were updated in March 2018, for the calendar year 2017 to 2067 were utilized.

The average amount of water used per day per person or gallons per capita per day (gpcpd) was determined by averaging the 2008-2016 average daily production for the water system for June, July, and August divided by the population for the respective year. The result equaled 310 gpcpd. The 310 gpcpd was applied to future projections to yield a future demand for the summer timeframe. In addition, there is a 20% reserve supply condition set by the State Engineer added to the supply for consideration of drought, equipment failure, and routine maintenance outages. A 10% above and below the current gpcpd demand which is approximately one standard deviation is provided to provide a less and more conservative estimate of future demand. This is depicted in Table 1. In 2017 water supply from the water system was consistently capable of providing 19 MGD.

Table 1 Summer Water Demand Projections

Summer Water Demand Projections			Water Production (MGD)					
			Low Projection			High Projection		
			Gallons per Capita per Day			Gallons per Capita per Day		
Year	Low Population Projection	High Population Projection	280	**310**	340	280	**310**	340
2017	55,438	55,438	16	17	19	16	17	19
2020	56,658	57,634	16	18	19	16	18	20
2030	60,318	64,954	17	19	21	18	20	22
2040	63,978	71,664	18	20	22	20	22	24
2050	67,638	77,764	19	21	23	22	24	26
2060	71,298	83,864	20	22	24	23	26	29
2067	73,960	88,134	21	23	25	25	27	30
Reserve @ 20%								
2017	55,438	55,438	19	21	23	19	21	23
2020	56,658	57,634	19	21	23	19	21	24
2030	60,318	64,954	20	22	25	22	24	27
2040	63,978	71,664	21	24	26	24	27	29
2050	67,638	77,764	23	25	28	26	29	32
2060	71,298	83,864	24	27	29	28	31	34
2067	73,960	88,134	25	28	30	30	33	36

Updated with revised population projections 3/18/2018

This results in identifying a need for additional water supply during the summer peaking season, which is generally from June through September of a low of 6 MGD to as much as 17 MGD. It is prudent to be conservative in developing water supply so the TAC determined that for planning

purposes a future demand using the high population projection was appropriate and to use the current gpcpd rates, which then indicate future demand goal will be approximately 33 MGD or an increase of 14 MGD.

This increase translates into approximately 4,500 Acre Feet of new water production for the summer demand period to meet the 33 MGD Maximum Day Demand.

Development of new water resources will be done in increments to meet the demands as they increase. The projected schedule for the summer season water supply demands starting from the actual quantity of production for the base year of 2017 to 2067 is presented in the following Table 2, Summer Season Increase in Demand. The 2017 demand is based on the actual water production capability of the water system for 2017. All future demands beyond 2017 include the 20% reserve required to meet the State guidelines for municipal water planning.

Table 2 Summer Season Increase in Demand

Year	High Population Projection	Median Water Demand (310 gpcd)	Summer Season Increase in Demand
2017	55,438	19	Current Supply Capability
2020	57,634	21	System needs 2 mgd additional supply
2030	69,954	24	System needs 3 mgd additional supply
2040	71,664	27	System needs 3 mgd additional supply
2050	77,764	29	System needs 2 mgd additional supply
2060	83,864	31	System needs 2 mgd of additional supply
2067	88,134	33	System needs 2 mgd additional supply

The projections indicate that the Carson City water summer season demands will increase from the current 19 MGD by 14 MGD to 33 MGD by the year 2067. The Capital Improvement Program needs to identify and program projects that can provide this increase in supply by 2067.

Once the demand schedule was developed, the Technical Advisory Committee reviewed the range of potential methods for increasing water resource supply to meet the future resource demands which is addressed in the following sections.

Future Water Planning Data

The 2006 Land Use Master Plan identified residential and mixed-use land use designations to accommodate a buildout population of approximately 75,000-80,000. The water population projections above provide for more growth than the current land master plan provides so the higher projections are used since the land use master plan is 12 years old and will be updated in the future. This is a conservative approach to water supply planning ensuring there will be adequate supply in the future.

In the Integrated Water Supply and Facilities Plan completed in 2011, the population projections and water demand for each pressure zone were determined by combining the Land Use Map with the Traffic Analysis Zone (TAZ) map to determine the mix of residential, commercial and non-residential developments. The Water Service Area boundaries were drawn to enclose the TAZs, or, that portion of a TAZ which was underlying developed land use.

The projections for population increases were then based on the projections for residential, commercial and non-residential growth within each Water Service Area, each area then multiplied by their respective unit rate demand; gallons per capita per day (gpcd) per dwelling unit for residential demand and gallons per day per square foot for non-residential development or gallons per employee-day for schools. The total demands were then converted to Millions of Gallons per day (MGD).

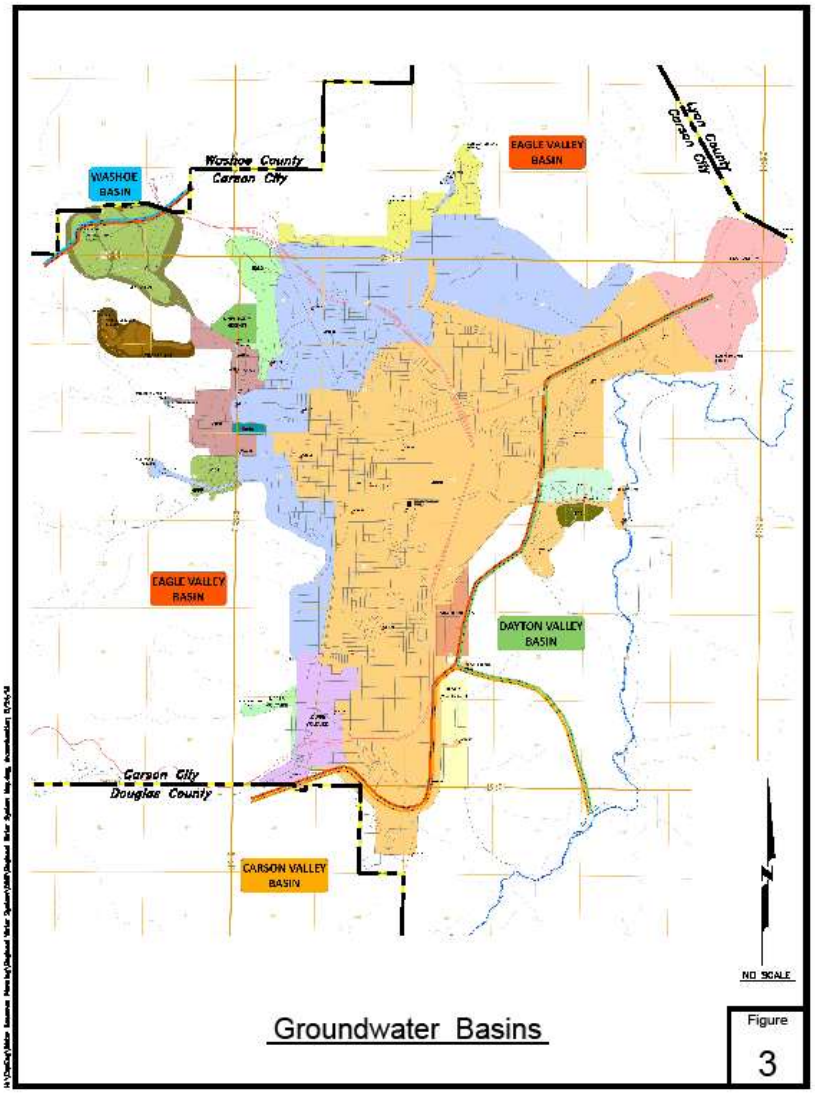
This approach is the basis for the Public Works Water Division's Computer Model, Water-Gems, which is updated on a periodic basis.

A similar effort will be undertaken later in 2018 for updating water demand projections to further define the resource requirements by looking at water usage per land use for residential, commercial and other non-residential growth based on water meter data and take that data to estimate buildout projections. This will also be used to tie in with the Water-Gems Computer Model to allow for determining demand within specific geographic areas of the City such as different water pressure zones.

CHAPTER 2

CARSON CITY GROUNDWATER RESOURCES

Carson City has numerous groundwater permits and wells located within the Carson Valley, Eagle Valley and Dayton Valley groundwater basins within the City boundaries as shown in Figure 3. The permitted amounts of water in each basin are held in good standing with the State Engineer and the permitted rights exceed the amounts of water pumped from each basin. The quantities of water developed in each basin are not limited by the permitted values but are limited due to the difficulties in finding suitable groundwater production wells within the groundwater aquifers that have acceptable groundwater quality. In Eagle Valley, the State Engineer has set pumping limits for production, but with the water quality impacts, the current wells do not have the capacities to approach the State pumping limit.



CARSON VALLEY – BASIN 105

Carson City has three wells within the City boundaries that are in the Carson Valley, Hydrographic Basin 105. These wells have a total permitted value of 675.7 AFA and the average pumping during the 2011 through 2016 period was 441.4 AFA. The three wells have produced water of good quality.

Table 3 Carson City Wells- Carson Valley – Basin 105

Carson City Wells - Carson Valley -Basin 105								
2011-2016								
Well No.	Well Name	Permitted AFA	Quantity Pumped			Max As Level[1] 2007/2017	Max U Level[2] 2007/2017	Issues/Notes
			High	Low	Average			
38	Snyder	117.0	132.1	0.0	82.8	3/3	7.8/19	
43	Bennet Drive	292.0	399.3	67.3	194.3	2/2	5.8/7.4	
50	Prison Underground Well*	266.7	289.0	39.9	164.3	-/3.3	-/5.1	
		675.7	820.4	107.2	441.4			
1	Regulatory Max for Arsenic: 10 mg/l							
2	Regulatory Max for Uranium: 30 mg/l							
*	Well 50: Well completed and started to system in 2010							

In addition to the wells in the Carson Valley Hydrographic Basin the City owns a substantial amount of additional water rights within the Carson Valley. An interlocal agreement between Douglas County, the Town of Minden, the Indian Hills General Improvement District and Carson City provides for the regional Douglas-Carson Intertie Pipeline which links the Minden well field to the Carson City water system. The agreement includes provisions that allowed Carson City to relocate a portion of its Carson Valley groundwater permits to the Minden well field as well as purchasing a substantial amount of water rights from the Town of Minden. This regional pipeline is administered in accordance with an Inter-Local agreement between Carson City and Douglas County, the Town of Minden, and the Indian Hills General Improvement District.

For the period 2014 through 2017 this regional system has supplied an average of 2,766 AFA of imported groundwater to Carson City. This represents 25% of the total water supply produced through the Carson City water system.

EAGLE VALLEY – BASIN 104

Carson City's main groundwater production facilities are in the Eagle Valley, Hydrographic Basin 104. There are 20 groundwater production wells located in Basin 104, of which five wells can currently produce over 500 gallons per minute, and, all five of these wells are over twelve years old with two of the five being over thirty-three years old. Eleven of the twenty wells are

adversely impacted by either Arsenic or Uranium levels which exceed the regulatory limits. The amount of supply generated from these eleven Arsenic or Uranium impacted wells is significantly reduced due to the Nevada Division of Environmental Protection (NDEP) approved Alternative Management Plans which requires a blending process applied to meet regulatory water quality requirements. One well, Well No. 4, is not operated due to the high Arsenic levels. Table 4 summarizes the production wells in Basin 104 with the highest production wells highlighted in bold font.

The City has NDEP approved Alternative Management Plans to manage the blending of the production generated by the Uranium and Arsenic impacted wells. The blending plans involve moving the water from the impacted wells in a manner which mixes the impacted water with nearby better-quality wells in such a manner that the running annual average based on the last four quarters does not exceed the Maximum Contaminant Level set by EPA. The requirement is that the blended water must meet the regulatory limits prior to the first potable water tap. The ratio of flows from the group of wells involved can vary from day to day and sometimes hour to hour, depending on the demand from the users on a particular water line.

The cluster of high production wells between Kings Canyon Road and the Community College (West Side Water System) has Uranium levels that exceed the Federal Maximum Contaminant Level of 30 µg/l. Due to the levels of Uranium, the City must use the NDEP approved Alternative Management Plan for blending between the wells to meet water quality standards. The blending process limits the production of this cluster of wells.

There is another cluster of four high production wells in the center of the City water supply system between Little Lane on the South, 5th Street on the North, Stewart Street on the West and Saliman on the East (Central City Water System) that have high Arsenic levels that exceed the Federal Maximum Contaminant level of 10 µg/l. In 2007 the City installed an Arsenic removal plant to treat the Arsenic in this cluster of wells to gain the production capability from this series of wells.

However, due to chemical reactions between the different waters of the wells, the Arsenic plant has not been able to properly treat the combined flows from these wells, resulting in use of the treatment facility for Well 49 only. A NDEP approved Alternative Management Plan using blending is used for this cluster of wells but the blending process has limited the production from this series of wells.

Recommendations for mitigating the impacts of Uranium and Arsenic are included in Section 8 of this report.

Table 4 Carson City Wells- Eagle Valley – Basin 104

Carson City Wells - Eagle Valley -Basin 104 2011-2016								
Well No.	Well Name	Permitted AFA	Quantity Pumped			Max As Level[1]	Max U Level[2]	Issues/Notes
			High	Low	Average	2007/2017	2007/2017	
3	**Winnie Lane**	**1,814.6**	**228.6**	**87.6**	**180.1**	**1/1**	**17/17**	
4*	**Elaine Street**	**806.5**	**0.0**	**0.0**	**0.0**	**40/--**	**0.5/--**	**Arsenic; Not in use**
5	Bath Street	470.2	272.8	112.4	206.5	1/1	23/29	
6	**Desert Peach**	**1,978.1**	**564.2**	**211.4**	**421.2**	**3.1/3.1**	**33/33**	**Uranium; Blend**
7	Carson Furniture	407.2	1,249.9	135.4	358.0	23/23	29/30	
8	Silver Sage/S. Roop	432.8	258.4	120.1	173.2	2.2/2.2	2.4/2.9	
9	Ross Gold Park	271.1	258.7	91.8	203.8	2/2	3.3/4.3	
10b**	**WNCC**	**3,418.3**	**303.8**	**0.0**	**89.6**	**4/4**	**58/85**	**Uranium; Not in Use**
11A/B***	**Sheriff's Office**	**809.8**	**493.4**	**195.5**	**368.4**	**34/34**	**16/19**	**Arsenic; Blend**
16b	Combs Canyon	49.2						**Well not in use**
33	Sheep Drive	177.4	73.2	49.0	62.4	7.1/7	2.9/4	
34	**Mills Park**	**1,208.5**	**252.4**	**67.6**	**149.0**	**9.1/9.1**	**36/36**	**Uranium; Blend**
45	Sonoma Park	406.7	315.9	69.8	174.1	14/14	3.1/3.1	Arsenic; Blend
46	**Silver Oak**	**1,729.8**	**355.1**	**0.0**	**172.6**	**2.5/2**	**41/41**	**Uranium; Blend**
48	**Kings Canyon**	**774.6**	**323.4**	**144.9**	**200.1**	**2/2**	**3.4/4.2**	
49****	**Fire Station #1**	**973.2**	**179.8**	**0.0**	**61.3**	**34/-**	**NA**	**Arsenic; Blend**
51	**Foothill**	**851.4**	**644.8**	**597.7**	**587.8**	**4/4**	**23/26**	
53	Sunset Park	456.0	63.3	0.0	34.1	20/12	-/13	Arsenic; Blend
54	Fuji Park	109.9	39.6	0.0	10.6	10/10	-/6.8	Arsenic; Blend
55	**College Well**	**647.3**	**531.6**	**406.7**	**462.7**	**6.7/6.7**	**26/37**	**Uranium; Blend**
	Total EV Wells	17,792.6	6,408.8	2,289.8	3,915.6			
	Total Highest Producing Wells (Bold)	**15,012.1**	**3,877.1**	**1,711.3**	**2,692.9**			
1	Regulatory Max for Arsenic: 10 mg/l							
2	Regulatory Max for Uranium: 30 mg/l							
*	Well 4 is listed for permitting but not included in the Average Pumped. Well not used due to WQ impacts.							
**	Well 10b used very sparingly due to high U levels							
***	Wells 11/11A: Wells run in conjunction; test results are for combined samples							
****	Well 49 not used due to high As levels							
NDEP Approved Alternative Management Plans								
Uranium								
	Blending Well 10B and 34 with existing distribution system							
	Blending Wells 51 and 55 with existing distribution system							
	Well 46; Blending for summer use							
Arsenic								
	Blending Wells 7, 11A&B, 24B, 45, and 57 with existing distribution system							

DAYTON VALLEY – BASIN 103

Cason City has four groundwater wells within the City boundaries that are in the Dayton Valley, Hydrographic Basin 103. These wells have a total permitted value of 3,205.8 AFA and the average pumping during the 2014 through 2017 period was 1,242.5 AFA. Two wells, No. 24B and No. 40 represented 98% of the total water pumped from Basin 103. Well No. 47 was not pumped due to the levels of Arsenic and Fluoride exceeding the Maximum Contaminant Levels. Well No. 44 was only pumped intermittingly due to high Arsenic and Fluoride levels. **Table 5** summarizes the production wells in Basin 103.

Table 5 Carson City Wells- Dayton Valley – Basin 103

Carson City Wells - Dayton Valley -Basin 103
2014-2017

Well No.	Well Name	Permitted AFA	Quantity Pumped			Max As Level[1] 2007/2017	Max U Level[2] 2007/2017	Issues/Notes
			High	Low	Average			
24b	East 5th Street	1,084.4	624.9	412.0	532.2	1/1	17/17	
40	Morgan Hill	1,191.7	831.9	604.4	683.4	4/4	0.6/0	
44*	Dayton Valley Test Well	318.0	63.0	0.6	26.9	14/14	0.5/0	Wells 44 and 47 taken out of service for potable water due to Arsenic, Fluoride exceeding EPA Maximum Contaminant Levels
47**	Hidden Meadows	611.7	0.0	0.0	0.0	24/--	4.5/6.1	
		3,205.8	1,519.8	1,016.9	1,242.5			

1 Regulatory Max for Arsenic: 10 mg/l
2 Regulatory Max for Uranium: 30 mg/l

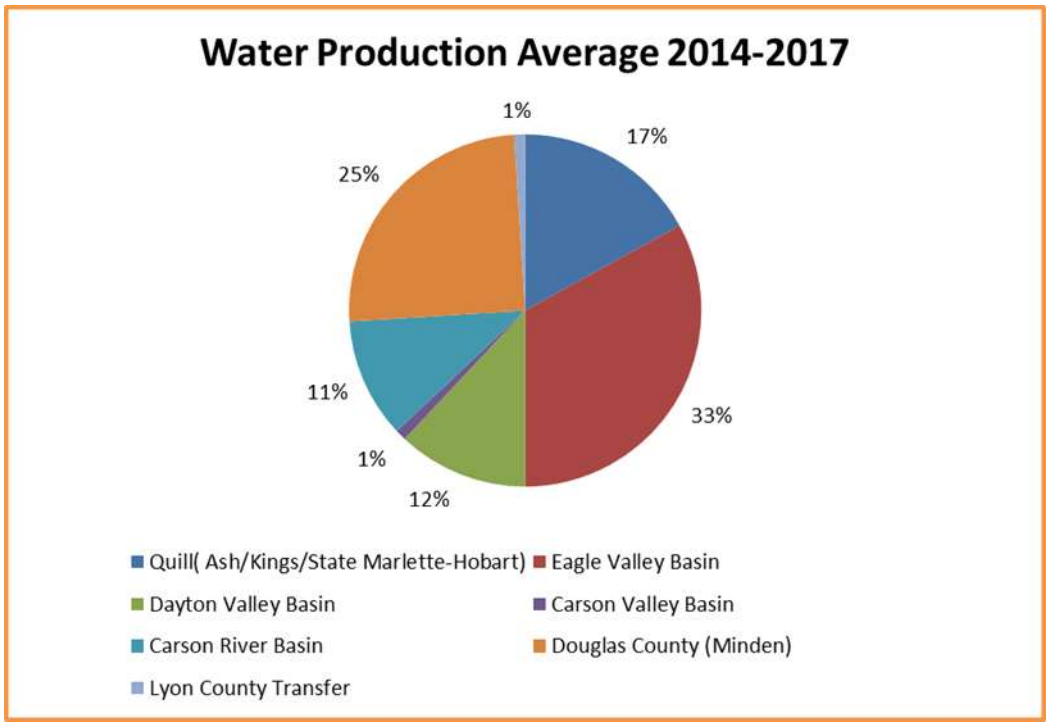
* Well 44: Retired from potable use and placed on Empire Ranch Golf Course for irrigation. Resulting reuse transferred to State Prison Farm.

** Well 47: Retired from potable use and placed on River Park Open Space for irrigation.

SUMMARY OF ALL GROUNDWATER RESOURCES

Currently, all groundwater resources for the Period 2014 through 2017 provided approximately 72% of the Cities total supply. For this period the imported groundwater through the Carson-Douglas Intertie Pipeline provided 35% of the total groundwater supply and 46% of the total groundwater supply is generated from the twenty groundwater wells within the Eagle Valley. That portion of the Dayton Valley Hydrographic basin within the Carson City boundaries supplied 17% of the groundwater supply and that portion of the Carson Valley Hydrographic basin within the Carson City boundaries supplied 2% of the total supply. The following Figure 4 illustrates the groundwater and surface water resources available to the City.

Figure 4 Water Production Average 2014-2017



The projections for groundwater use at buildout are summarized in Table 6. The projections indicate that as the City progresses towards the buildout population the groundwater resource in Eagle Valley will become the dominate source of groundwater.

The State Engineer has approved groundwater permits for a total of 21,674 AFA from groundwater basins within the City Boundary as summarized in the below table. This table also includes the Carson City owned water right permits within Carson Valley that are pumped from the Minden well field through an inter-local agreement bringing the total ground water rights to 24,414 AFA. This summarizes all the current groundwater permits owned by Carson City.

Table 6 Carson City Groundwater Permitted and Useable Water Rights

Carson City Groundwater Permitted and Useable Water Rights (AFA)					
	Current Usage			Projected Usage	
Basin	**Annual Permitted**	**Average Pumped (2014-2017)**	**% of Useable Groundwater Supply (2014–2017)**	**Average Usable with improved well performance**	**% of Useable Groundwater Supply**
103 - Dayton Valley	3,206	1,322	17%	2,330	20%
104 – Eagle Valley	17,793	3,642	46%	6,000**	51%
105 – Carson Valley	675	155	2%	675	6%
Totals	21,674	5,119	65%	9,005	77%
Carson-Douglas Intertie pipeline	2740	2,766	35%	2,740	23%
Total	24,414	7,885	100%	11,745	100%
** Estimated amount of groundwater that can be pumped from Eagle Valley on a sustainable basis.					

The challenge facing the Carson City water system is to find groundwater wells with acceptable quality that can provide wet water from the groundwater permits issued. For example, the estimated amount of groundwater pumpage for 6,000 AFA from the Eagle Valley Basin is dependent on finding areas that can produce that amount of water on a sustainable basis with acceptable water quality from the Eagle Valley groundwater aquifers may be a challenge. Currently, the pumping of the existing wells in the Eagle Valley is averaging 3,642 AFA.

As of this report, in the Eagle Valley Basin there are only five wells that can currently produce over 500 gallons per minute, and, all five of these wells are over twelve years old with two of the five being over thirty-three years old. Eleven of the twenty wells are adversely impacted by either Arsenic or Uranium levels which exceed the regulatory limits. The amount of supply generated from these eleven Arsenic and Uranium impacted wells is significantly reduced due to the NDEP approved Alternative Management Plans which requires a blending process applied to meet regulatory water quality requirements.

This report recommends that the Eagle Valley groundwater well system should be improved for developing additional summer peaking supplies. The older wells are not able to produce the water that they have in the past. The loss in production is a mixture of the age of the wells and the degradation of groundwater quality. The current groundwater production needs to be substantially increased during the summer peaking season.

Water quality issues with Arsenic and Uranium need to be mitigated through treatment and/or blending. Well drilling technology today can perform a water quality profile as a well if being developed which will identify water production zones with higher water quality, blanking off those zones with higher levels of contaminants. If found this may reduce treatment and/or blending, but it can also reduce production.

To achieve sustainability for the Eagle Valley groundwater production and manage the well development program, this report recommends a 3-Dimensional hydro-geologic groundwater basin model be completed to assist the water system managers in determining a viable and sustainable Eagle Valley groundwater production program with the most optimal costs. This program will include the groundwater well development and, if necessary, groundwater treatment/blending to augment the current summer water supply capabilities and to generate the needed future summer season supplies.

The USGS prepared and published a similar Model for the Carson Valley in 2012 titled “Carson Valley Groundwater Flow Model”, (http://pubs.usgs.gov/sir.2012/5262).

CHAPTER 3

COORDINATION OF POTABLE WATER MANAGEMENT AND WASTEWATER REUSE

The Carson City Wastewater Reuse Program has been a significant asset to the water supply management of the Carson City water system. From 2010 through 2017 an average of 3,169 AFA of reuse water was applied to City contracted uses for irrigation of the three golf courses within the City, the State Prison Farm, and City owned parks, open spaces and other public use areas.

Table 7 Reclaimed Wastewater Use Summary 2010 – 2017

Reclaimed Wastewater Use Summary 2010 - 2017										
Year	2010 AF	2011 AF	2012 AF	2013 AF	2014 AF	2015 AF	2016 AF	2017 AF	Total	Average AF
Eagle Valley Golf Course	792	778	920	828	778	801	857	727	6,481	810
Empire Ranch Golf Course	536	531	680	765	938	832	837	602	5,721	715
Silver Oak Golf Course	428	420	486	465	425	451	504	300	3,479	435
Prison Farm Usage	1,397	1,510	968	780	1,103	753	1,208	1,188	8,907	1,113
Subtotal	3,153	3,239	3,054	2,838	3,244	2,837	3,406	2,817	24,588	3,074
Pet Cemetary	3	3	0	0	0	0	0	0	6	1
Governors Field	23	21	25	21	0	0	0	0	90	11
Upper Centenial Field	23	19	25	17	0	0	0	0	84	11
Saliman Landscape	0	0	0	0	0	0	0	0	0	0
Edmonds Park	70	73	85	85	0	0	0	0	313	39
Lone Mtn. Cemetary	22	21	27	20	4	0	0	0	94	12
WWRP Landscape	0	0	0	0	0	0	0	0	0	0
Butti Way Reuse Overheads	0	1	0	0	10	1	0	0	12	2
Butti Way Hyd S.	0	3	1	0	4	1	0	0	9	1
Overhead	11	8	4	0	0	0	0	0	23	3
College Parkway	51	33	29	18	0	0	0	0	131	16
Subtotal Parks, other	203	182	196	161	17	2	0	0	761	95
Total AF Reuse	3,356	3,421	3,250	2,999	3,261	2,839	3,406	2,817	25,349	3,169
Potable Water Supplementation to Prison Farm					327	159	185	0		168

The gallons per capita of potable water use has decreased over the past decade because of water conservation efforts including more efficient household, commercial and industrial water use fixtures, outside landscaping, a tiered water rate structure, and the recent drought. This decrease in potable water is reflected in a decrease of available treated wastewater for reuse. As the recent drought continued, and the amount of reuse water available declined, the Carson City Public Works Department, in 2014, began transferring potable water to parks, recreational facilities, the Lone Mountain Cemetery and other public greenbelt areas in lieu of providing reuse water. In 2016, all public greenbelt facilities outside of the contracted obligations were using potable water in lieu of wastewater reuse water. In addition, in 2014 through 2016, the contractual supply of reuse water was supplemented with potable water as shown in Table 7.

The projections for the availability of reuse water in the future is projected to increase by approximately 2-3 million gallons a day over the next 50 years as the City is built out. This indicates that future planning for reuse water that may assist in increasing the availability of potable water should be investigated.

There is a close relationship between the Carson City wastewater reuse program and the management of the Carson City water system. Reuse water can offset the need to irrigate City contracted uses of water on golf courses, the State Prison Farm, parks, open spaces and other public use areas. The following scenarios represent near-term potable water and reuse water management options that can increase potable water supply.

State Prison Farm

The Northern Nevada Correctional Center was opened in Southern Carson City in 1964. The site includes approximately 1,000 acres of which several hundred acres are an alfalfa farm that supports the Northern Nevada Dairy Farm that supports the Northern Nevada Correctional Facilities and Conservation Camps, as well as State and Federal wild horse programs. The irrigated fields provide feed for the cattle and horses. The water for irrigation of the fields is treated effluent from Carson City.

Initially, the State used groundwater wells for irrigating the alfalfa. After years of operating the State Prison Farm the State was faced with replacing the wells or finding another source of water. The State contacted the City as a potential water source which resulted in the State and the City entering into an agreement to supply City wastewater reuse water in lieu of the State replacing the wells. The State Prison Farm has historically used between 1,000 to 1,500 AF of reuse water at no cost to the State.

Two State groundwater irrigation permits are not currently active. An option may be for the City to approach the State to have the City drill a new well. The City could operate the new well and could place the water into the potable water system in exchange for the reuse water applied to the State Prison Farm and to keep the water rights active. This would provide a source of water entering the southern portions of the City water system, which will help balance the management of the southern portion of the City water supply system.

Wells No. 44 and No. 47

Well No. 44, is located next to the Empire Golf Course and is impacted with Arsenic and Fluoride levels that exceed the regulatory Maximum Contaminant Levels and cannot be blended efficiently within the distribution system. Well No. 44 can produce up to 180 AF during the irrigation season. An option would be for this well to be transferred to the City reuse program by pumping into the reuse system that is now providing irrigation to the Empire Golf Course.

Well No. 47, which is located next to the Mexican Ditch approximately one mile south of the Eagle Valley Middle School, has high levels of Arsenic and Fluoride that exceed the Maximum Contaminant Levels. Well No. 47 has not been used for over 10 years and is not close enough to other water supply lines for blending. An option for this well would be to transfer the well to the reuse program. There are several options for pipeline alignments that will allow pumping the water into existing reuse facilities or to use the water to supplement the irrigation of the open space along the Mexican Ditch.

These two wells would provide the wastewater reuse managers between 350 to 400 AF of additional supply during the summer season for the reuse program. This would offset the potable water that has been used to supplement the reuse supply.

These two scenarios, a new groundwater supply well on or near the State Prison Farm and the transfer of Wells No. 44 and No. 47 to the reuse program would increase the potable water supply during the critical summer supply season. As reuse amounts increase over time as the City grows there will not be a need to supplement the reuse system with domestic water and wells No. 44 and No. 47 could be utilized for irrigation of open space lands the City owns along the river.

CHAPTER 4

WESTSIDE CITY WATER SYSTEM

The West Side Water System includes the most diverse group of water production facilities within the City water supply system. The West Side Water System consists of:

- Water delivered through the State-owned Marlette-Hobart water system.
- Surface water supply from the Ash and Kings Canyon Creeks through a series of collection systems that divide the water from these creeks with private owners.
- The Quill Ranch Water Treatment Plant which receives water from the Marlette-Hobart Water System and Ash Canyon and Kings Canyon Creeks.
- A cluster of groundwater wells located between Kings Canyon Road and the Community College.
- A series of recharge basins on the alluvial fan in the vicinity of the Western Nevada Community College.
- Wells No. 10B, 51 and 55 are designed for “Aquifer Storage and Recharge” (ASR).

The coordinated management of water production from this group of facilities has historically provided the highest production of water to the Carson City water distribution network. However, this group of water production facilities has experienced water quality issues with elevated levels of Uranium, Arsenic and water-borne organics that has impacted the overall production. The following text will describe each of the West Side Water System components and the issues associated with each component.

The Marlette-Hobart Water System

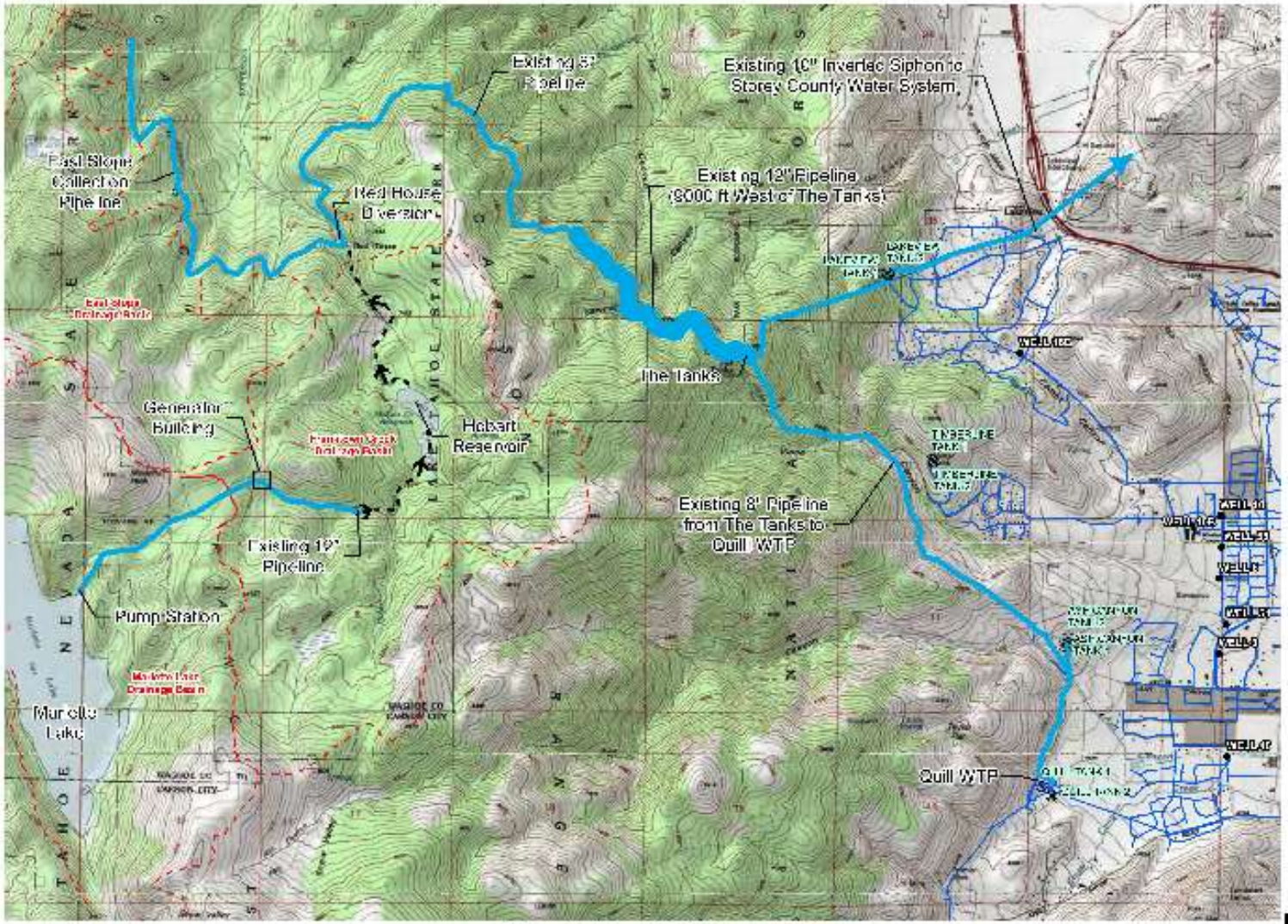
The Marlette-Hobart Water System (MHWS) is perhaps the oldest continuing operating water system in the State of Nevada. This system was initially developed in the 1870's to support water demands associated with the Comstock Lode mining boom in and around Virginia City. The system included Marlette Lake, a flume from Marlette Lake to the Incline Tunnel, the Incline Tunnel, the East Slope flume from the Incline Tunnel to the Red House Diversion Structure on Franktown Creek, Hobart Reservoir, three flumes from the Red House Diversion Structure to the “Tanks”, which provided the head structure to the three Lakeview Siphons and the flume to the Virginia City water system. See Figure 5**.**

The Marlette Dam was formed by an earth-fill dam across the outlet of Goodwin Lake, a small natural lake on Marlette Creek. The original dam was built in 1873 and provided water to the flume system carrying logs down Clear Creek to a saw mill in Carson City. In 1876, Marlette Lake was integrated into the Virginia and Gold Hill Water Company and shortly thereafter flumes, tunnels and the first of three siphons began supplying water to the Virginia City area. The Marlette Dam was raised several times until it reached its present height of 45 feet. This system provided up to 10,000 AFA to the Virginia City System.

As the Comstock mining operations declined, two of the siphons were taken out of service, the Marlette-Incline flume was abandoned, and the Incline Tunnel was taken out of service. In 1963 the water system including its associated water rights and approximately 5,400 acres of land, were purchased by the State of Nevada. The current operating components include Marlette Lake, Hobart Reservoir, The East Slope System which consists of a pipeline and collection boxes on the East Slope, the Red House Diversion structure, and a pipeline that was installed in the location of the remaining flume in the early 1950's from Red House to the Tanks.

Marlette Lake

The Tanks



Marlette / Hobart Map

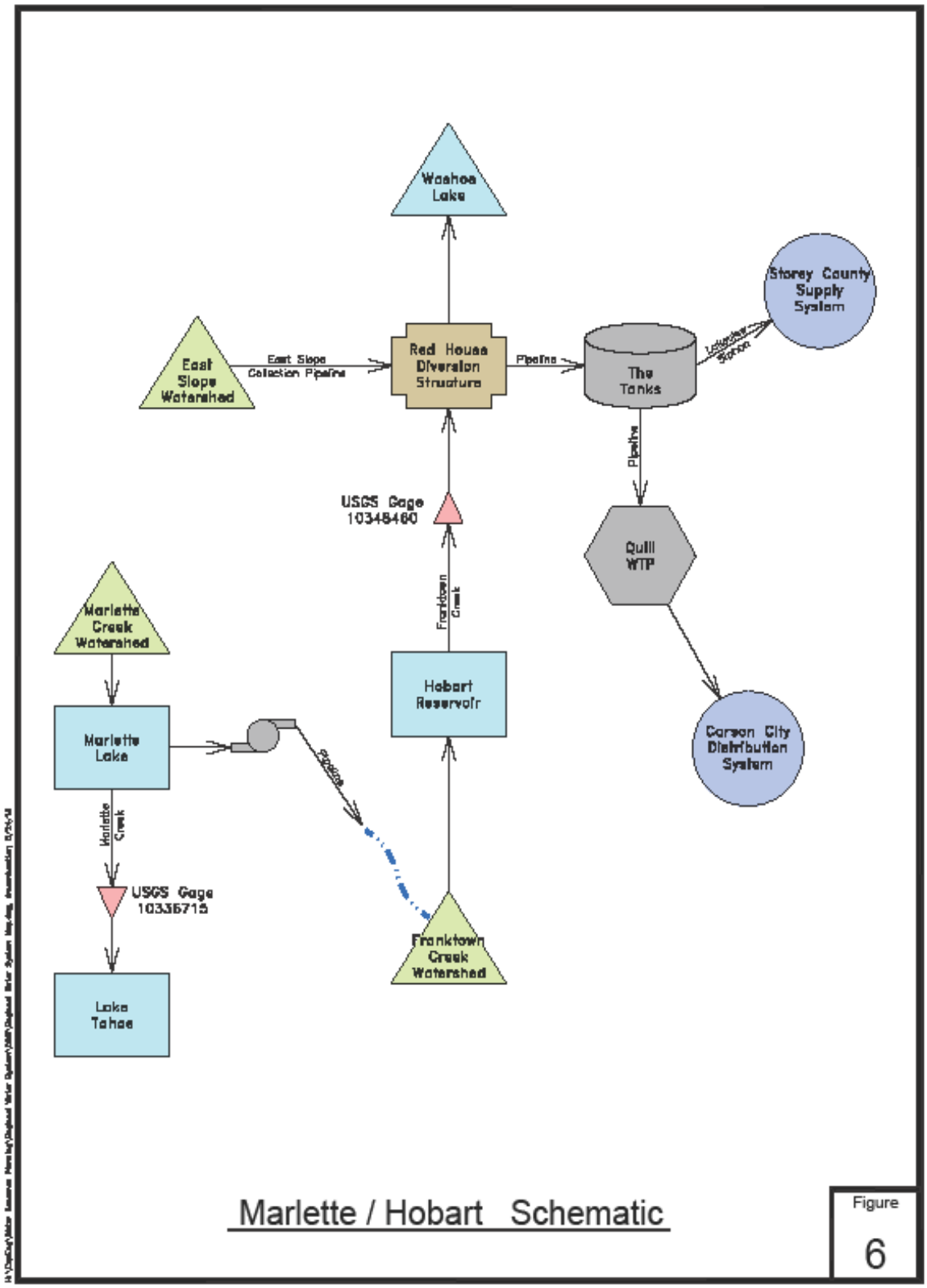
Figure 5

At the Tanks, the State operates one of the original siphons, which connect to a pipeline to the Virginia City, Gold Hill and Silver City water system. The MHWS supplies water to Carson City through a pipeline from the Tanks to the Ash Creek Pond. The combined water of Ash Creek and the MHWS water are then transported via a pipeline to the Quill Water Treatment Plant.

To augment the water supply from the State system during the summer season, the State installed a diesel-powered pump in Marlette Lake and a pipeline over the Sierra Crest ridge between Marlette Lake and the Hobart/Franktown drainage basin that discharged into a tributary to Hobart Creek. Hobart Creek feeds water into Hobart reservoir and Franktown Creek.

The State of Nevada Department of Buildings and Grounds (B&G) installed an upgraded water pumping and pipeline system for pumping from Marlette Lake to Hobart Reservoir in 2004. These upgrades included: laying over 9,600 linear feet of 12-inch diameter ductile iron and PVC pipe following primarily the existing pipe alignment; installation of a natural gas service line to power a new continuous duty generator; construction of a 1,500 GPM pump station on Marlette Lake's shoreline; replacement of the existing pump intake line and construction of a new generator building located east of the Sierra crest. These improvements increased pumping capacity and reduced environmental risks to the area previously associated with the hauling of diesel fuel. The costs for these improvements are being paid by Carson City through bonds issued by the state.

In addition to the important water resource Marlette Lake provides, Marlette Lake is also used by the Nevada Department of Wildlife as a brood lake for Rainbow and Lahontan Cutthroat trout and is a popular recreational area. The pumping of water from Marlette Lake is restricted in the spring due to the spawning runs of the Rainbow and Lahontan Cutthroat Trout. A schematic of the current operating facilities in the MHWS is presented in Figure 6.



Marlette / Hobart Schematic

Figure 6

As noted the MHWS system itself has three potential sources supplying blended flows to Storey County and Carson City; Marlette Lake, Hobart Reservoir, and the East Slope spring catchments. When pumping operations at Marlette commence, the water is pumped from Marlette Lake through a pipeline to an open conveyance channel into Hobart Reservoir. From Hobart, water is then released into an open channel to a small settling pond area just upstream from Red House Diversion. At this point, East Slope water is introduced to the blended flows from Marlette/Hobart. If desired, the Marlette/Hobart flow can be directed down Franktown Creek and East Slope water supplied into the collection system by itself. All MHWS flow to Carson City is supplied to a reservoir in Ash Canyon which is known as Ash Pond. From Ash Pond, water can be diverted either to Carson City through pipeline, or to Andersen Ranch through the Ash Creek drainage.

Over the past decade the water quality from the State-owned Marlette-Hobart water system reservoirs has been declining due to increased algae production in Marlette Lake and the Hobart Reservoir which has caused issues with the Quill Water Treatment Plant (WTP) filtration system. This may possibly be due to climate change. Due to the declining water quality, the water pumped from Marlette Reservoir combined with water from Hobart Reservoir is not being diverted from the state system to the Quill facility. When the water is not diverted the only water being received from the State is from the East Slope collection system. Use of the State water from Marlette and Hobart Reservoirs may necessitate modifying or expanding the water filtration and/or the water treatment process now used at the Quill WTP facility.

Hobart Lake

A possible mitigation plan to improve the water quality from the Marlette-Hobart System could be to extend the intake line deeper into the lake to avoid algae in the upper strata of the lake. An investigation of this issue would need to be under taken to determine its feasibility and effectiveness. Another possible alternative may be to bypass Hobart Reservoir by extending the pipe from the existing Marlette Lake pipeline across the Hobart drainage basin and up to the Ash Canyon summit, then following Ash Canyon Creek down to the Ash Creek Pond. The pressure generated in the existing Marlette-Hobart pipeline from the crest of the Sierra ridge would push the water almost to the Ash Canyon Summit, likely making a booster station necessary to reach the Ash Canyon Summit or refitting the existing pumps in Marlette. The fall from the Ash Canyon Summit to the Quill WTF may support a small hydroelectric plant, which should more than offset the power costs and may provide some power support to the Quill WTF.

Quill Ranch Water Treatment Plant

The Quill Water Treatment Plant is supplied by three surface water sources when available; Ash Creek, King's Creek and springs, and the Marlette Hobart Water System owned and operated by the State of Nevada.

All raw water sources are conveyed in two separate pipelines terminating at Pond 1 at Quill. The two pipelines originate at Kings and Ash intake structures respectively. The intake structures consist of concrete headwalls with diversions to bypass the intake pipelines and/or to supply downstream users. The Kings pipeline originates from the Kings Creek intake structure and proceeds north to Quill with three separate spring catchments fed into the pipeline downstream from Kings Creek along the way down to Pond 1. The upper two spring catchments are accessed via Copper Springs Court, and the lower spring catchment is located on the Quill property just above Pond 1. The Ash pipeline originates at the Ash Creek intake structure with flow from MHWS feeding into the pipeline from Ash Pond tied in downstream of the intake structure then proceeds south to Quill on the west side of the Joost Ranch property. See Figure 7.

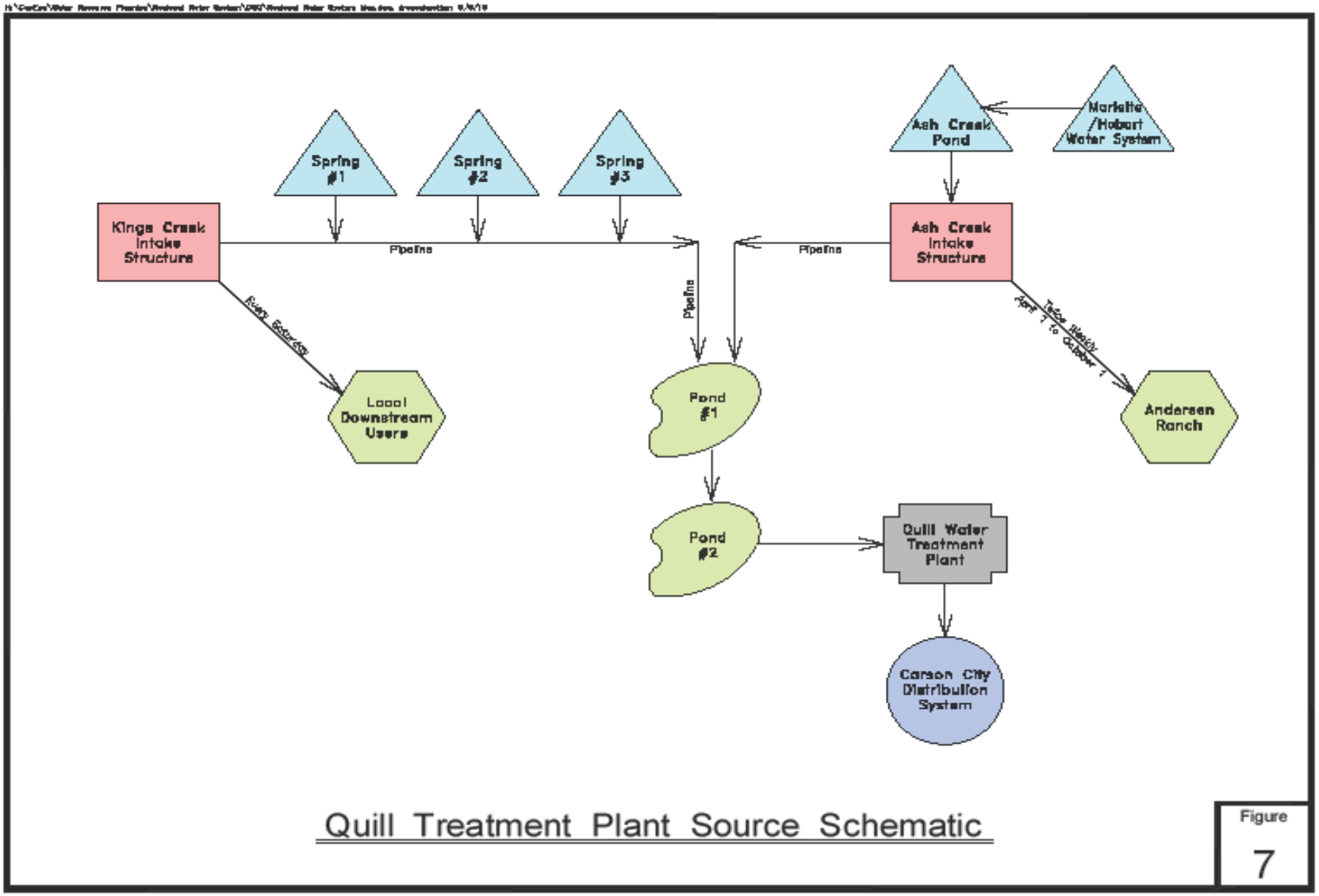
The Quill Water Treatment Plant was originally designed and constructed to treat a maximum surface water flow of 3200 GPM, or 4.6 MGD at one gallon per minute per square foot of filter area to a maximum turbidity of 0.5 NTU . With proven efficiency, it was subsequently approved to treat a maximum of 4800 GPM, or 6.9 MGD at 1.5 gallons per minute per square foot of filter area to the same turbidity standards.

The current treatment process consists of two raw water settling ponds with a working capacity of 1.9 million gallons followed by two raw water pumps supplying four pressure filter vessels utilizing diatomaceous earth filtration. A pre-coat cake of DE slurry is applied to the thirty five stainless steel screens in each vessel upon filter start-up combined with a continuous application of body feed slurry throughout the filter run. After the filtration process, a continuous injection of 12% sodium hypochlorite meets the demands of disinfection. A 500,000 gallon chlorine contact tank is utilized to achieve proper chlorine contact time before gravity feeding into a 4 million gallon finished water storage tank feeding the distribution system.

However, over the past four years, the production capacity of the Quill Water Treatment Plant has been reduced to approximately 1.9 MGD due to the water quality issues with water delivered from Marlette-Hobart Water System and reduced quality from Ash Canyon creek. The total production from the Quill Water Treatment Plant averaged 2,100 AFA for the period 2014 through 2017.

The water supplied water from the State-owned Marlette-Hobart Water System to the Quill Water Treatment Plant has deteriorated to levels that limit the supply from the State-owned system to almost only water from the East Slope Collection System. This is a significant reduction in the base load and summer demand season supply.

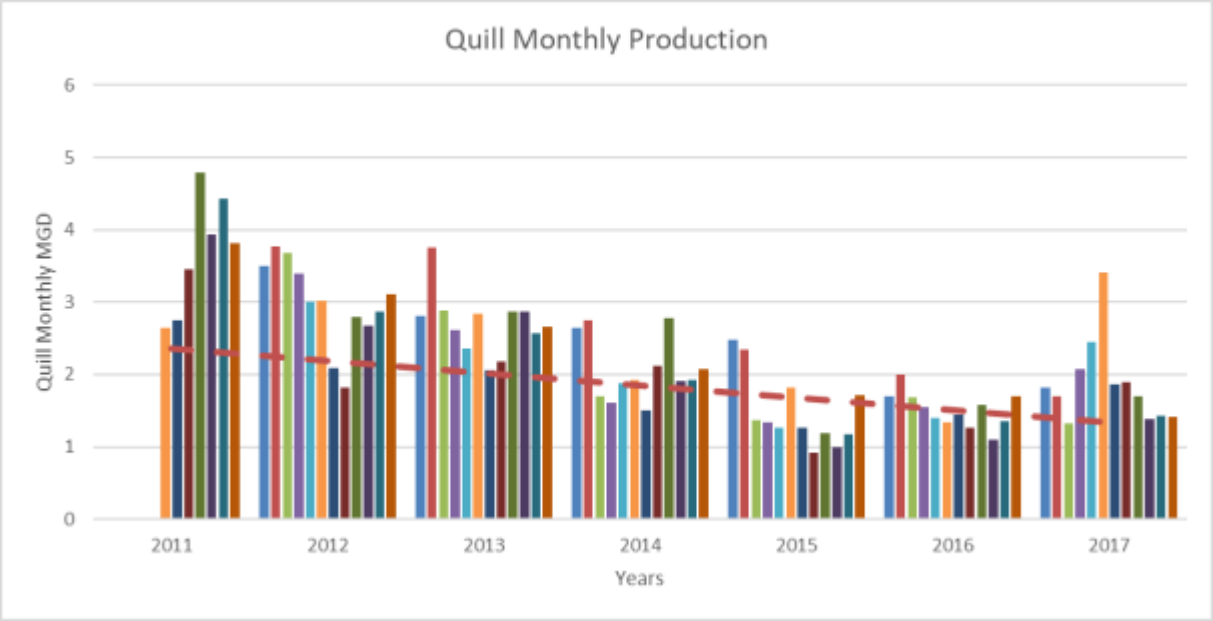
The raw water quality from the Ash Canyon water supply has also deteriorated over time due to increased organics. This deterioration of the water quality has impacted the ability of the current water treatment process to produce water meeting regulatory requirements at flows above the 1.9 MGD. In addition, the degradation of the source waters has triggered the need for upgrades to the treatment processes to meet requirements contained in the Safe Drinking Water Regulations. The downward trend in the reduction in production from the Quill Water Treatment Plant for the period from 2011 through 2017 is summarized in Figure 8**.**



Quill Treatment Plant Source Schematic

Figure 7

Figure 8 – Quill Treatment Plant Production



Quill Water Treatment Plant

Quill Water Treatment Plant

Quill Pond

Ash Canyon Creek Watershed

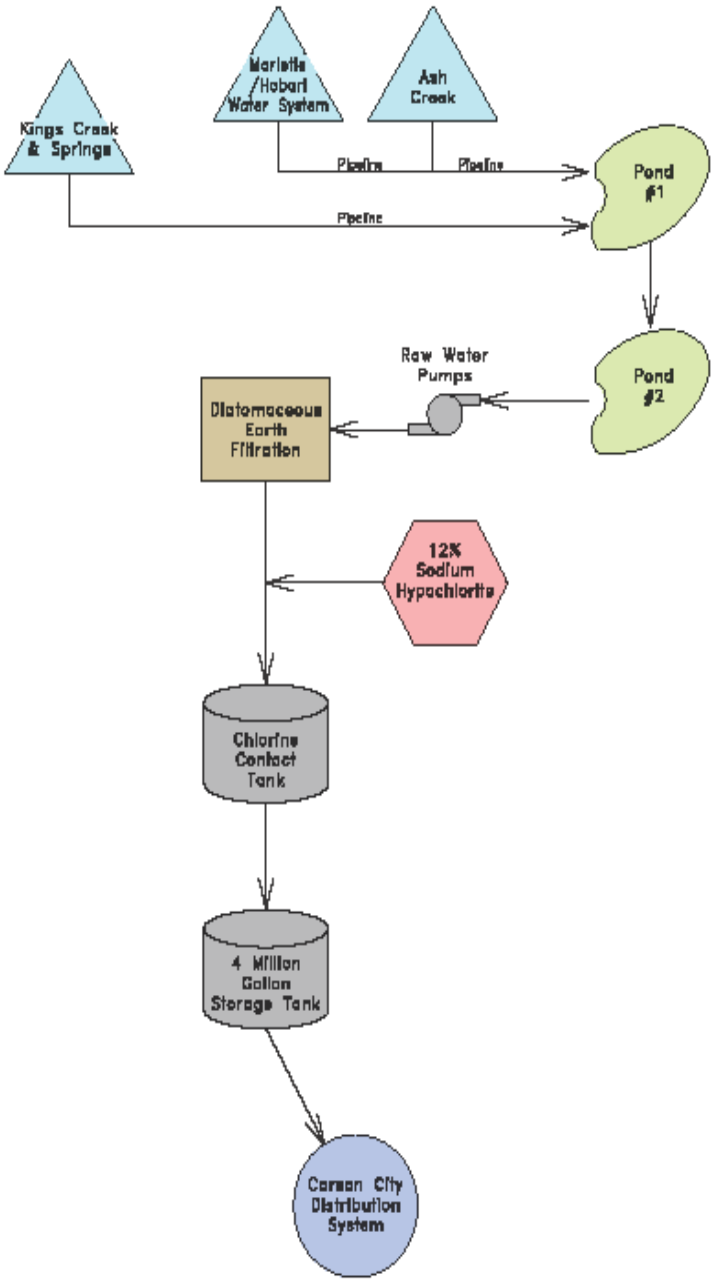
The flows from Ash Canyon are diverted to Ash Pond via a diversion structure with a splitter box. Water from the Marlette-Hobart Water System is piped to the Ash Pond. The blended flows are then piped to Pond 1, which is the first of two settling ponds feeding the Quill Water Treatment Plant. There is a regulating reservoir, Pond 2, between Pond 1 and the Quill Water Treatment Plant which provides a steady release of water into the Quill Water Treatment Plant.

Flows in excess of storage/treatment capacities are allowed to continue downstream of the diversion dam in Ash Canyon Creek. The flows in the creek that are not used by other entities with water rights on Ash Canyon creek eventually disappear as they infiltrate and recharge the underlying alluvial fan aquifer and Eagle Valley. This historical use of water from Ash Canyon

can be supplemented by User Agreements with the other water owners to increase the Ash Canyon supply to Quill during drought or dryer years.

Carson City has received permitted water rights from Ash Canyon that constitute 66.88 percent of the total flow. Historically, water rights were designated as an annual volume allowance, rather than a percentage of flow. As a result, water rights in Ash Canyon were set at the median flow of approximately 2,630 AFA. Of these water rights, 170 AF were previously owned by Virginia and Truckee Railroad (V&T), 1,625 AF are owned by Carson City and the remaining permitted water rights, 805 AFA, were owned by local farmers and ranchers. Carson City purchased the V&T lands and the water rights and utilizes the water rights associated with those lands as additional supply to the Quill Water Treatment Plant.

The division of water on Ash Canyon Creek involves the City and the other users of the Ash Canyon Creek flows to meet as often as needed during a summer season to concur on the frequency and amount of water diverted to the private users, with the remaining flow being available to the Quill Water Treatment Plant. In most summers, the City will pay the private owners for the amount of privately owned water diverted to the Quill Water Treatment Plant. Thus, it is conceivable that Carson City could utilize all the water rights allocated for Ash Canyon Creek, and in fact, in drought years, it is often the case that the City will lease the rights of other users, enabling the City to take the maximum amount of water available.



Quill Treatment Plant
With Ponds #1 & #2

Figure
9

Ash Canyon Creek accounts for approximately 10 percent of total Carson City's permitted surface and groundwater resources within the City's boundaries.

Production rates from Ash Canyon are directly impacted by low-precipitation years or drought conditions. During the series of drought years from 1989 through 1993; 2001 through 2004; and 2013 through 2016 the minimum monthly flow of 33 AF per month occurred in August 1992. The Annual Average City diversions from Ash Canyon during these drought periods are summarized in Table 8**.**

Table 8 - Ash Canyon Drought Year Flows

Drought Years	Drought Year Flow (AFY)	City Rights at 66.88% (AFA)	Percent of Median Flow
1989	1,593	1,065	41
1990	1,161	776	30
1991	1,157	774	30
1992	889	595	23
1993	1,809	1,209	47
2001	1732	1158	45
2002	1676	1121	43
2003	1913	1279	49
2004	1683	1125	43
2013	1956	1308	51
2014	1490	996	39
2015	1091	729	28
2016	1674	1120	43

Ash Tank

For drought planning purposes, it is assumed that Ash Canyon will be able to supply the equivalent of water year 1991- 1992 recorded flow volumes, or 889 AFY. Subject to agreement with the private users, Carson City may be able to divert water rights from other owners in exchange for payment, enabling the City to take full utilization of all flows in Ash Canyon.

Sampling data by the City from 2007 through 2014 indicates that Ash Canyon Creek and its tributaries have recorded elevated concentrations of Uranium with a blended average concentration of 26.5 µg/L at the intake structure for flows from Ash Canyon. The Uranium concentrations in Ash Canyon Creek range from the mid-thirties to the low twenties, with the low concentrations during the drought years 2013 and 2014. During 2008 and 2009, when the Ash Canyon Creek flows was in average flow conditions, the annual average range of Uranium varied from 30 to 34.5 µg/L. This may indicate that Ash Canyon Creek Uranium levels are sensitive to flow conditions. From a water planning perspective, if a water source is within 80% of the regulatory standard, in the case for Uranium the 80% level would be 24 µg/L, appropriate water treatment and/or blending methods should be considered.

This level of uranium in Ash Canyon Creek is significant. Currently the Ash Canyon Creek flows are blended with the East Slope Water from the State Marlette-Hobart Water System in the Ash Pond and then these combined flows are blended with the flows from Kings Canyon creek in Pond 1 prior to entering the Quill Water Treatment Plant. This blending maintains a low concentration of Uranium in the finished water from Quill.

The Quill Water Treatment Plant finished water flows are used for blending uranium concentrations in the series of the West Side Water System groundwater wells that have experienced escalating uranium concentrations. Reducing the Uranium levels in the Quill Water Treatment Plant finish water will increase the production of the West Side Water System cluster of groundwater wells significantly. Therefore, any reduction in Uranium levels in the Quill Water Treatment Plant finished water flow will benefit the production of groundwater from the West Side Water System.

There are other contaminates from increased organics and sediments generated from the Ash Canyon Creek that are contributing to the reduction in the production from the Quill Water Treatment Plant. The organic loading from Ash Canyon Creek may be the result of increased livestock activity in the Ask/Kings Creeks watershed and additional urban development on Kings Canyon Creek above the Quill Water Treatment Plant. This highlights the need for increased watershed protection measures.

Kings Canyon Creek Watershed

The flows from Kings Canyon are diverted to the Quill Water Treatment Plant via a diversion structure and then piped to the Quill WTP, collecting additional flow from three natural springs prior to reaching Pond 1. The Kings Canyon Creek water enters the Pond 1, providing blending with the Ash Canyon Creek and Marlette-Hobart Water. The combined water from all sources is then released to Pond 2, which is used to equalize the flows into the Quill Water Treatment Plant.

Flows greater than the storage/treatment capacities are allowed to continue downstream of the diversion dam in Kings Canyon Creek. The flows in the creek that are not used by other entities with water rights on Kings Canyon Creek eventually disappear as they infiltrate and recharge the underlying alluvial fan aquifer and Eagle Valley. This historical use of water from Kings Canyon Creek can be supplemented by User Agreements with the other water owners to increase the Kings Canyon supply to Quill during drought or dryer years.

Carson City has received permitted water rights from Kings Canyon that constitute 63.90 percent of the total flow. Historically, water rights were designated as an annual volume allowance, rather than a percentage of flow. As a result, water rights in Kings Canyon were set at the median flow of approximately 909 AFY. Of these water rights, 580 AFY were owned by Carson City and the remaining permitted water rights, 328 AFY, were owned by local farmers and ranchers.

Today, similar to Ash Canyon, the City and the other users of the Kings Canyon Creek flows meet as often as needed during a summer season to concur on the frequency and amount of water diverted to the private users, with the remaining flow being available to the Quill Water Treatment Plant. The ranchers/farmers have the option to lease excess water to Carson City. Thus, it is conceivable that Carson City could utilize all the water rights allocated for Kings Canyon, and in fact, in drought years, it is often the case that the City will lease the rights of other users, enabling the City to take the maximum amount of water available.

Kings Canyon accounts for approximately 2 percent of Carson City's permitted surface and groundwater resources within the City's boundaries.

Production rates from Kings Canyon are directly impacted by low-precipitation years or drought conditions. During the series of drought years from 1989 through 1993 the minimum monthly flow of 124 GPM occurred in October 1992. The Annual Average City diversions from Kings Canyon during this drought period are summarized in Table 9.

Table 9

Kings Canyon Drought Year Flows

Drought Years	Drought Year Flow (AFY)	City Rights at 63.9% (AFA)	Percent of Median Flow
1989	440	281	31
1990	284	181	20
1991	281	180	20
1992	195	125	14
1993	427	273	30
2001	523	334	37
2002	481	307	34
2003	402	257	28
2004	297	190	21
2013	307	196	22
2014	251	160	18
2015	277	177	19
2016	327	209	23

For drought planning purposes, it is assumed that Kings Canyon will be able to supply the equivalent of water year 1991- 1992 recorded flow volumes, or 195 AFY. Subject to the agreement with private users, Carson City may be able to divert water rights from other owners in exchange for payment, enabling the City to take full utilization of all flows in Kings Canyon.

Kings Canyon Creek has historically recorded uranium concentrations below 5 µg/L. This level of uranium is significant as the Kings Canyon flows are blended with the higher uranium levels in the Ash Canyon flows prior to processing through the Quill Water Treatment Plant. This blending process is critical to provide lower Uranium levels entering the Quill Water Treatment Plant. As in Ash Canyon Creek, other contaminants from organics and increased sediments are contributing to the decline of production from the Quill Water Treatment Plant.

The organic loading from King Canyon Creek may be the result of increased livestock activity in the Ask/Kings Creeks watershed and additional urban development on Kings Canyon Creek above the Quill Water Treatment Plant. This highlights the need for increased watershed protection measures.

Vicee Canyon/Timberline/Combs Watersheds

The combined Vicee Canyon/Timberline/Combs Watersheds does not have gages to monitor the seasonal flows from these watersheds. By prorating the areas of each of these watersheds with the areas of the Kings Canyon and Ash Canyon watersheds, it is estimated that combined probable flow contribution to the West Side Water System is 800 AFA.

Rose Creek, which is a tributary in the Timberline watershed, has a history of Uranium levels in the 100 µg/l and higher range.

West Side Water System - Groundwater Wells

The West Side Water System includes nine groundwater wells (Wells Nos. 3, 5, 6, 7, 10B, 46, 48, 51, and 55). This cluster of wells has produced significant supplies of water in the past. Currently, the production from these groundwater wells has been reduced due to a mixture of the age of the wells and the degradation of groundwater quality due to elevated Uranium levels.

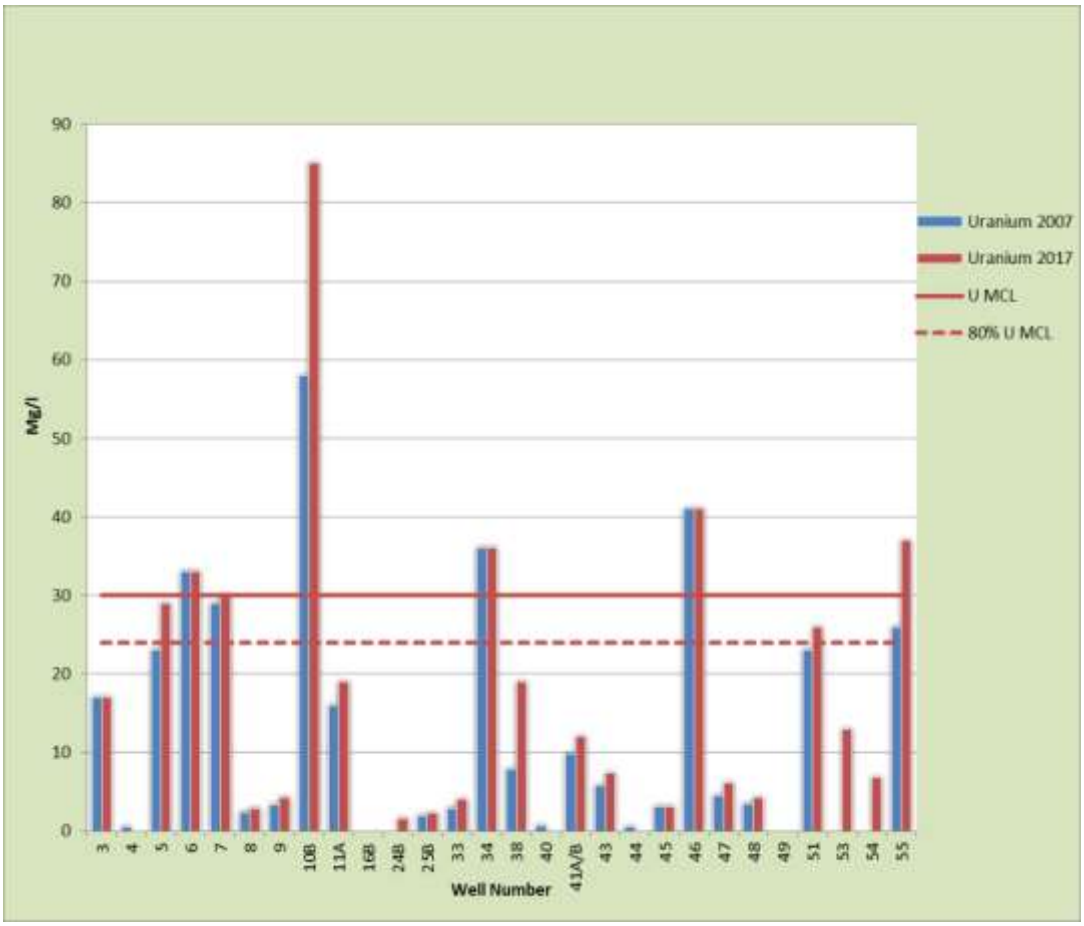
The cluster of the nine high production wells between Kings Canyon Road and the Community College has eight wells with Uranium levels that exceed the Federal Maximum Contaminant Level of 30 µg/l or are within 80% of the Maximum Contaminant Level. Due to the levels of Uranium, the City must use a NDEP approved Alternative Management Plan for blending the resources in a manner that provides potable water to the first water delivery point that meets the regulatory standards.

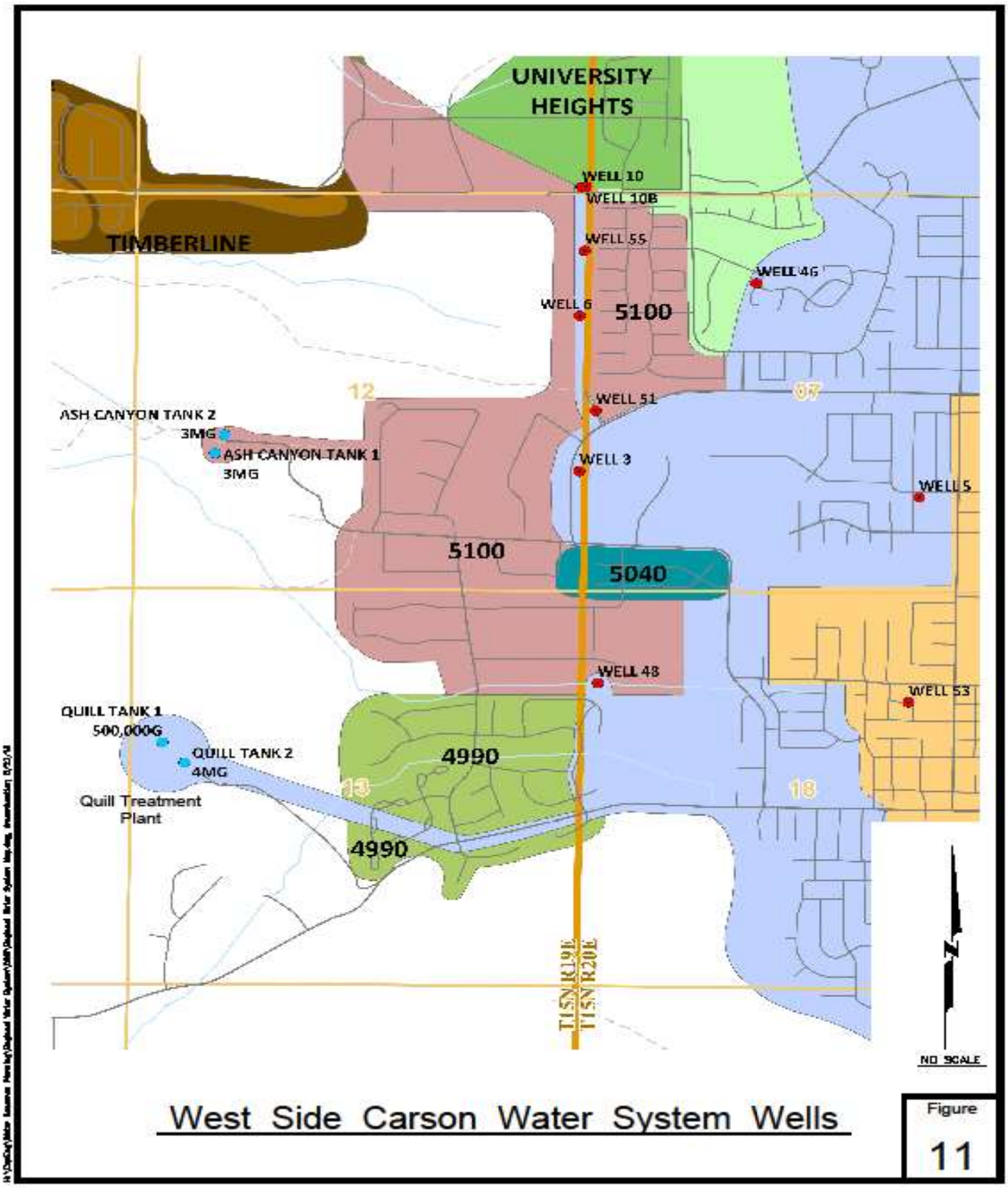
The combined rated capacity of this cluster of wells is approximately 5,177 AFA and has been a major contributor to the summer season demands. The blending process limits the production of this cluster of wells to approximately 3,000 AFA, significantly reducing the summer season supply.

There are eight groundwater wells out of the 28 City groundwater wells that exceed the 80% threshold of the Maximum Contaminant Level (MCL) for Uranium and five of these wells exceed

the MCL of 30 µg/l. All but one of the eight Uranium impacted wells is in the West Side Water System. The remaining well, Well No. 34, is in the Central City Water System and exceeds the Uranium MCL of 30 µg/l. See **Figure 10.**

Figure 10 Uranium Levels in Groundwater Wells





West Side Carson Water System Wells

Figure 11

Recharge Basins

There are ten (10) recharge basins in the alluvial fans formed by Kings Canyon Creek, Ash Canyon Creek and Vicee/Timberline/Combs Canyon Creek watersheds. The upper three basins are measured for recharge and reported. These recharge basins have been used sporadically in the past for collection of storm water and, in years with more precipitation, excess water from the Marlette-Hobart Water System.

Due to the declining water quality from Marlette-Hobart Water System causing issues with the Quill Water Treatment Plant, these basins should be evaluated for receiving water from the Marlette-Hobart Water System for recharge of the alluvial fan. The credits to the alluvial fan groundwater system would need to be approved by the State Engineer and possibly by the Nevada Division of Environmental Protection.

Aquifer Storage and Recovery (ASR) wells

Well No. 10B, 51 and 55 are among the newer wells to the Carson City groundwater system. They are also designed to function to pump water back into the groundwater zone of production that services the wells. The Carson City water managers and operators have recharged water that comes from the Marlette-Hobart Water System with limited success. This should be reviewed to evaluate how or if the ASR function of these wells can be improved.

Summary of the Potential Production for the West Side Water System

The following summarizes the potential average amounts of water delivered to the West Side Water System from the different water sources:

● MHWS		
○ East Slope Collection System	869 AFA	
○ Marlette-Hobart	1,200 AFA	
● Total MHWS	1,969 AFA	
● Kings Canyon (Median Flow)	909 AFA	
● Ash Canyon (Median Flow)	2,630 AFA	
➢ Total Potential Average Supply Through Quill AFA		5,508
● Total Quill Supply without Marlette-Hobart	4,308 AFA	
● West Side System Groundwater Wells with AMP Uranium Blending	3,400 AFA	
➢ Total West Side System with AMP Groundwater Uranium Blending and without Marlette-Hobart		7,708 AFA
● Total Potential West Side System Groundwater With EC Uranium Mitigation	5,177 AFA	
● Total West Side System without Marlette-Hobart and with Groundwater EC Uranium Mitigation		9,485 AFA

The above production from the West Side system needs to be evaluated carefully. For example; the total average flows from Kings and Ash Canyon Creeks, prior to any diversions, is 3,358 AFA for the period 1976 through 2016. In 1993 the Quill Water Treatment Plant was activated and has averaged approximately 4 MGD (4,480 AFA with a historical average of 2,000 AFA from the Marlette-Hobart Water System and 2,480 AFA from Ash and Kings Canyons Creeks). The private owners, primarily the Anderson Ranch, also used water from Ash and Kings Canyon Creeks for irrigation of agriculture fields.

In the early 1970s the City constructed three wells in the area of the Kings-Ash alluvial fan, Wells No. 3, 5 and 6. In 1990, Well No. 3 was re-drilled to increase production. The current production from these wells is approximately 1,175 AFA. The total water production from the drainage areas for Kings and Ash Canyons is approximately 3,175 AFA with and average flow from the respective creeks of 3,358 AFA.

In the drainage areas from Vicee Canyon/Timberline/Combs Canyon watersheds the City has constructed Wells No. 10B, 55, 6, & 46. This series of wells can produce up to approximately 1,150 AFA with Uranium blending. The estimated total flows that would recharge these drainage basins are 800 AFA.

An option considered previously was to construct blending lines from Wells 10b, 55, 6, and 51 to the transmission main sourced water through a blending tank. This alternative should be reviewed upon completion of the groundwater model noted following and more investigation of well rehabilitation and water quality testing of rehabilitated wells.

Three-Dimensional Groundwater model.

The Eagle Valley basin area has also experienced a reduction in the flows in the associated creeks due to natural climate influence. If the above median flows for water contributed to the West Side Water System are compared with the amounts that were pumped, it would indicate that this area is being over-pumped by approximately 1,800 AFA. In comparison, if the recorded flows for Kings and Ash Canyon combined with the estimated input from Vicee/Timberline/Combs Canyons with the Quill and groundwater well production for the period 200 through 2009 are assessed monthly, the area has a balanced inflow compared to production result.

As stated in earlier text a groundwater basin is, in essence, a reservoir, which will have groundwater levels fluctuate due to the natural cyclic variations in snow and precipitation levels and the seasonal withdrawals for the community water supply. To provide the management tools necessary to achieve a sustainable water management program for the Eagle Valley groundwater reservoir, this report recommends that the Three-Dimensional Groundwater Model be completed for the Eagle Valley groundwater basin.

CHAPTER 5

CENTRAL CITY WATER SYSTEM

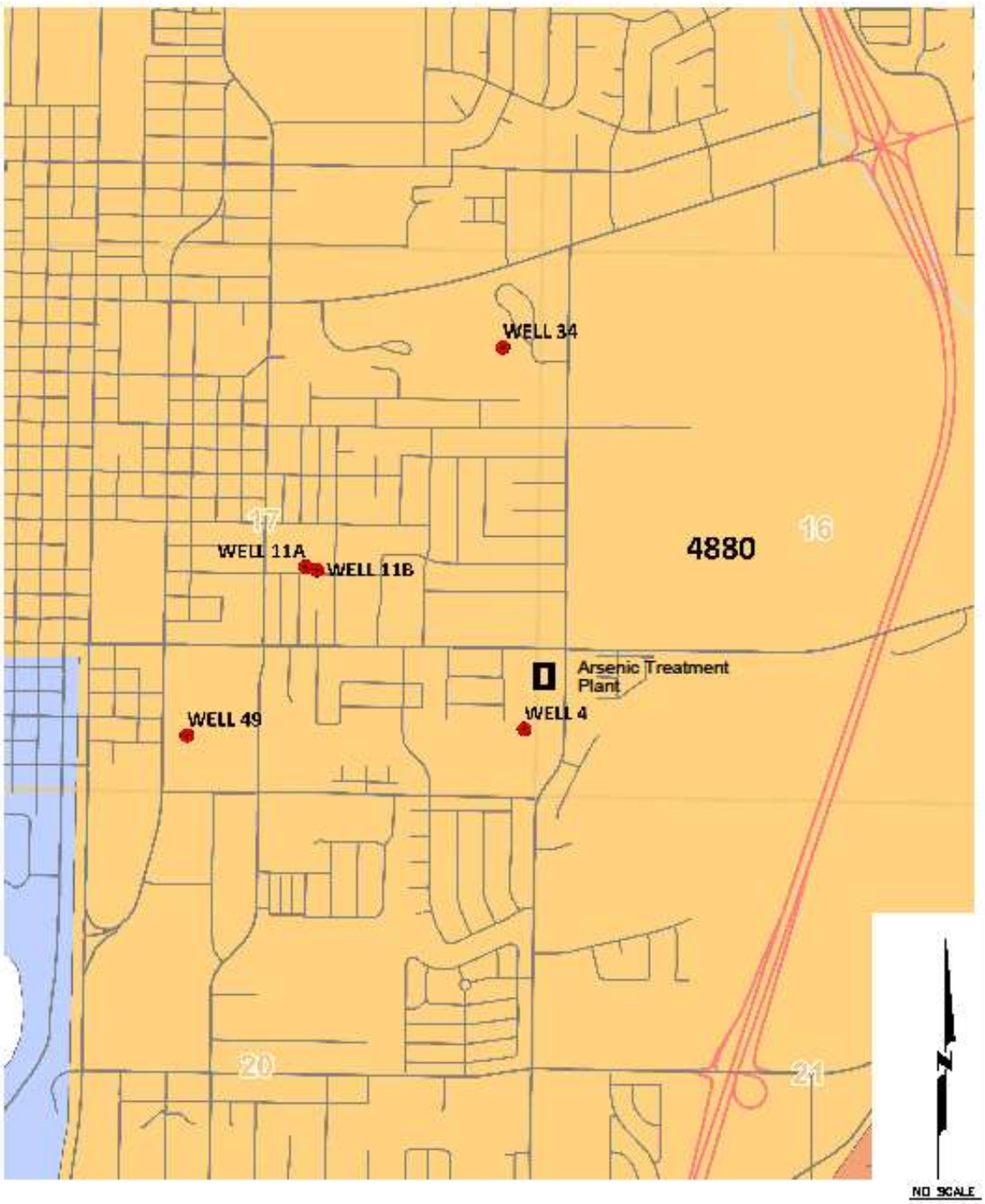
In the center of Eagle Valley there is a system of wells generally located between US 50 on the North, Saliman Road on the East, Little Lane on the South and Stewart Way on the West. This group of wells includes Wells No. 4, 11A&B, 34, 49 and 53. See **Figure 12**.

Well 34 in Mills Park

Well 49

There are now twelve City wells that exceed the 80% threshold of the Maximum Contaminant Level (MCL) for Arsenic and nine of these wells exceed the MCL of 10 µg/l. Four of the five wells that comprise the Central City Water System exceed the MCL of 10 µg/l. Well No. 34, which is located in Mills Park, exceeds the 80% threshold of 8 µg/l. Well No. 34 could be dedicated to irrigation only for Mills Park if desired. Well 4 has been taken out of service due to the high Arsenic levels. Wells No. 53 and No. 11 have Arsenic levels that exceed the Arsenic MCL and are used sparingly, and in many years, are not in service.

Prior to the implementation of Arsenic regulations between 2000 and 2003 which lowered the Maximum Contaminant Levels (MCL) for Arsenic from 30 µg/l to 10 µg/l, the Central City Water System production averaged between 3,300 to 3,620 AFA from the Eagle Valley groundwater aquifer.



Central Carson Water System Wells

Figure 12

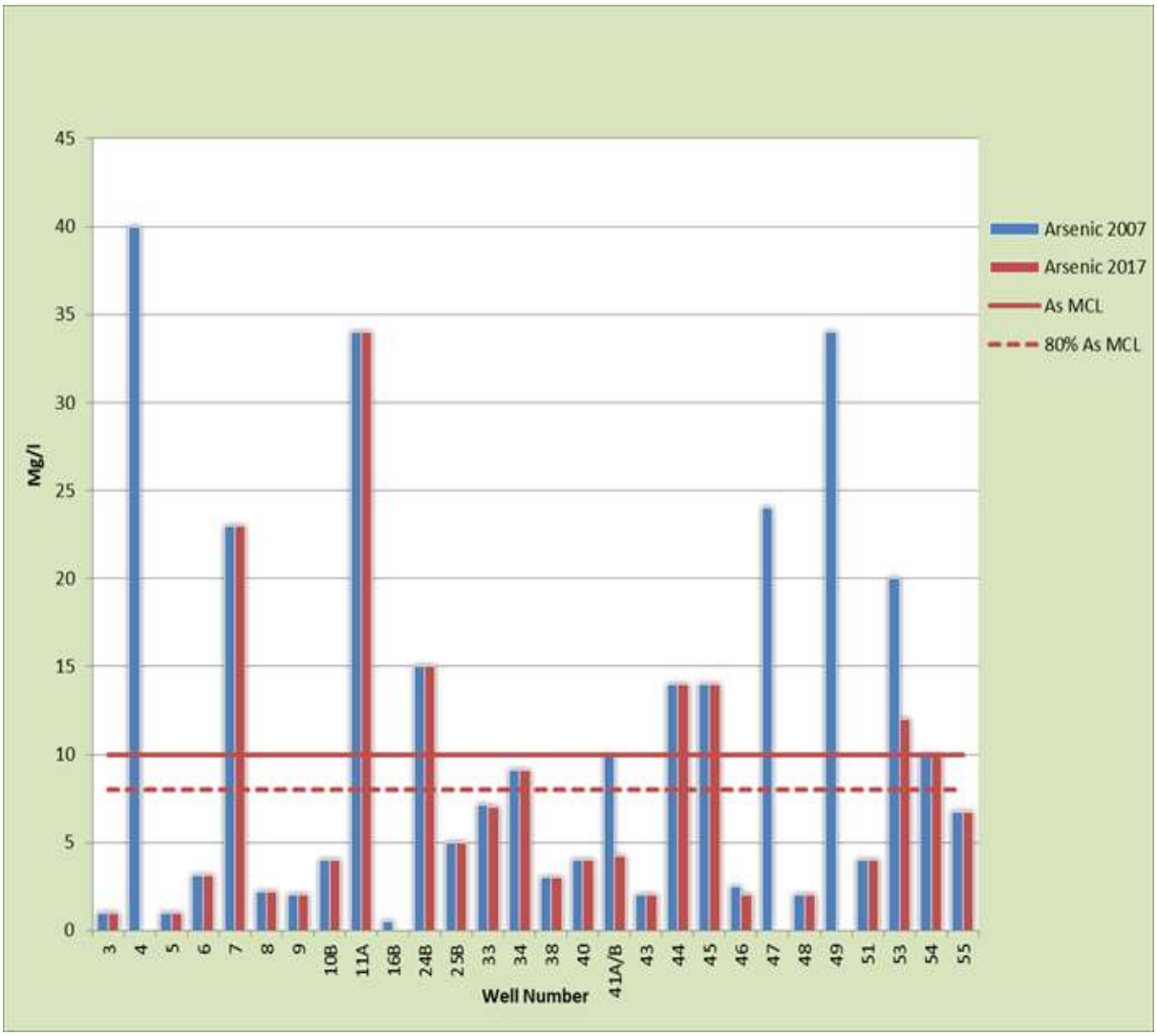
In 2007 the City installed an Arsenic removal plant for the combined flows of Wells No. 4 and 49 that should have mitigated the Arsenic issues for these wells and improved their production capability. However, due to chemical reactions between the different waters of the wells, the Arsenic plant has not been able to properly treat the combined flows from these wells. The City has been limited to running restricted flows from Well No. 49 only through the Arsenic plant. Prior to the Arsenic regulations Well No. 49 contributed approximately 920 AFA to the City supply. However, due to the Arsenic levels in the well and the issues with the Arsenic treatment plant, Well No. 49 has been restricted to an average production of 61 AFA. During the period from 2011 through 2016, the Central City Water system has averaged 612 AF during the summer season.

Arsenic Removal Plant

It is proposed that the City drill a pilot well in the vicinity of Well No. 4. This pilot well would be monitored and sampled as it is drilled to determine if the Arsenic contamination is from a portion of the aquifer that could be blocked off from production. If so, it may be possible to construct a high production well with acceptable Arsenic levels that can be used to blend with the other wells within this group. In addition, the information gained from a pilot hole in this location will provide additional data to support a three-dimensional model of the Eagle Valley basin.

The proposed three-dimensional groundwater model will assist in identifying locations for drilling other deeper wells that will minimize the levels of Arsenic and Uranium, reducing costly treatment to mitigate the impacts of the Arsenic and Uranium regulations.

Figure 13 Arsenic Levels in Groundwater Wells



CHAPTER 6

INTERLOCAL WHOLESALE WATER AGREEMENTS

Douglas County/Minden Water

In January 2010 Carson City, Douglas County, the Town of Minden and the Indian Hills General Improvement District entered into a series of interlocal agreements for the North Douglas County and Carson City Water Line Intertie Project. This agreement facilitated the delivery of Carson City Carson Valley water rights from the Town of Minden Water Utility through the Douglas County water system to Carson City. The water line connecting the Town of Minden and Douglas County water system to the Carson City water system was completed in 2013 and Carson City began receiving water from the regional water line soon thereafter. The initial agreements were amended several times to address water rates and construction of the Project.

The total amount of water agreed to in the initial agreements was to deliver 4,500 gpm to the Carson City system. Carson City has been receiving the 4,500 gpm since 2013. The agreement provides for possible future delivery up to 7,500 gpm.

In addition, in Chapter 5 of the agreement between Carson City and the Town of Minden contains the following provision:

> "MINDEN and CARSON CITY agree that if, in the future, CARSON CITY wishes to purchase water rights from MINDEN, in addition to the Minden water rights, the Parties shall meet and negotiate in good faith for the purchase of additional water rights owned by MINDEN and the delivery of the water produced by those additional water rights from MINDEN to CARSON CITY."

Therefore, a future option is the possibility of purchasing additional water rights and pumping them from Minden wells for delivery through the intertie line to the City.

Carson City and Lyon County - Dayton Water Utility

Lyon County through its Dayton Water Utility and Carson City previously entered into an agreement relating to Water Service in 2008 and updated it in 2018. The agreement anticipates the continued need to work cooperatively to expand the delivery of water resources between the parties to provide existing and future residents with an adequate supply of potable water to meet the projected water demands pursuant to their respective master plans. It is envisioned it may become necessary for the parties to develop additional improvements to their respective water systems and/or utilize water rights in a cooperative manner to meet these demands. Lyon County and Carson City have also previously entered into Agreements with Vidler Water Company for the design and construction of certain improvements which includes a pipeline,

which has been completed and which provides connection between the Lyon County Dayton Water Utility system and the Carson City water utility system.

Highway 50 Tank and Booster

Lyon County has transferred water rights to Carson City for withdrawal by Carson City and delivery to the Dayton Water Utility. While a small amount of water, the exercising of the rights has been beneficial. Additionally, Lyon County has provided water at times to Carson City when additional supply was needed during peak times in the summer. The delivery of the water is monitored and has been about equal in volume each way to date.

The “Carson River Springs”, noted earlier in this report, which are a result of the Brunswick Reservoir leakage and which are permitted by State NDEP, discharges to the Carson River downstream of Mexican Dam, but within the Segment 7A of the Alpine Decree. The total amount of water discharged to the Carson River is approximately 500-1000 AFA.

An option for placing this water into the Carson City water supply includes moving the water rights downstream to the Lyon County Dayton water utility for withdrawal through a Dayton water utility river induction well and then pump the water back to the Carson City water system through existing infrastructure and agreements with Lyon County. This may entail a third-party agreement with the Vidler Water Company who is working with Lyon County for a similar venture relating to withdrawal of surface water in the same manor by utilization of a river induction well. Variations on this concept are being explored by the three parties. See Figure 1 Water System Source Overview.

CHAPTER 7

STORAGE AND USE OF CARSON RIVER SURFACE WATER RIGHTS

Carson City owns or leases a host of Alpine Decree River Rights in the upper Carson River including:

- 240 Acre Feet (AF) from the Williams Slough that is stored in Ambrosetti Pond (Owned).
- A long-term lease for 100 AF stored in Lost Lake through the Carson Water Subconservancy District.
- A total consumptive use right of 1,915.09 AF from irrigation rights within Segment 7A serviced through the Mexican Ditch and River Induction Wells (Owned), and
- A long-term lease for 489.41 AF of storage in Mud Lake through the Carson Water Subconservancy District.

The total decreed, storage and leased rights available for use is approximately 2,744.50 AF annually (AFA). All the rights either are or can be accessible through the Mexican Ditch.

Currently, the City manages the Segment 7A river rights by accessing the water through the river induction wells; Wells No. 25 and 41, which are in the Dayton Hydrographic Basin, Basin No. 103. Each year, the Carson City Public Works Department begins the pumping program for the Decreed river rights by pumping the junior priority rights from Segment 7A through the induction wells when the river has adequate flow and is not on regulation, usually during the months of April, May and the first part of June. The amount of water pumped is subject to the capacities of Wells No. 25 and No. 41. Then, as river flows decrease, and the river is placed on regulation, the City will pump the remaining portions of their junior rights as the priorities permit, leaving the more senior rights for pumping during July, August and September. This is an excellent practice to maximize the use of the river rights, particularly the Segment 7A river rights, without storage.

Water stored in Ambrosetti Pond is released during the summer season and augments the quantity of water pumped through Wells No. 25 and No. 41. The water stored in Ambrosetti Pond is tail water from the Williams Slough and is released from the Ambrosetti Pond and recovered through the induction wells during the irrigation season.

Ambrosetti Pond

Mud lake water is released after the irrigation season and recovered through the induction wells during the off-irrigation season. Lost Lake water is released intermittently and usually used in the off-irrigation season, October through March.

In the Alpine Decree, Section X of the Administrative Provisions, states that "No user entitled to the use of water under this Decree shall be allowed to divert more than 40% of his total entitlement in any one calendar month." This provision has allowed a water user to divert on a 40-40-20 schedule to storage at a rate of 40% during the first month, usually April; 40% in May; and 20% in June. Re: State Engineer Ruling # 4207, upheld by the Federal Court, United States v. Alpine Land & Reservoir Co., 919 F.Supp.1470 (D. Nev. 1996). This decision allowed Aqueduct I to store the stated decreed consumptive use of 2.5 AF per acre of water in an enlarged Mud Lake on a 40-40-20 schedule. Generally, diversions can occur if the diversion of the consumptive use specified in the Decree does not place the river on regulation, meaning that there is enough water remaining in the river to meet downstream water diversion rights. Once the river goes on regulation, the water can either be used or stored in sequence with the priority of the rights.

During the period 2008 through 2015, the average use of surface rights without storage ranged from approximately 77% to 19%, with an average use of 49%. With storage, the use is projected to range from 100% to 30%, with an average use of 85%. The low yield for the 2008-2015 period with and without storage is influenced by the severe drought years of 2012 through 2015 and is used as an example of the added efficiency of storage.

Table 10 – Segment 7A River Rights

Segment 7A Mexican Ditch Water Rights Use (AFA)						
	Historic Use without Storage for Period 2008 through 2015				Projected Use with Storage for Period 2008 through 2015	
	Year	Total Use all River Rights	Segment 7A Use	% of 7A Rights used	7A Rights Available with storage	% of River Rights Use with Storage
	2008	2,038.1	1,473.6	76.9%	1915.1	100.0%
	2009	1,506.1	1,120.4	58.5%	1915.1	100.0%
	2010	1,334.1	732.9	38.3%	1915.1	100.0%
	2011	1,893.2	1,265.9	66.1%	1915.1	100.0%
	2012	1,786.1	1,076.5	56.2%	1723.6	90.0%
	2013	1,861.2	965.9	50.4%	1685	88.0%
	2014	1,108.7	359.2	18.8%	1417.2	74.0%
	2015	1,351.9	573.4	29.9%	573.5	29.9%
Total use over the period 2008-2015		12,879.3	7,567.7		13059.7	
Average Use		1,609.9	946.0		1632.5	
Total Rights Available		2,744.5	1,915.1			
Average percent of River Rights used		58.7%	49.4%		85.2%	

A significant advantage for implementing storage of the river rights is providing the ability to move the maximum amount (74% to 100%, except for the worst drought year of record, 2015) of the river rights for use during the peak summer demand season, usually mid-June through September.

Over the period from 2008 through 2015, the City has been able to use an average of approximately 940 AFA without storage. With storage, the total amount usable would increase to an average of approximately 1630 AFA, an increase of 690 AFA or 73%, with the flexibility to move and use this amount of water during the summer demand season.

The following options for storage of the river rights were evaluated for this report:

- **<u>Storage of Seven 7A River Rights above Mexican Dam (Segment 6)</u>**

  Ambrosetti Pond is in the upper reach of Segment 6. The water stored in Ambrosetti Pond is from the Williams Slough tail waters. The City uses Ambrosetti Pond to store water which is usually released season and pumped into the City system through the river induction wells. The City does not own Ambrosetti Pond or the land that Ambrosetti Pond occupies but has an easement for its facilities. The City has acquired the 240 AF of water that has storage rights from the Williams Slough in Ambrosetti Pond.

  The Ambrosetti Pond was evaluated as a potential for storage of the Williams Slough rights and a portion of the Cities Segment 7A river rights, but was considered not viable due to:

  - If the Segment 7A river rights were moved upstream into Segment 6 the priorities of the 7A rights would become the most junior priority in Segment 6. Although

there are only two small rights being pumped between Ambrosetti Pond and the Carson City gage located immediately above the Mexican Ditch Dam, and the beginning of Segment 7A, the City would need to have agreements in place allowing their Segment 7A water to be moved during the irrigation season prior to using Ambrosetti Pond to store Segment 7A rights. This agreement would be difficult to achieve, and if achieved, difficult to manage.

- The City does not own the property that Ambrosetti Pond occupies. To store additional water in Ambrosetti Pond there would be a host of improvements including but not limited to enlarging and deepening the pond, constructing higher levies, managing Williams Slough in and around the pond, and constructing a pumping station on the Carson River to pump the river rights into Ambrosetti Pond.

- The area that Ambrosetti Pond occupies is not large enough to hold up to 750 AF of storage without major construction of levies, which would invoke the State Engineers 20-20 rule, requiring the levies to meet construction standards similar to a dam.

- **Storage of River Rights through Mexican Ditch Dam (Segment 7A)**

  The Mexican Ditch Dam is an existing diversion structure on the main stem of the Carson River and at the uppermost position in Segment 7A of the Alpine Decree. The Mexican Ditch Dam has been in use since the initial efforts to establish a water decree on the upper Carson River. A small detention pond is created behind the dam and an existing diversion structure releases water from the pond to the Mexican Ditch. Water is carried through the Mexican Ditch in a North to Northeast direction for approximately 5 miles, terminating near the Empire Golf Course.

Mexican Ditch

The Mexican Ditch water has serviced agriculture lands along the Mexican Ditch alignment for over 100 years. Carson City now owns a large portion of the agricultural lands that were historically served by the Mexican Ditch between the Mexican Dam Diversion to the Empire Golf Course. The lands are now used for the Silver Saddle Ranch, Riverside Park, and open space along the Carson River.

The portion of the Mexican Ditch alignment that is under evaluation for potential storage sites is from the Mexican Dam pond to Marsh Road, approximately 3.5 miles. These initial candidate storage areas are illustrated in Figure 14.

The method of diversion to storage is envisioned to use the existing Mexican Ditch diversion point at Mexican Dam and transfer the water to a series of storage ponds on the City owned lands now designated for recreation and open space between the Mexican Ditch diversion structure and Marsh Road. The preliminary analysis indicates that, depending on how the stored water is delivered to the Carson City water system, a total storage capacity of between 2,000 AF to 1,300 AF would be needed to utilize the full allotment of Segment 7A river rights.

The Mexican Ditch profile is very flat, with about 1 foot of drop in five miles of alignment. The strategy is that storage sites should be next to the Mexican Ditch, so the water could be easily diverted to the storage ponds.

Once the water has been diverted to storage in the ponds adjacent to the Mexican Ditch, small inflatable dam structures or gates would be placed in the Mexican Ditch to allow water pumped back into the Mexican Ditch to flow by gravity back to the Mexican Dam Pond. The amount of water returned to the Mexican Dam Pond would then be released to the river and pumped into the City water supply system through river induction wells, Well No.25 and 41.

The unoccupied areas along the Mexican Ditch were evaluated for potential storage sites. Areas were removed from consideration if an area has other established and continuing uses, would impact the Ducks Unlimited improvement area, and if the area was limited in available size to include in a storage program. After review, two areas were considered eligible for consideration.

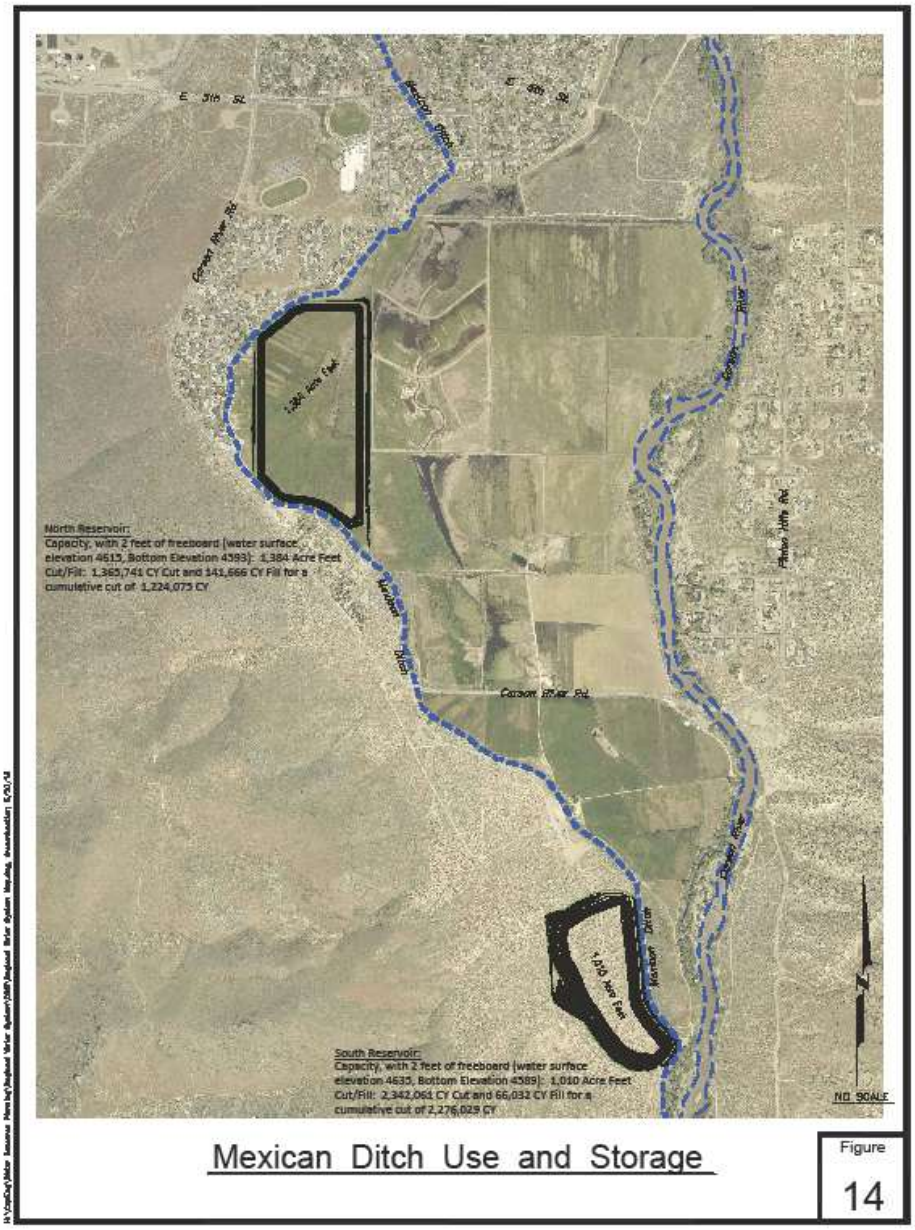
A field review of the Mexican Ditch alignment and the two potential storage areas was conducted on December 16th, 2016. There are several areas along the Mexican Ditch alignment that could be used for ponds by excavating the area to hold the storage needed. Other areas may be suitable, but it probably would mean combining storage with several smaller ponds which was not deemed feasible from a storage management perspective.

The southern storage site is in an area on the West side of Mexican Ditch of approximately 45 acres covered with what appears to be native vegetation and probably not used for agricultural purposes in the past. It is the closest area to the Mexican Dam Pond and therefore would incur the least amount of losses in transporting water from

and back to the Mexican Dam Pond. The soil conditions and depth to groundwater would need to be investigated.

A small historic structure identified by the BLM prior to the land transfer of the area to the City was located within the southern storage area. The structure will need assessment to determine proper mitigation methods.

The northern storage site is in the open space area below the site of Well 47. It appears that the recent grading for the Ducks Unlimited ponds are just east of the area highlighted. Also, there is an electrical pole line that crosses the area that would need to be relocated. Soil conditions and depth to groundwater would need to be assessed for this area.



Mexican Ditch Use and Storage

Figure 14

Existing Infrastructure for delivery of stored water

The river induction wells; Well No. 25 and Well No. 41, have a stated design capacity of 1,000 GPM and 1,600 GPM respectively. The records indicate that aggregate production from both wells often produce between 2,100 and 2,650 GPM of water during the summer demand season. The actual well performance will need to be reviewed to determine if they will need additional work to meet the summer demands with storage.

Well No. 25

The existing transmission system has been upgraded with a new 24-inch line from the City Park at the East end of Fifth Street to Edmonds Drive. The water is then transported through the new North-South Transmission Main to either the Prison Hill Tank or to the Butti Way transfer facility connecting to the East-West Transmission Main.

Water Production Scenarios with Storage

If off stream storage is introduced to the system, the use of the Segment 7A decreed water rights combined with the other surface water rights would become flexible. For each of the following scenarios it is assumed that the water that is not pumped through the river induction wells under the 40-40-20 provision of the Alpine Decree but would be diverted to an off-stream storage facility to provide carry over storage for use during the summer peak demand season, from mid-June through October.

From the years of record included in this analysis, the 2008 year was selected as the “Normal Year” and 2014 was selected as the “Drought Year” for Carson River flows. The 2015 Year was the worst drought year of record for the Carson River, but was not used due to the records indicating that there was not enough flow in the river that could have been moved to storage.

The objective of the selected years is to determine the amount of storage that would be needed along the Mexican Ditch. The amount of storage is influenced by the way the City would manage the use of production from Wells No. 25 and No. 41 and transfer of water to and from storage.

The following scenarios include City use as they currently operate and, to demonstrate the benefits of storage, moving the use of the water to the Summer Demand Season, usually early June through September. These scenarios provide a maximum amount of storage needed and a minimum amount of storage needed. The river water is stored in a pond or ponds along the Mexican Ditch as described above. See Figure 14.

Scenario A; Moving the water to Storage for use during the Summer Peaking Season:

This scenario assumes that the river water is placed into storage on a 40% in April; 40% in May; and 20% in June schedule. From mid-June through September the amount of water after augmentation for the Prison Farm, is removed from storage on a fixed pumping basis for use during the months of June through September to maximize the use of the stored water during the heavier demand summer months.

This scenario estimates that the storage required would be approximately 1,427 AF, rounded to 1,400 AF. However, as the effluent available for reuse increases in the future, the analyses indicates that the amount of storage would increase to approximately 1,531 AF, rounded up to 1,600 AF of storage.

During “Normal Years” the delivery and transport systems from Wells 25 and 41 would need to be improved to approximately 4,000 GPM. Refer to Table 10.

Scenario B; Storage of water available from the current method of operations:

This scenario assumes that the river induction wells pump water from the river starting in April and continuing through September in concert with the Alpine Decree provisions. Any water that the inductions well does not pump would be placed into storage during the months of April, May and June. From mid-June through September the amount of water, after augmentation for the Prison Farm, is removed from storage on a variable pumping basis for use during the normal summer season months of April through September as a base flow for the water delivery system.

This scenario estimates that the storage required would be approximately 1,300 AF. If the effluent available for reuse increases in the future, the analyses indicates that the amount of storage would be approximately 1,400 AF of storage.

However, this option does not maximize the use of the river rights during the peak summer demand season.

During “Normal Years” the delivery and transport systems from Wells No. 25 and No. 41 should be able to deliver the projected water flow rate at 2,000 GPM. Refer to Table 10.

CHAPTER 8

PROJECTED WATER SYSTEM IMPROVEMENTS, COSTS, SCHEDULE AND RECOMMENDATIONS

The increase in projected water demands are used as the basis for determining the amounts and timing for the development of future water supply that will meet the requirements to buildout of the City.

The projected schedule for the summer season water supply demands starting from the base year of 2017 to buildout was presented previously in Chapter 1, Table 1 and reproduced here as Table 11 and represented below. All future demands beyond 2017 include the 20% reserve required to meet the State guidelines for municipal water planning:

Table 11 Summer Season Increase in Demand

Year	High Population Projection	Median Water Demand (310 gpcd)	Summer Season Increase in Demand
2017	55,438	19	Current Supply Capability
2020	57,634	21	System needs 2 mgd additional supply
2030	69,954	24	System needs 3 mgd additional supply
2040	71,664	27	System needs 3 mgd additional supply
2050	77,764	29	System needs 2 mgd additional supply
2060	83,864	31	System needs 2 mgd of additional supply
2067	88,134	33	System needs 2 mgd additional supply

For example, the projections indicate that the Carson City water summer season demands will increase from the current 19 MGD by 14 MGD to 33 MGD by the year 2067. The Capital Improvement Program needs to identify and program projects that can provide this increase in supply by 2067.

Once the demand schedule was developed, the Technical Advisory Committee reviewed the individual blocks of water to determine how flexible the blocks were for incremental development of additional supply to meet the above schedule for demands. The blocks were then divided into sub-blocks when possible. The following is a listing of system planning and management recommendations included with developable blocks of water to meet future summer water demands.

THE PERIOD FROM TODAY THROUGH 2020

The projections indicate that the system needs to develop an additional 2 MGD by 2020. It is recommended that this initial effort focus on the development of two wells that have historically produced water more than 600 gallons per minute. One MGD is equivalent to approximately 695 GPM.

Well No. 3, which is within the West Side cluster of groundwater wells and was re-drilled in 1990, needs to be reconstructed using current well design and construction methods. Records indicate that this well was capable of 1,000 GPM and drilled to a depth of 480 feet. The water quality of the existing well is good, with levels of Arsenic and Uranium well below the regulatory limits.

It is recommended that a pilot drill be conducted adjacent to the existing well to greater depths, in the range of 900 to 1200 feet unless the pilot hole reaches bedrock prior to the depth range. The pilot hole will determine the water production zones and will record a water quality profile for the well as it is drilled. The well will then be designed and constructed to produce the sustainable quantity with the highest quality.

Well No. 4, which is within the Central City Water System was drilled in 1969 to a depth of 800 feet. The records indicate this well produced up to approximately 800 GPM. However, the water quality exceeded the Arsenic regulatory standards. It is unknown if the Arsenic impacts are associated with a particular zone. The Uranium levels were very low, recoded at 0.5 µg/l with a standard of 30 µg/l.

It is recommended that a pilot drill be conducted adjacent to the existing well to greater depths, in the range of 900 to 1200 feet unless the pilot hole reaches bedrock prior to the depth range. The pilot hole will determine the water production zones and will record a water quality profile for the well as it is drilled. The well will then be designed and constructed to produce the sustainable quantity with the highest quality.

Prison Well, as stated in Chapter 3 of this report, the State of Nevada has State groundwater permits that are not currently active due to the State use of City wastewater reuse water. It is recommended that the City approach the State to have the City drill a new well at a site within the irrigated area of the State Prison Farm for municipal supply. The City would operate the new well and place the water into the potable water system in exchange for the reuse water applied to the State Prison Farm and to keep the State water right permits active. This would provide a source of water entering the southern portions of the City water system, which will help balance the management of the southern portion of the City water supply system.

Existing Arsenic Removal Plant. This facility should be reviewed to determine if the plant can be re-configured to remove Arsenic from the Central City system of groundwater wells. If re-configuring the plant is feasible, this could increase the production from the Central City Water System from approximately 600 GPM today to levels between 3,000 to 3,500 GPM.

Eagle Valley Basin Groundwater Model. Groundwater development in the Eagle Valley needs to be advanced in a well-planned program in order to achieve a sustainable level of water production. The modeling technology has advanced significantly and now include three-dimension models. There is a data base in the Eagle Valley basin that includes all of the existing groundwater wells completed by the City and an extensive groundwater data system developed through the USGS and others in the basin.

As stated in earlier text a groundwater basin is, in essence, a reservoir, which will have groundwater levels fluctuate due to the natural cyclic variations in snow and precipitation levels and the seasonal withdrawals for the community water supply. To provide the management tools necessary to achieve a sustainable water management program for the Eagle Valley groundwater reservoir, this report recommends that the Three-Dimensional Groundwater Model be completed for the Eagle Valley groundwater basin.

The Lawrence Berkley National Laboratory recently completed a three-dimensional groundwater model for the City of Wells. After review of the figures and information developed through this modeling effort, it is recommended that the Lawrence Berkley National Laboratory be retained to evaluate the existing data bases in the Eagle Valley for development of a three-dimensional model. If the data base is acceptable, the funding for the development of the model would be included in the budgets for the next two years. It is expected that the model could be completed within a six to nine month time frame if authorized.

Planning Level Costs and Schedule for Period Today through 2020:

The rehab/re-drilling of Wells No. 3 and 4 would include the completion of a pilot drill adjacent to the existing wells. These pilot holes would be completed to approximately 900 to 1200 feet, depending on the information that is developed as the pilot hole is being completed. The goal is to determine the water quality of the aquifers as they are penetrated and to go deep enough to achieve the desired production levels for each well. To determine the production capabilities, the hole drilled should be a minimum of 6-inches diameter. The estimated cost for each pilot drill is estimated to be approximately $125,000. The time frame for completion of the pilot drill program would be about six-nine months, including the development of the specifications for each drill, advertising, and selection of a driller and then completion of the drill.

Once the information from the pilot drill program is completed, the final costs and schedule of the completion of the replacement wells is expected to be approximately $1 to $1.2 million dollars for each completed well.

The review of the Arsenic Removal Plant is expected to take up to six months, including a 60-90 day period for selection of a consultant to complete the review. The cost for this review is estimated to be approximately $100,000.

The Period from 2020 through 2030

The projections indicate that by 2030 an additional 3 MGD of production will be needed. Once the Eagle Valley Basin Model is completed, the focus on production should be the West Side Water System and the Central City Water System.

If the Kings, Ash and Combs Canyon alluvial fan can sustain the expansion of the Quill Water Treatment Plant, this is recommended to be the next production expansion for the Carson City Water System. This is an existing facility that can be expanded to a production level of 7 to 8 MGD with an acceptable cost factor.

If the modeling indicates that the expansion of production by the Quill Water Treatment Plant may not be sustainable, then the effort should shift focus to the Central City Water System with re-configuring the existing Arsenic Treatment Plant. The improved Central City Water System, with the re-drilling of Well No. 4, should expand the City water production by 4 MGD.

The Period from 2030 to Buildout (approximately 2067)

Either of the above programs would provide the City production to the 2030 projections.

The remaining water production programs contained in this report should provide the City a sustainable water supply to reach the buildout projections. However, this report does not make recommendations beyond the improvements to the West Side Water System and the Central City Water System.

Water treatment technologies are expected to increase in the future. As water treatment technology continues to advance, it may change how one of the future programs are considered for future water resource planning.

The following are the additional identified available programs for increasing water production.

West Side Water System

Quill Water Treatment Facility:

The Quill WTF is an integral source of water that is a part of the base water supply as well as the summer season supply. In the past, Quill has been a reliable source of supply and would operate comfortably at the 4.5 +/- mgd. The fact that the source waters have deteriorated to levels that impact the Quill ability to produce potable water in the quantities needed for that sector of the supply system needs to be addressed. A high priority is to up-grade this facility to provide the quality and quantities produced, but to also be expanded to treat the additional water that is now available from the Ash and Kings Canyon tributaries.

In January 2018, the TAC conducted a demonstration of an old technology that has been modified to treat municipal water systems water quality issues with heavy metals such as Arsenic and Uranium, removes Total Dissolved Solids and Total Suspended Solids, and treats surface water systems for cysts including giardia and cryptosporidium. This technology, Electrocoagulation, has been used in the mining, oil and gas industries since the early 1900s. It has recently been modified for use in the municipal water and wastewater systems.

A preliminary assessment of the Quill facility should be conducted to identify the scope of improvements that will be needed to bring the Quill facility up to standards and to achieve the water production levels of 6 to 8 MGD.

The Planning Level Cost to expand the facility up to 6.0 MGD is on the order of $14.5 million or $2,160/AFA with a yield of 4.5 to 6.0 MGD.

West Side Cluster of Groundwater Wells

The West Side System cluster of groundwater wells includes Wells No. 3, 6, 7, 10B, 46, 48, 51 and 55. Of these wells, Wells No. 10B, 51, and 55 were reconstructed in 2005. Well No. 3 was last drilled in 1991, 1991 and is recommended for re-drilling in the first period of develop of this water planning effort. Of the remaining wells in the West Side Cluster of Wells Well No. 6 was drilled in 1972, Well 7 was drilled in 1973, Well No. 46 was drilled in 1994 and Well No. 48 was drilled in 2000. All of the above wells should be reviewed and a priority set for reconstruction following the same process as Wells No. 3 and 4. All wells within this group are impacted with Uranium except for Wells Nos. 3, 5 and 48. Wells No. 5 and 48 are lower producing wells with projected outputs of 340 and 300 gpm respectfully. The higher production wells are impacted with Uranium that exceed the maximum contaminant level of 30 µg/l or at 80% or more of the maximum contaminant level. This group of wells has high production levels, but the blending process necessary to provide potable water within the maximum contaminate level severely limits the production, especially during the summer demand season.

Options for mitigating the uranium issue and increase production from this cluster of wells include:

- Dedicating a significant portion of the Douglas/Minden water for blending. This will require a blending facility, piping, and a probable dedicated water tank.
- Use the Electrocoagulation treatment on a split flow from Ash Canyon. The treated water would be released into Ash Pond, providing additional blending of the Uranium levels with the East Slope System water, and then transport the blended combined flow to The Quill Water Treatment Facility. The finish water from the Quill Water Treatment Plant would then be transported by the existing piping to the Ash Canyon Tank. The Uranium impacted groundwater wells then would be pumped to the Ash Canyon Tank for blending with the Quill flows to bring the groundwater supply to compliance with the Uranium regulations.

The Planning Level Cost to construct a blending facility or construct an EC Treatment Facility for 8,193 AFA is on the order of $10.1 million to $15.6 million or $1,232 to $1,904/AFA with a yield of 14.8 MGD.

Central City Water System

The Central City Water System includes Wells No. 4, 11 A&B, 34 and 49. This cluster of wells has a potential summer season production of 3,300 to 3,620 AFA. In 2007 the City installed an Arsenic removal plant for this series of wells that should have improved the production capability. However, due to chemical reactions between the different waters of the wells, the Arsenic plant has not been able to properly treat the combined flows from these wells. The City has been limited to running restricted flows from Well No. 49 and 11 A&B through the Arsenic plant. The production from this series of wells has averaged 475 AF during the summer season due to the Arsenic impacts.

Blending this group of wells with the Minden is not an option. If the entire flow of Minden water was treated to a level of As of 1 µg/l, the blend still would exceed the maximum contaminant level of 10 µg/l.

If the existing Arsenic Treatment Plant cannot be re-configured to treat the Arsenic level in the Central City Water System groundwater wells, then the option of using the Electrocoagulation treatment of the combined waters should be evaluated.

The planning Level Cost for an Electrocoagulation Treatment facility for 3,780 AF is on the order of $16.1 million or $4,260/AFA with a yield of 5.2 MGD.

Coordination of Water Development Options with Wastewater Reuse

Due to the need for additional potable water in the water supply system, the use of potable water for irrigation of parks, open space, the State Prison Farm and other applications should be transferred back to non-potable sources as the reuse water becomes available.

Well No. 47

Well No. 47 has elevated arsenic and fluoride levels and has not been in service for several years. This well should be evaluated for diversion to the Water Reclamation Facility reuse system and dedicated to the State Farm summer irrigation program.

For example, the reuse water contracted for application to the State Prison Farm has been almost entirely replaced with potable water from the Douglas/Minden supply. The average amount of potable water delivered to the State Farm between 2010 and 2016 was 1,100 AF annually. If well 47, which has high Arsenic and Fluoride levels, is directed to the reuse system at the Water Reclamation Facility, that water can replace approximately 315 AF annually of water back to the potable water supply system. Alternatively, or in addition, the City could work cooperatively with the State Prison Farm to re-drill one of their old wells which could provide water to the Farm for irrigation in lieu of the potable water supply. The State would benefit additionally by exercising their water rights.

The Planning Level Cost to construct a pipeline to the WRF is on the order of $0.9 million or $3,405/AFA with a yield of 279 AF or 350 gpm or 0.5MGD

Carson River Springs

Submit secondary use applications and any necessary permit applications to transfer the flows in the River from the Carson River Springs to the Dayton Water Utility. The water can then be transported to the Carson Water System through existing infrastructure and agreements.

The planning Level Cost for permits and applications is on the order of $150,000 or $300/AFA with a yield of approximately 500 AFA or 350 GPM or 0.5 MGD.

Carson River Segment 7A Storage Program Through the Mexican Ditch

The description of the storage of the river rights is presented in Section 1 of this report. This option enhances the use of the river rights and provides a large block of water that can be dedicated to the summer season demands. However, this option is projected to have the highest cost of the available scenarios and it would require the longest lead time to complete.

The storage of Decreed water in Mud Lake for Aqueduct I does set the precedent for the Mexican Ditch Storage program. However, it is expected that the planning, permitting and implementation of the storage option would eventually involve reviews and comments by the Bureau of Reclamation and Truckee Carson Irrigation District on behalf of the Newlands Project as well as the Pyramid Lake Indian Tribe.

This project would only be done if needed. The Planning Level Costs for Planning, Permitting, and Construction would be the order of $24.7 million or $6,275/AFA and would yield 3,936 GPM or 10.79 MGD