Secondary Irrigation Master Plan

January 2019

Prepared for:

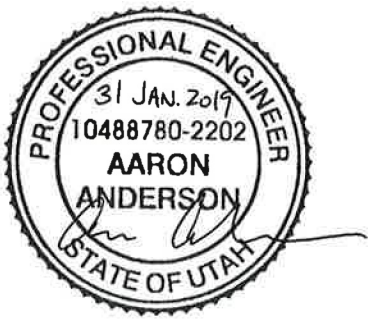
IVINS CITY UTAH

Prepared by:

BOWEN COLLINS & ASSOCIATES

SECONDARY IRRIGATION MASTER PLAN

January 2019



Prepared for:

IVINS CITY
UTAH

Prepared by:

BOWEN COLLINS & ASSOCIATES

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EXECUTIVE SUMMARY

INTRODUCTION

Ivins City (City) contracted the services of Bowen, Collins & Associates, Inc. (BC&A) to complete a Secondary Irrigation System Master Plan. The purpose of this irrigation master plan is to develop a plan for the Ivins City secondary irrigation system by evaluating existing infrastructure and identifying the required steps to implement the system.

SERVICE AREA

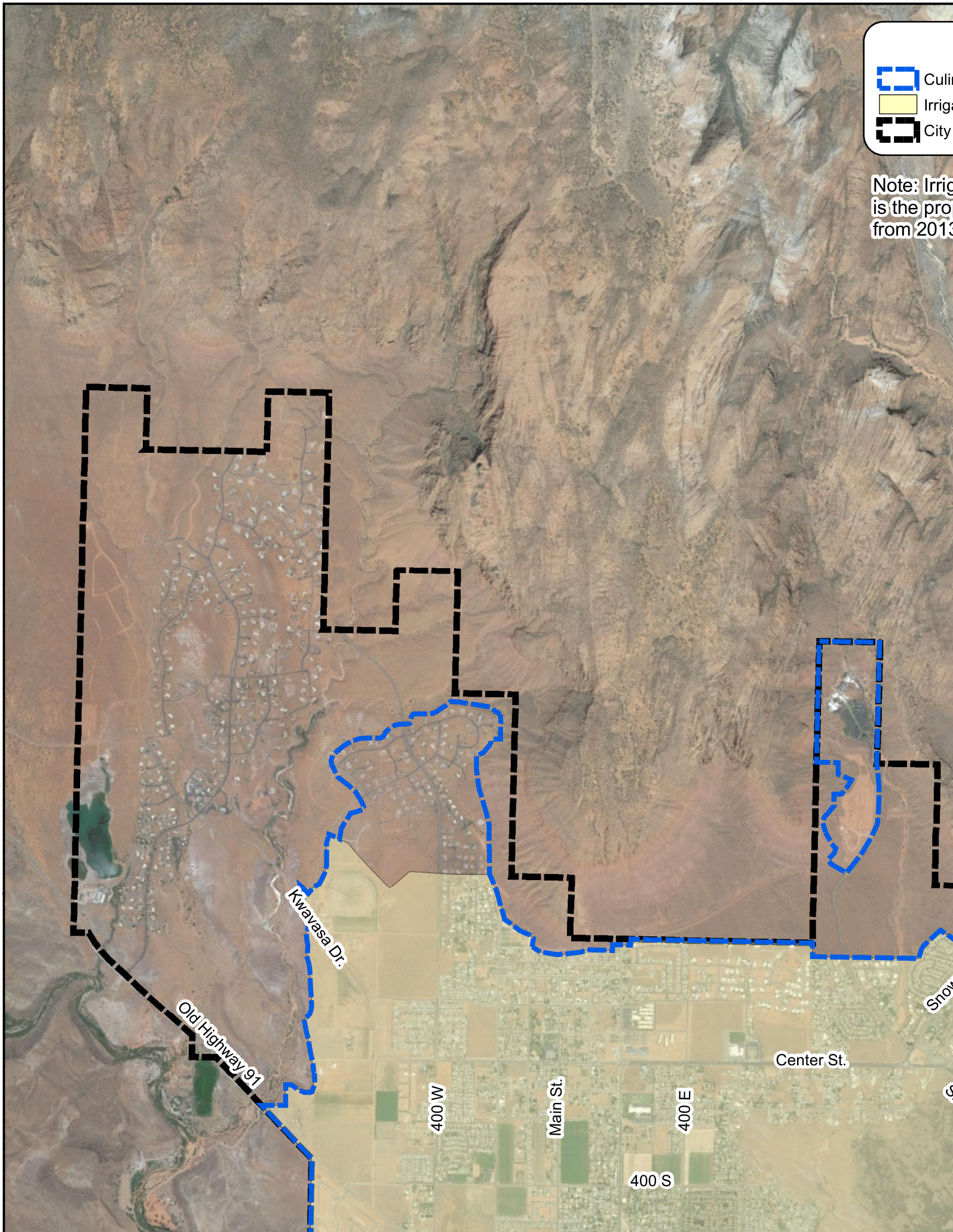
The proposed secondary irrigation system service area is shown in Figure ES-1.

PROJECTED IRRIGATION WATER USE

Irrigation demand in Ivins City has been evaluated to determine the estimated irrigation water usage for the City under current and future conditions. Table ES-1 provides a summary of the estimated irrigated acreage and water use for the secondary irrigation service area for the existing and future system. Note that the table provides the estimate for total irrigation demand in the service area, not the amount of water proposed to be supplied to the system for a given point in time.

Table ES-1
Secondary Irrigation Demand Summary

Year	Total Residential Irrigated Acres	Total Non-Residential Irrigated Acres	Total Estimated Volume of Irrigation Demand (AF/Year)
2016	289	38	**1,096**
2020	365	45	**1,374**
2026	453	74	**1,766**
2030	537	94	**2,114**
2036	673	117	**2,647**
2040	741	124	**2,898**
2046	826	134	**3,216**


Culi
Irriga
City
Note: Irrig
is the pro
from 2013
Kwavasa Dr.
Old Highway 91
400 W
Main St.
400 E
400 S
Center St.

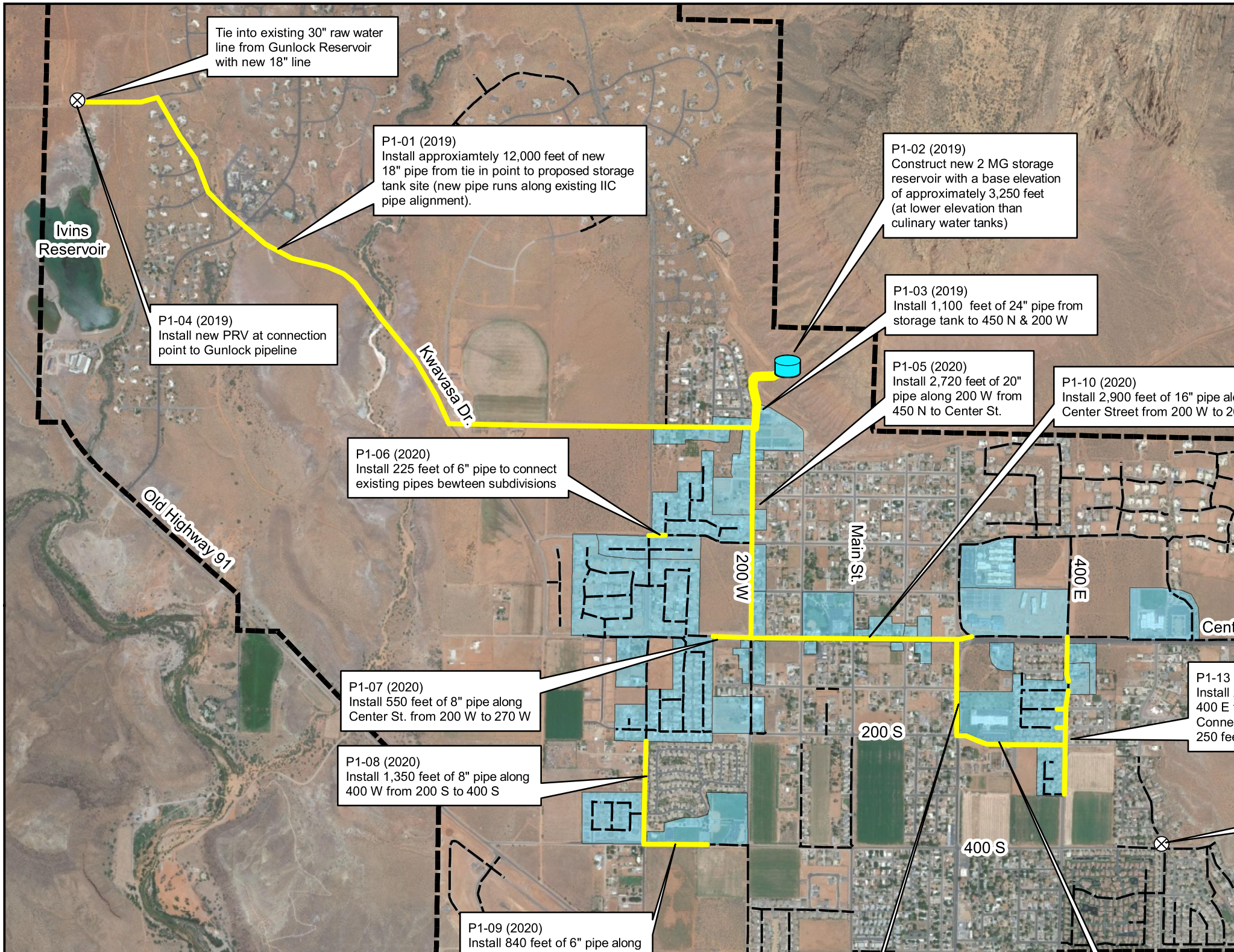
LAYOUT AND TIMING OF PROPOSED SECONDARY IRRIGATION SYSTEM

Using the irrigation demand estimates for the proposed secondary irrigation system, a network of pipelines, pumps, and tanks has been developed to provide the City with a recommended conceptual layout of the new system. The implementation plan breaks the construction of the proposed system into a number of 'phases', with each phase expanding secondary irrigation service to additional parts of the City. While the City currently holds some irrigation water shares that will be used in the system, additional water sources will be needed to expand the system in the future. Table ES-2 provides a summary of the potential future water sources for the secondary irrigation system.

Table ES-2
Potential Irrigation System Sources

Source	Potential Source Capacity
St. George Reuse Facility	Based on Volume of Storage Reservoir (up to 4,500 acre-feet, filled in off season, drained during irrigation season)
Ivins Irrigation Company Shares	984 shares (approximately 1,500 AF)
Ence Well/Additional Well near Santa Clara River	380 acre-feet
Gunlock Reservoir	Unknown Availability

Chapter 8 of this report provides a detailed outline of all proposed phases of construction of the secondary irrigation system. Phases 1 and 2, which are proposed to be constructed over the next 10 years, are summarized in table ES-3 and ES-4, respectively. Figures ES-2 and ES-3 provide a visual reference for the phase 1 and phase 2 improvements.


Tie into existing 30" raw water line from Gunlock Reservoir with new 18" line
P1-01 (2019)
Install approxiamtely 12,000 feet of new 18" pipe from tie in point to proposed storage tank site (new pipe runs along existing IIC pipe alignment).
P1-02 (2019)
Construct new 2 MG storage reservoir with a base elevation of approximately 3,250 feet (at lower elevation than culinary water tanks)
Ivins Reservoir
P1-04 (2019)
Install new PRV at connection point to Gunlock pipeline
P1-03 (2019)
Install 1,100 feet of 24" pipe from storage tank to 450 N & 200 W
Kwavasa Dr.
P1-05 (2020)
Install 2,720 feet of 20" pipe along 200 W from 450 N to Center St.
P1-10 (2020)
Install 2,900 feet of 16" pipe al
Center Street from 200 W to 2
P1-06 (2020)
Install 225 feet of 6" pipe to connect existing pipes bewteen subdivisions
Old Highway 91
200 W
Main St.
400 E
Cent
P1-07 (2020)
Install 550 feet of 8" pipe along Center St. from 200 W to 270 W
P1-13
Install
400 E
Conne
250 fe
200 S
P1-08 (2020)
Install 1,350 feet of 8" pipe along 400 W from 200 S to 400 S
400 S
P1-09 (2020)
Install 840 feet of 6" pipe along

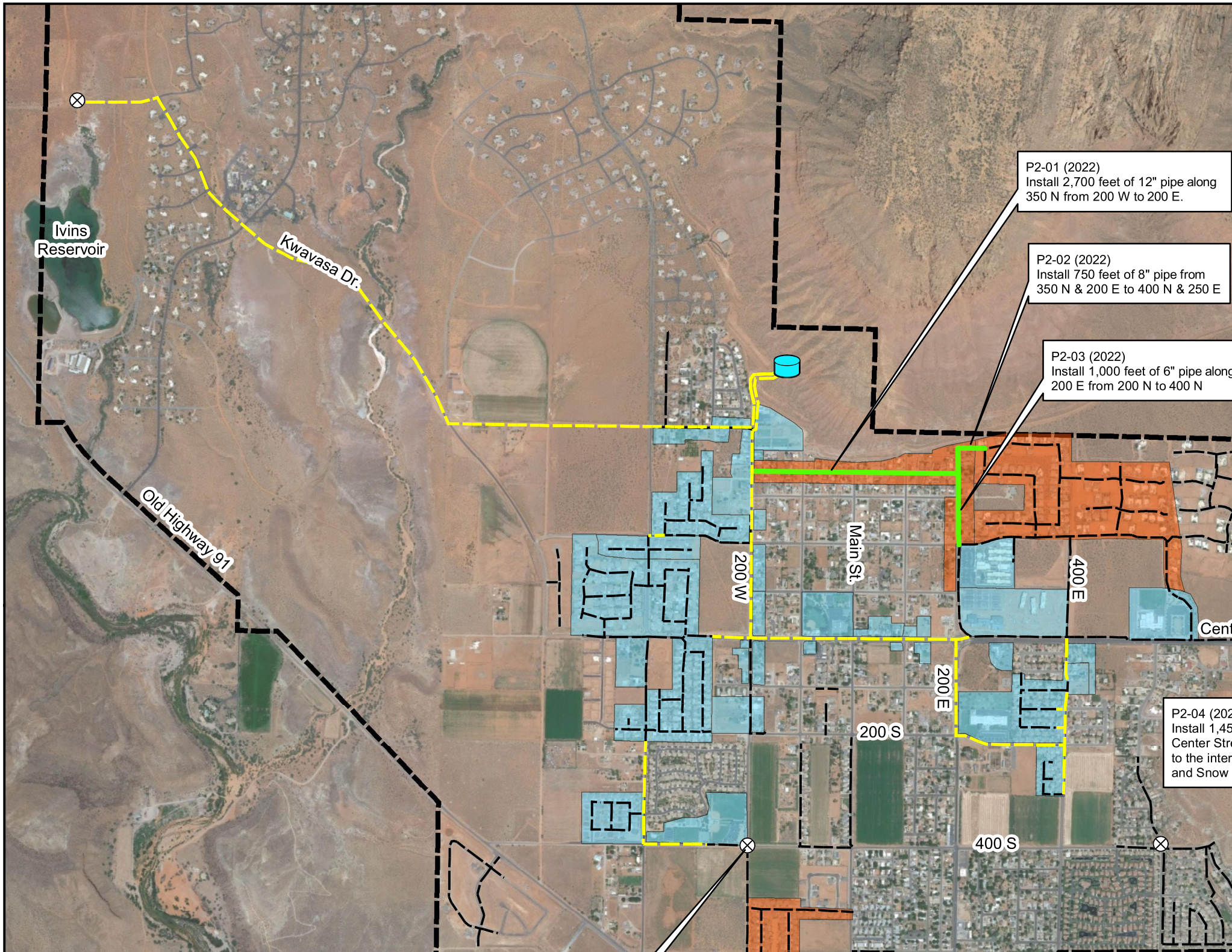

Ivins Reservoir
Kwavasa Dr.
Old Highway 91
P2-01 (2022)
Install 2,700 feet of 12" pipe along 350 N from 200 W to 200 E.
P2-02 (2022)
Install 750 feet of 8" pipe from 350 N & 200 E to 400 N & 250 E
P2-03 (2022)
Install 1,000 feet of 6" pipe along 200 E from 200 N to 400 N
200 W
Main St.
400 E
200 E
200 S
400 S
Cent
P2-04 (202
Install 1,45
Center Str
to the inter
and Snow

Table ES-3
Phase 1 Recommended Project Schedule

Project ID	Project Year	Project Description	Unit Cost	Quantity	Total Estimated Cost (2017 Dollars)
P1-01	2019	Install approximately 12,000 feet of 18-inch pipe from Gunlock Pipeline to proposed storage tank site	$150.00	12,000	$1,800,000
P1-02	2019	Construct new 2 MG irrigation water storage facility	$1.00	2,000,000	$2,000,000
P1-03	2019	Install 1,100 feet of 24-inch pipe from new storage facility to 450 N	$175.00	1,100	$192,500
P1-04	2019	Install PRV at connection to Gunlock Pipeline	$60,000	1	60,000
P1-05	2020	Install 2,720 feet of 20-inch pipe along 200 W from 450 N to Center Street	$170.00	2,720	$462,400
P1-06	2020	Install 225 feet of 6-inch near intersection of 400 W and 200 N	$100.00	225	$22,500
P1-07	2020	Install 550 feet of 8-inch pipe along Center St. from 200 W to 270 W	$110.00	550	$60,500
P1-08	2020	Install 1,350 feet of 8-inch pipe along 400 W from 200 S to 400 S	$110.00	1,350	$148,500
P1-09	2020	Install 840 feet of 6-inch pipe along 400 S from 400 W to 300 W	$100.00	840	$84,000
P1-10	2020	Install 2,900 feet of 16-inch along Center St. from 200 W to 200 E	$165.00	2,900	$478,500
P1-11	2021	Install 1,250 feet of 6-inch pipe along 200 E from Center St. to 200 S	$100.00	1,250	$125,000
P1-12	2021	Install 1,450 feet of 6-inch pipe along 200 S from 200 E to 400 E	$100.00	1,450	$145,000
P1-13	2021	Install 2,100 feet of 8-inch pipe along 400 E from Center St. to 300 S and 250 feet of 4-inch pipe to connect to existing piping	$110.00	2,100	$231,000
P1-14	2021	Install PRV on Puerto Drive	$60,000	1	$60,000
M1-1	2019-2021	Meter Installation/Connection Cost	$1,500.00	426	$639,000
				Total	**$6,508,900**

Table ES-4
Phase 2 Recommended Project Schedule

Project ID	Project Year	Project Description	Unit Cost	Quantity	Total Estimated Cost (2017 Dollars)
P2-01	2022	Install 2,700 feet of 12-inch pipe along 350 N from 200 W to 200 E	$130.00	2,700	$351,000
P2-02	2022	Install 700 feet of 8-inch pipe from 350 N & 200 E to 400 N & 250 E	$110.00	750	$82,500
P2-03	2022	Install 1,000 feet of 6-inch pipe along 200 E from 200 N to 400 N	$100.00	1,000	$100,000
P2-04	2023	Install 1,450 feet of 12-inch pipe along Center St. from Painted Hills Dr. to the intersection of Tuachan Dr. and Snow Canyon Dr.	$150.00	1,450	$217,500
P2-05	2023	Install 50 feet of 2-inch pipe to loop existing piping	$60.00	50	$3,000
P2-06	2023	Install 150 feet of 6-inch pipe to connect existing piping in The Springs subdivision	$100.00	150	$15,000
P2-07	2023	Install PRV at 200 W and 400 S	$60,000	1	$60,000
M-2	2022-2023	Meter Installation/Connection Cost	$1,500	570	$855,000
				Total	**$1,684,000**

CHAPTER 1
INTRODUCTION

INTRODUCTION

Ivins City is one of the quickest growing communities in Washington County. Located just south of Snow Canyon Park, what was previously a small rural town has rapidly turned into a large residential community. To meet the needs of growth in the city, the 2013 culinary water master plan identified the need to implement a secondary irrigation water system. Since the early 2000's, Ivins City has required that new development include the installation of dry secondary water lines with the intent to bring an irrigation system online in the future. As growth has continued in Washington County, the need to supplement culinary water sources with irrigation quality water has become more apparent.

Ivins City has retained Bowen Collins & Associates (BC&A) to prepare a master plan for the City's irrigation water production and distribution system. The purpose of this irrigation master plan is to develop a plan for the Ivins City irrigation system by evaluating existing infrastructure and identifying the required steps to implement and operate a secondary irrigation system.

SCOPE OF SERVICES

The general scope of this project involved an analysis of the City's irrigation water system and its ability to meet the present and future water needs of its residents. As part of the Secondary Irrigation Master Plan, BC&A completed the following tasks.

Task 1: Collected information as needed to develop the irrigation master plan, including GIS data from the City and information from Ivins Irrigation Company.

Task 2: Evaluated irrigation usage for residential and non-residential development to estimate irrigation water use for the proposed irrigation system under existing and future conditions.

Task 3: Identified potential water sources for the City's irrigation system and discussed estimated available water quantities from the identified sources.

Task 4: Calculated the volume of storage which will be required to service the irrigation system under existing and future conditions.

Task 5: Developed a hydraulic model of the irrigation system for existing and future demand conditions.

Task 6: Identified projects needed to service the irrigation system, including sources, storage facilities, transmission, and distribution piping.

Task 7: Developed an implementation plan for the irrigation system, providing recommendations for the phasing of the new system.

Task 8: Developed a 10-year capital facilities plan identifying recommended improvements to be completed within a 10-year planning window.

Task 9: Documented results in this master plan report.

AUTHORIZATION

Ivins City contracted the services of BC&A to prepare this Irrigation System Capital Facilities Plan in January of 2016.

PROJECT STAFF

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

Keith Larson	Principal-In-Charge
Todd Olsen	Project Manager
Aaron Anderson	Project Engineer
Mike Hilbert	Technical Writing

IVINS CITY STAFF

Ivins City staff worked closely with BC&A personnel in collecting data associated with this master plan. The following City personnel were influential in the completion of this master plan:

Dale Coulam	City Manager
Chuck Gillette	Public Works Director/City Engineer
Tom Jorgensen	Assistant Public Works Director of Administration
Shiloh Pentz	Assistant Public Works Director of Operations
Wally Ritchie	Director of Finance

IVINS CITY COUNCIL

The following elected officials participated in the review and approval of this master plan:

Chris Hart	Mayor
Ron Densley	Councilperson
Dennis Mehr	Councilperson
Cheyne McDonald	Councilperson
Jenny Johnson	Councilperson
Miriah Elliott	Councilperson

CHAPTER 2
EXISTING SYSTEM FEATURES

INTRODUCTION

Ivins City does not currently operate a secondary irrigation water system. However, since the 2000's, the City has required developers to install dry irrigation lines as part of all new developments with the intent to bring the system online in the future. This said, a considerable amount of irrigation piping is currently in place and ready to use. In addition to piping owned by Ivins City, the Ivins Irrigation Company (IIC) owns and operates a pipe network, delivering water primarily to farmers and larger-quantity water users throughout the City. Some additional piping owned by private Home Owner's Associations (HOAs) is also present in the City. This chapter provides a summary of the proposed service area of the future irrigation system as well as a catalog of all known irrigation infrastructure owned by the City, the Irrigation Company, or private HOAs.

SERVICE AREA

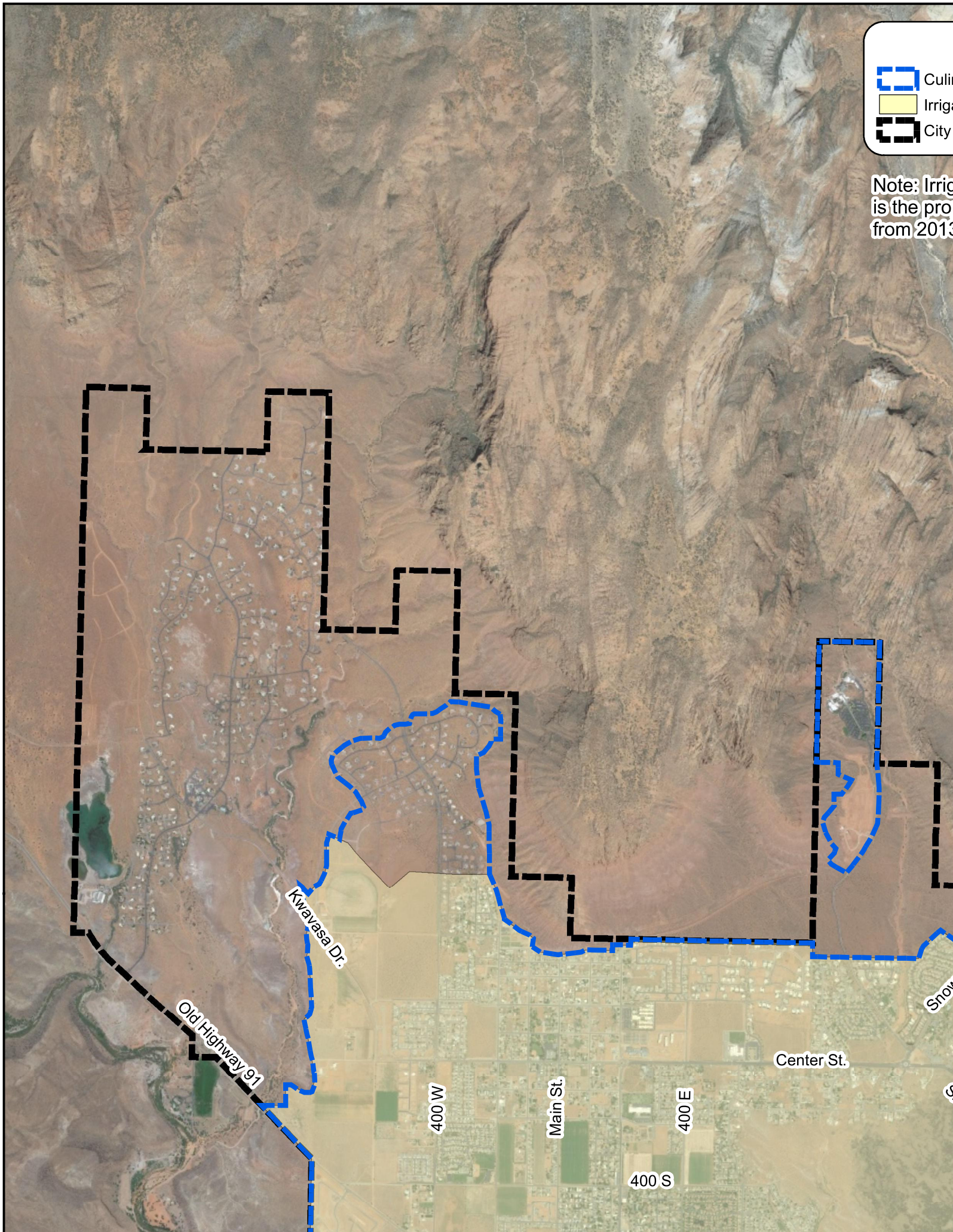
The 2013 Ivins City Culinary Water Master Plan and Impact Fee Facilities Plan identified the irrigation system service area shown in Figure 2-1. As shown in the figure, the proposed irrigation system service area generally follows the boundary of the Ivins City culinary water service area, with the exception of the Tuachan Amphitheater area and the Taviawk area of Kayenta.

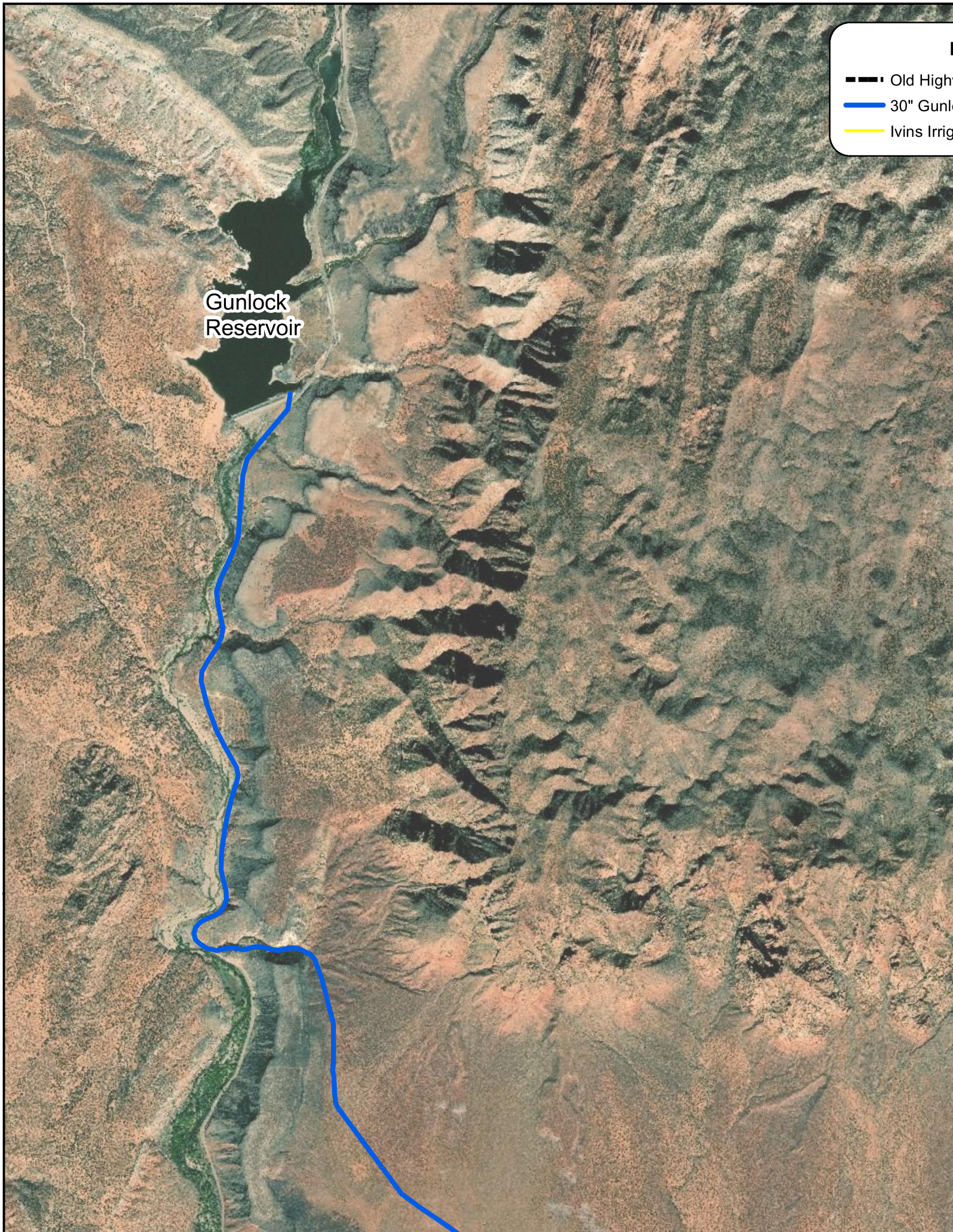
SUPPLY SOURCES

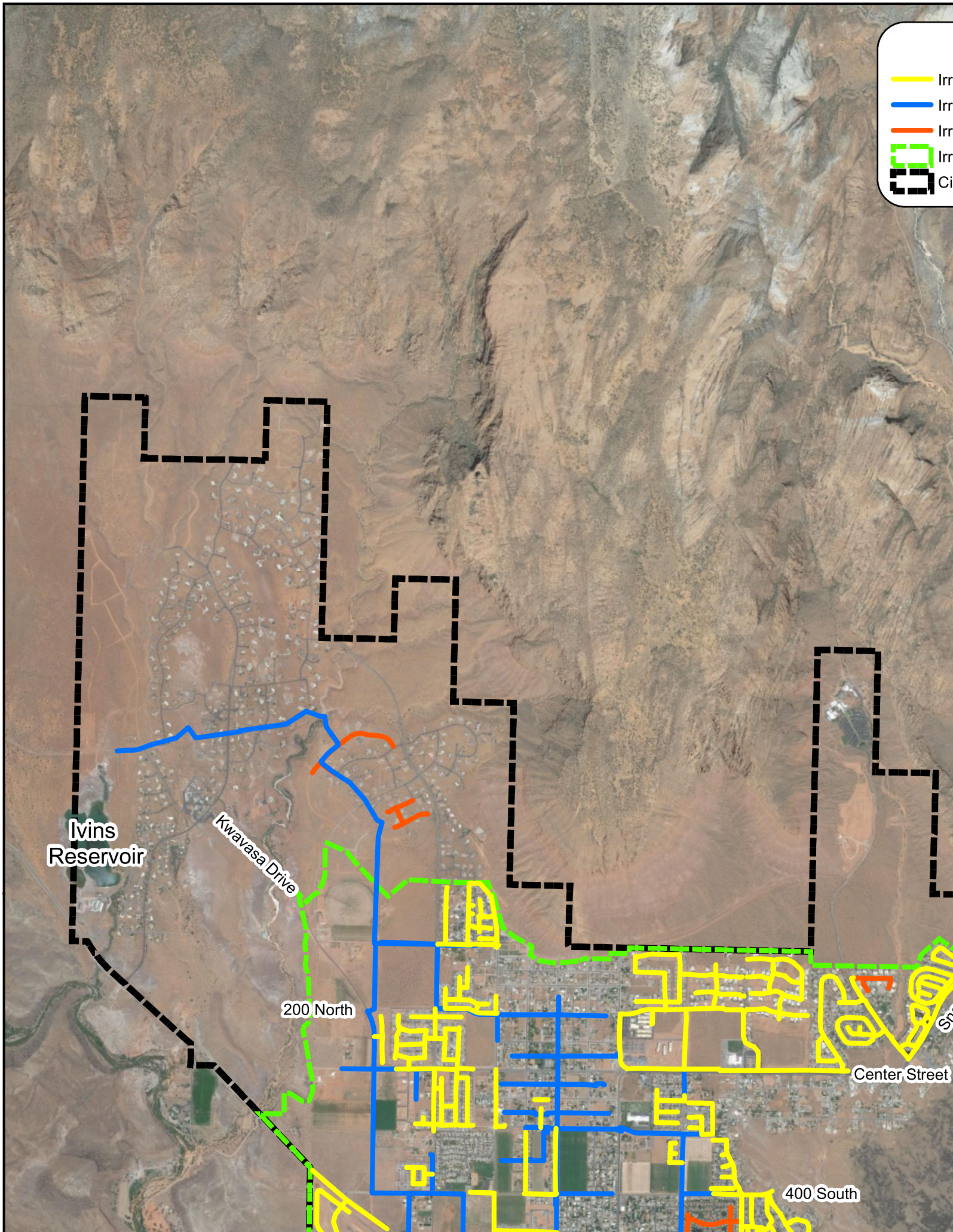
Ivins City currently holds ownership of 347 acre-feet of water in the Ivins Irrigation Company, Santa Clara Irrigation Company, and St. George Clara Company. The Ivins Irrigation Company receives water from Gunlock Reservoir, a 12,000 acre-feet (AF) reservoir located approximately 8 mile west of Ivins. A 30-inch pipeline runs from the reservoir to Ivins Reservoir (see Figure 2-2). From this point, a 12-inch line runs into Ivins to service the irrigation company.

IRRIGATION DISTRIBUTION PIPING

As previously discussed, the existing irrigation water distribution piping in Ivins is comprised of pipelines owned by three different entities: Ivins City, the Ivins Irrigation Company, and private HOAs. Figure 2-3 displays a map with the location and ownership of each of these systems, while Figure 2-4 shows the size of existing pipes. It should be noted that the actual diameter of some of the waterlines in the system could not be verified in the field or from record drawings; the size of these pipes has been assumed based on the known diameter of upstream and downstream pipes. A summary of all existing irrigation piping is shown in Table 2-1.


Culi
Irriga
City
Note: Irrig
is the pro
from 2013
Kwavasa Dr.
Old Highway 91
400 W
Main St.
400 E
400 S
Center St.


Gunlock
Reservoir
Old High
30" Gunl
Ivins Irrig


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Ivins
Reservoir
Kwavasa Drive
200 North
Center Street
400 South

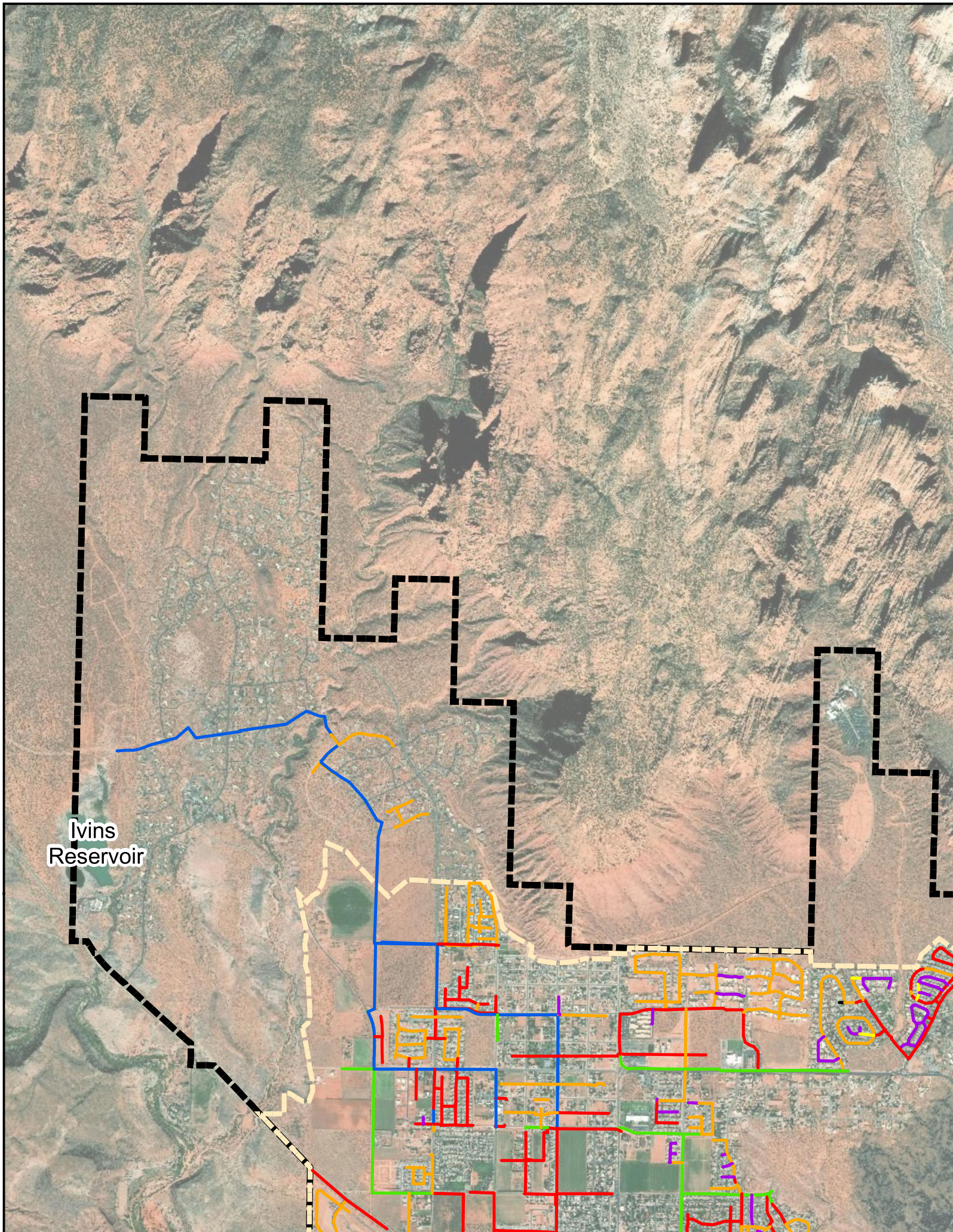

Ivins
Reservoir

Table 2-1
Existing Irrigation System Piping

Pipe Diameter (in)	Length
Ivins City	
1	116
2	13,470
3	687
4	57,623
6	36,805
8	7,286
12	973
Subtotal	**116,959**
Ivins Irrigation Company	
2	394
4	10,256
6	26,602
8	10,940
12	26,186
Subtotal	**74,379**
Private HOA	
2	1,845
3	226
4	9,910
6	3,016
8	1,095
Subtotal	**16,092**
Total	**207,431**

The majority of existing pipe is comprised of 4-inch and 6-inch distribution piping. A good portion of the piping resides in isolated areas, and will require new pipe projects to connect the areas together.

CHAPTER 3
EXISTING DEMANDS & FUTURE DEMAND PROJECTIONS

INTRODUCTION

The purpose of this chapter is to evaluate the irrigation needs for existing users as well as future users in Ivins City. Historical water use data and Geographic Information Systems (GIS) have been used to develop baseline water use estimates for the purpose of projecting demands in future scenarios. Growth projections for the secondary irrigation system are based on the projections developed as part of the 2013 Ivins City Culinary Water Master Plan and Impact Fee Facilities Plan prepared by Ivins City.

EXISTING ANNUAL IRRIGATION DEMAND

Outdoor water demands for residential and commercial users in Ivins City are currently satisfied by the municipal culinary water system. This considered, metered flow to a residence or a business represents the combination of both indoor and outdoor water use. However, due to the fact that irrigation does not take place year round, monthly meter data can be a useful tool to help distinguish between indoor and outdoor usage. Table 3-1 shown below contains a summary of monthly water sales for Ivins City from 2010 - 2015.

Table 3-1
Historical Water Sales for Ivins Municipal Water System (gallons x 1,000)

Year	2010	2011	2012	2013	2014	2015
January	15,916	16,109	16,199	16,876	17,030	16,505
February	14,161	15,512	15,869	20,869	17,710	20,138
March	15,689	17,854	21,555	24,351	25,784	23,319
April	34,074	31,108	35,668	41,669	43,008	45,485
May	40,986	43,293	48,927	118,949*	48,191	43,172
June	55,146	49,251	65,632	67,088	63,978	53,558
July	66,915	66,610	67,362	67,667	71,254	70,841
August	65,195	66,462	60,576	74,358	65,666	66,884
September	60,650	63,202	56,290	51,064	58,893	59,636
October	51,131	43,609	44,885	48,588	42,147	55,057
November	30,207	30,242	34,503	35,733	36,677	34,402
December	16,221	19,531	20,700	17,792	21,079	18,491
Annual Total	**466,291**	**462,783**	**488,166**	**585,004**	**511,417**	**507,716**

*Data from May 2013 appears to contain an error

As shown in the table, water use over the course of the year follows a relatively consistent pattern. Water use during winter months is low due to the lack of outdoor water use, representing the amount of water used indoors which should remain relatively constant throughout the year. As irrigation begins in the early spring, water usage begins to ramp up, peaking in the summer

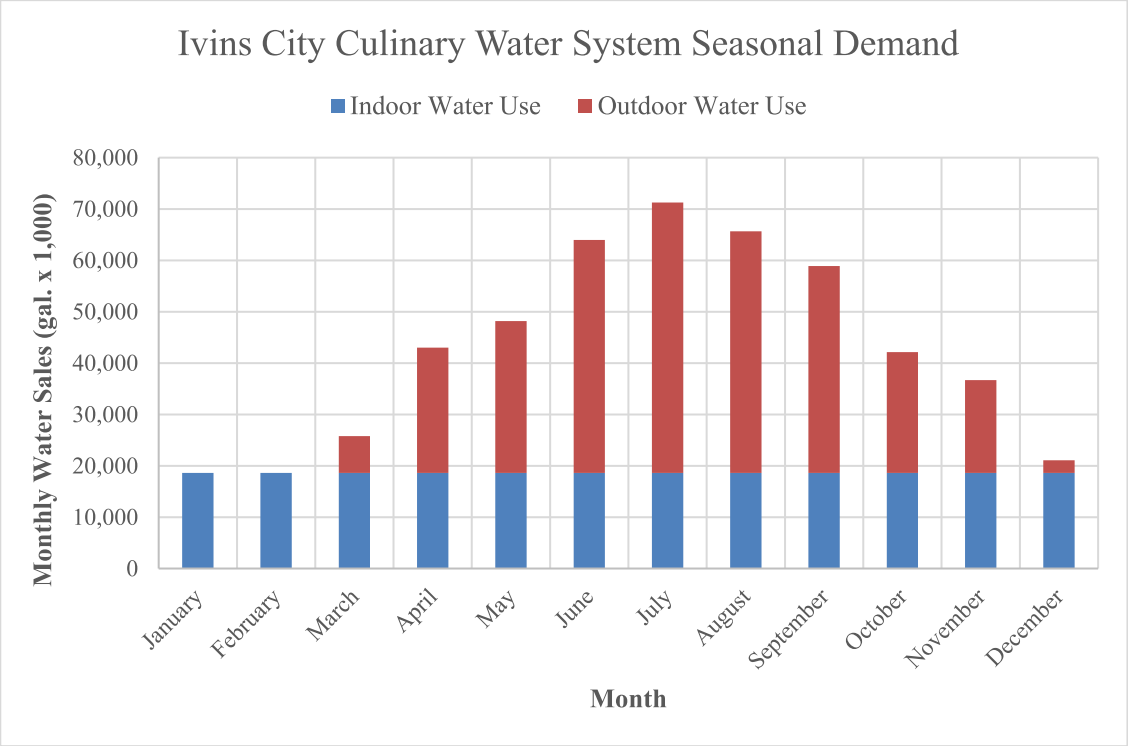
months of July and August. Using the information from Table 3-1, Table 3-2 provides the estimated distribution of Ivins culinary water between indoor and outdoor demand.

Table 3-2
Division of Indoor/Outdoor Use for Ivins Municipal Water System

Year	Annual Water Sales (gal x1,000)	Winter Water Use (Monthly Average, gal x 1,000)	Estimated Annual Indoor Water Use (Average Winter Month Usage x 12, gal x 1,000)	Estimated Annual Outdoor Water Use (Total Water Sales - Indoor Use, gal x 1,000)	Indoor Acre-Feet per Year	Outdoor Acre-Feet per Year	% Indoor	% Outdoor
2010	466,291	15,433	185,192	281,099	568	863	40%	60%
2011	462,783	17,051	204,608	258,175	628	792	44%	56%
2012	488,166	17,589	211,072	277,094	648	850	43%	57%
2013	585,004	18,512	222,148	362,856	682	1,114	38%	62%
2014	511,417	18,606	223,276	288,141	685	884	44%	56%
2015	507,716	18,378	220,536	287,180	677	881	43%	57%

To further illustrate the information presented in Table 3-1 and 3-2, Figure 3-1 displays a graphical representation of culinary water usage in Ivins using data from the year 2014 (the highest usage year in the past 5 years, not counting 2013 which contained apparent data errors).

Figure 3-1
Ivins City Culinary Water System Seasonal Demand



From the data presented in the previous tables and figure, it is estimated that approximately 884 acre-feet (AF) per year are used for outdoor irrigation from the Ivins City culinary water system (taken from the data in 2014 which was highest usage year from 2010-2015, not counting 2013 data which contained errors). Using this information, irrigation demand in the future can be projected based on the anticipated rate of development throughout the City. When projecting culinary water usage, particularly indoor water use, the primary unit of measurement is gallons per capita per day, which represents the quantity of water used by the average person over the course of the day. Multiplying this value by the entire population provides an estimate for the total water demand on the system, a value which is directly proportional to the number of people living in the City. However, outdoor water usage has more of an indirect relationship to population and is directly related to irrigated area. Take, for example, two identical residential homes; each home has the same amount of landscaping, but one home has 3 residents while the other has 6 residents. In theory, outdoor water use for each home should be the same, but indoor water use may be as much a double for the larger family. This considered, projecting irrigation water demand is not so much a question of population growth as it is a question of development growth.

Different types of development possess specific irrigation needs. A commercial building with a few small parking lot planters will require much less irrigation water than a park or baseball field. In order to determine a total existing irrigated acreage for Ivins City, recent aerial imagery and the general land use plan for the City were used in conjunction with tools in GIS. The general land use plan specifies the type of development that exists or is proposed to be built throughout the City, and contains classifications for different densities of residential development, commercial development, parks, etc. For each land use classification contained in the plan, samples were taken from aerial imagery and the ratio of the landscaped area to the total lot size was estimated. These ratios were then applied to the approximate total area which has been developed in Ivins to yield an estimate of total irrigated acreage across the service area of the culinary water system. The results of this assessment are contained in Table 3-3.

Table 3-3
Evaluation of Irrigated Area for Different Types of Land Use

Land Use	Approximate Developed Area in Ivins (acres)*	Approximate % Irrigated	Irrigated Area (acres)
Low Density Residential	229	34%	77.9
Medium Density Residential	476	32%	152.3
High Density Residential	212	28%	59.4
Residential Mixed Use - Village	16	30%	4.8
Residential Mixed Use - Town Center	22	30%	6.6
School	8.0	37%	3
Church	5.9	13%	0.8
Cemetery	6.4	85%	5.5
Park	19	80%	15.1
Commercial - Community	2.2	8%	0.2
Commercial - Professional	4.1	8%	0.3
Commercial - Neighborhood	7	8%	0.6
Commercial - Light Manufacturing	3.7	8%	0.3
Commercial - Resort	2.7	23%	0.6
Open Space (Undeveloped)	3	0%	0.0
Total	**1,017**		**327.4**

*Totals areas developed within each land use category were extracted from GIS. To account for the area of roadways in developed parts of the City, the areas measured in GIS were reduced by 20% in order to only account for the area of land developed in each category

As shown in Table 3-3, it is estimated that there are currently about 327.4 irrigated acres that are developed in Ivins. It should be reiterated that this number does not include undeveloped agricultural areas which are supplied with irrigation water from the Ivins Irrigation Company. The annual volume of water used per irrigated acre (application rate) can be estimated using the estimated total irrigated acreage and the total outdoor water used for developed areas in Ivins. As previously identified, the Ivins City culinary water system currently uses approximately 884 AF per year for irrigation, but some of the parks in the City are supplemented with flow from the Ivins Irrigation Company during the summer. To properly develop a reliable estimate for the amount of water needed to irrigate the developed land in the City, this volume of water needs to be included in the calculation. However, the amount of water delivered to the parks is difficult to quantify due to the fact that the flow from the Irrigation Company to the parks is not metered. This considered, the area of the parks in the City was estimated using GIS to be approximately 9 acres, and with an assumed application rate of 4.4 AF per year per irrigated acre of turf grass, it was estimated that the Irrigation Company currently supplies about 30 AF per year (assuming that the Irrigation Company supplies 75% of the water to the parks in Ivins). Under this assumption, the estimated irrigation rate of application per irrigated acre in Ivins is:

$$Application\ Rate = \frac{884\ AF + 30\ AF}{327.4\ \ Irrigated\ Acres} = \mathbf{2.79\ Acre\ Feet\ per\ Year\ per\ Irrigated\ Acre}$$

The Utah Administrative Code R309-510 "Facility Design and Operation: Minimum Sizing Requirements" provides estimates for yearly application rates for different areas across the State. While R309-510 pertains specifically to drinking (culinary) water standards and does not necessarily govern secondary water, it does provide a good guideline for system evaluation and planning. For Ivins, which is located in Map Zone 6, the codes specifies an irrigation application rate of 3.26 AF/irrigated acre, which is 17% higher than the value developed using the City's meter records. The difference in these two values is best justified by a further discussion of how the values in Table 3-3 were developed.

As previously mentioned, the percentage of irrigated area for different types of development was estimated using recent aerial imagery of the City. Landscaped areas consist of turf grass, trees, shrubs, flowers, etc., all of which have unique irrigation needs. The values shown in Table 3-3 take into account the total area irrigated for each respective land use type, and is a combination of these different types of landscaping. On average, most landscaping is about 50% turf grass and 50% trees, shrubs, etc. The annual application rate of 2.79 AF/year is the net volume of water needed per irrigated acre, which is the combination of these different types of landscaping. In actuality, outdoor water use likely follows the break down shown in Table 3-4.

Table 3-4
Estimated Distribution of Outdoor Irrigation

Landscaping Type	Estimated Annual Irrigation Rate (AF/Irrigated Acre)	Approximate % of Irrigated Area
Turf Grass	4.4	50%
Trees, Shrubs, Flowers	1.2	50%

Under the assumptions contained in Table 3-4, the likely distribution of irrigation on 1 acre of irrigated landscaping is:

$$(4.4\ AF\ per\ Year)(0.5\ Acres\ turf) + (1.2\ AF\ per\ Year)(0.5\ Acres\ Trees, shrubs, etc.) = 2.8\ AF\ per\ Irrigated\ Acre$$

For planning purposes, a conservative buffer of 10% has been applied to this estimate, along with an additional 10% increase to account for system losses, bringing the required annual irrigation volume per irrigated acre to **3.35 AF/year**.

Having developed an estimate for the required volume of water needed per irrigated acre of developed land, irrigation demand for future conditions has been projected using the current land use plan for the City. Table 3-5 and Table 3-6 provide the approximate irrigated area which will be applied to new residential and non-residential growth, respectively.

Table 3-5
Estimated Irrigated Area for Different Residential Development

Land Use	Average Lot Size (Acres)	Percent of Total Lot which is Irrigated	Estimated Irrigated Acreage per Connection	Irrigated Acreage per Gross Acre Developed	Annual Demand per Gross Acre Developed (AF)
Low Density Residential	0.65	34%	0.221	0.27	0.91
Medium Density Residential	0.34	32%	0.108	0.25	0.84
High Density Residential	0.2	28%	0.055	0.22	0.74

*For 1 developed acre of land, it is assumed that 20% is occupied by roads.

Table 3-6
Estimated Irrigated Area for Non-Residential Development

Land Use	Percent of Developed Area which is Irrigated	Irrigated Acreage per Gross Acre Developed	Annual Demand Per Gross Acre Developed (AF)
Residential Mixed Use - Village	30%	0.24	0.80
Residential Mixed Use - Town Center	30%	0.24	0.80
School	37%	0.30	1.00
Church	13%	0.10	0.34
Cemetery	85%	0.68	2.28
Park	80%	0.64	2.14
Commercial - Community	8%	0.06	0.20
Commercial - Professional	8%	0.06	0.20
Commercial - Neighborhood	8%	0.06	0.20
Commercial - Light Manufacturing	8%	0.06	0.20
Commercial - Resort	23%	0.18	0.60
Permanent Open Space (Undeveloped)	0%	0.00	0.00

*For 1 developed acre of land, it is assumed that 20% is occupied by roads.

Residential growth and non-residential growth have been projected using slightly different approaches. Irrigation demand stemming from residential growth has been projected on the basis of new connections and the housing densities contained in the current land use plan. Since planned housing densities are fairly specific for residential development, estimates as to how many homes will eventually occupy a given area (and the associated irrigated acreage) for residential zones should end up being relatively accurate. Non-residential development, however, is not as predictable, so basing irrigation demand on the number of projected commercial connections may not be as reliable. This considered, irrigation demand for non-residential zones has been based on an estimated increase of the percentage of land developed for each respective land use type.

Table 3-7 and Table 3-8 provide the projections for residential and non-residential growth within the irrigation system service area through the anticipated buildout year of 2046. The 2013 culinary water master plan contains estimated growth rates for the City over ten year periods. Using these percentages, average annual growth rates were determined, as shown in Table 3-9. These growth rates were used to estimate the growth of new residential irrigation connections through buildout.

Non-residential growth was evaluated in the following fashion:

- **Commercial/Mixed Use** – As discussed previously, non-residential growth has been evaluated on a percent developed basis rather than on the basis of new connections. Using the current land use plan, existing and buildout acreage for commercial and mixed use zones was determined, and a geometric growth pattern was fit to the two points. This assumes that new non-residential connections will be added at a constant annual rate and does not grow as a function of the size of the City.

- **Schools and Parks** – While commercial and mixed-use development has the potential to grow in small increments, parks and schools will likely develop in large blocks (meaning that the entire plot of land will develop at the same time). This said, growth of parks and schools was projected in blocks of acreage using the land use plan and engineering judgment. Changes can be made to future irrigation planning studies if more parks and schools develop more quickly.

Table 3-7
Residential Housing Growth within Municipal Irrigation Service Area

Year	Total Housing Units in Ivins Municipal Boundary	Residential Units in the Ivins City Secondary Irrigation System Service Area*	Low Density Housing Units in Irrigation Service Area	Medium Density Housing Units in Irrigation Service Area	High Density Housing Units in Irrigation Service Area	Estimated Irrigated Area from Residential Development**
2016	3,227	2,834	352	1,409	1,073	289
2020	4,240	3,308	586	1,615	1,107	365
2026	5,008	3,875	838	1,904	1,133	453
2030	5,520	4,306	1,185	1,945	1,176	537
2036	6,492	5,026	1,738	2,044	1,244	673
2040	7,140	5,571	1,925	2,177	1,469	741
2046	8,307	6,259	2,154	2,353	1,753	826

*Values contained in this column were calculated using the estimated annual growth rates shown in Table 3-9.
**Irrigated acreage is estimated based on the assumptions contained in Table 3-5 for each respective residential housing density.

Table 3-8
Non-Residential Developed Area within the Municipal Irrigation Service Area (Acres)

Year	Commercial	Residential Mixed Use	School	Church	Cemetery	Parks	Open Space	Estimated Irrigated Acreage from Non-Residential Development
2016	21	38	8	6	7	19	11	**38**
2020	36	57	8	6	7	19	11	**45**
2026	58	86	22	6	7	36	11	**74**
2030	72	105	22	6	7	36	11	**94**
2036	94	133	57	6	7	52	11	**117**
2040	109	152	57	6	7	52	11	**124**
2046	131	181	57	6	7	52	11	**134**

Table 3-9
Estimated Residential Growth Rates in Ivins City

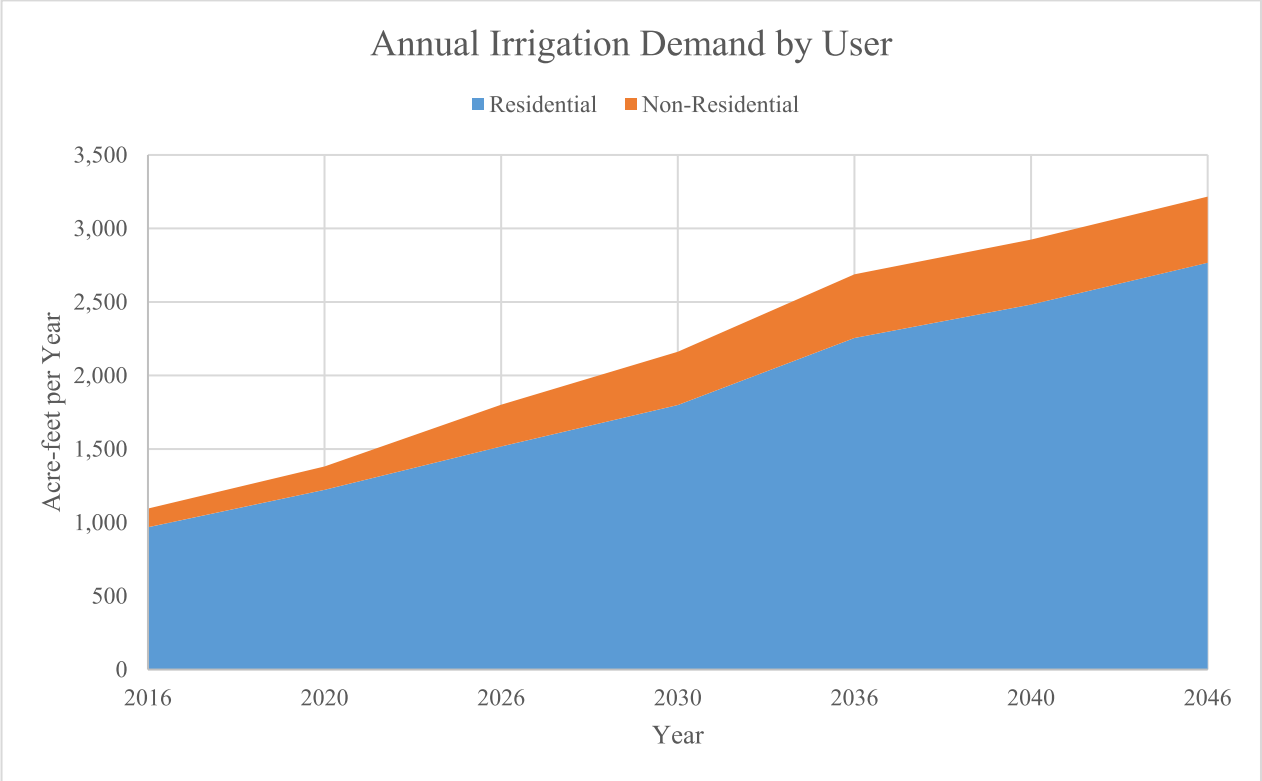
Year Range	10 Year Population Growth Rate*	Average Annual Population Growth Rate
2010 - 2020	49%	3.95%
2020 - 2030	30%	2.67%
2030 - 2040	29%	2.61%
2040 - 2050	28%	1.50%

Using the information contained in Tables 3-7 and 3-8, Table 3-10 and Figure 3-2 show a summary of the estimated outdoor water demand on the Ivins municipal irrigation system through buildout.

Table 3-10
Secondary Irrigation Demand Summary Through Buildout

Year	Total Residential Irrigated Acres	Total Non-Residential Irrigated Acres	Total Estimated Volume of Irrigation Demand (AF/Year)
2016	289	38	**1,096**
2020	365	45	**1,374**
2026	453	74	**1,766**
2030	537	94	**2,114**
2036	673	117	**2,647**
2040	741	124	**2,898**
2046	826	134	**3,216**

Figure 3-2
Summary of Projected Annual Irrigation Demand



ESTIMATING PEAK SYSTEM DEMANDS

Peak Day Demand

In addition to developing estimates for annual water demand on the irrigation system, it is important to consider peak system demands exerted by users. Peak day demand (PDD) refers to the volume of water consumed during the highest usage day over the course of the year. According to the data shown in Figure 3-1, peak day demand in Ivins likely occurs during the month of July. Peak day demand can be influenced by a number of factors and is often times unique to each individual system. In order to estimate the existing peak day demand for outdoor water use in Ivins, historical water use data has been further evaluated. Table 3-11 displays the historical monthly water usage for the year 2014. Also shown in the table is the ratio of peak month flow to average month flow. Peak day demand has been estimated by multiplying the average month to peak month demand by a factor of 1.1.

Table 3-11
Estimated Peak Day Demand Multiplier for Ivins Irrigation

Month	Monthly Billed Outdoor Water Usage (gal x 1,000)*
January	0
February	0
March	7,178
April	24,402
May	29,585
June	45,372
July	52,648
August	47,060
September	40,287
October	23,541
November	18,071
December	2,473
Average Monthly Outdoor Demand	24,012
Average Month to Peak Month Factor	2.19
Average Day to Peak Day Factor (1.1 x Peak Month)	**2.41**

*Values for monthly outdoor water usage assume that 18,606,000 gallons per month are used as indoor water usage (average water usage for the months of December, January and February). This value has been deducted from the total usage, yielding the values shown in the table.

Peak day demand per irrigated acre has been estimated by converting the average annual application rate per irrigated acre from AF/year to gallons per minute and multiplying the value by the peak day demand factor in Table 3-11, as shown below:

$$Annual\ Volume\ per\ Irrigated\ Acre = 3.35 \frac{AF}{Year} = 2.077\ gpm$$

$$PDD\ per\ Irrigated\ Acre = \ 2.077\ gpm\ x\ 2.41 = \mathbf{5.01\ gpm}$$

For Map Zone 6 in the UAC R309-510, the recommended peak day demand for irrigation is 4.90 gpm/irrigated acre. This considered, the estimated peak day demand for irrigation in Ivins of 5.01 gpm seems to be a reasonable estimate. Using this estimate for peak day demand, Table 3-12 provides the projected peak day irrigation demand on the proposed irrigation system through buildout.

Table 3-12
Projected Peak Day Demand on Ivins City Irrigation System

Year	Residential Irrigated Acres	Non-Residential Irrigated Acres	Estimated Peak Day Demand (gpm)
2016	289	38	1,638
2020	365	45	2,054
2026	453	74	2,640
2030	537	94	3,161
2036	673	117	3,958
2040	741	124	4,334
2046	826	134	4,810

Peak Hour (Instantaneous) Demand

While peak day demand refers to the average system demand during the highest usage day of the year, peak hour demand (PHD), otherwise known as peak instantaneous demand, is the highest instantaneous demand experienced by the system over the course of the year. Similar to peak day demand, Table 510-7 of UAC R309-510 provides requirements for peak instantaneous demand for different Map Zones across the State. For Map Zone 6, the State requirement for irrigation is 9.80 gpm per irrigated acre, which is twice the amount recommended for peak day demand (a PDD to PHD factor of 2.0). Based on previous studies carried out by BC&A, 2.0 is a typical multiplier from PDD to PHD and is a good value to use for planning purposes. Under this assumption, peak hour demand on the irrigation system through buildout has been projected and is shown in Table 3-13.

Table 3-13
Projected Peak Hour Demand on Ivins City Irrigation System

Year	Residential Irrigated Acres	Non-Residential Irrigated Acres	Estimated Peak Hour Demand (gpm)
2016	289	38	3,276
2020	365	45	4,108
2026	453	74	5,280
2030	537	94	6,322
2036	673	117	7,916
2040	741	124	8,668
2046	826	134	9,620

ANASAZI VALLEY ANNEXATION AREA

There is the possibility that Ivins City will annex a large portion of land in the Anasazi Valley area to the southwest of the current City boundary. A large portion of this annexation area sits at a relatively high elevation, making it potentially unserviceable using the system identified in Chapter 8 of this report. This considered, as plans for the Anasazi Valley become more clear and refined, updates should be made in future master plan update to reflect the demand from the annexation.

CHAPTER 4
SUPPLY SOURCE EVALUATION

INTRODUCTION

The primary purpose of the Ivins City secondary irrigation system is to provide Ivins with the needed source capacity to meet future system demands. The feasibility of this system is heavily influenced by the availability, location, and quality of water sources, all of which will affect the overall cost to initiate and maintain the system. The purpose of this chapter is to identify and quantify existing and potential future sources for irrigation water.

REQUIRED ANNUAL SOURCE CAPACITY

Utah Administrative Code R309-510 requires that sources for a public water system be capable of physically and legally meeting water demands under two conditions:

1. **The water system's source capacity shall be able to meet the anticipated water demand on the day of the highest water consumption, which is the peak day demand.**

2. **The water system's source capacity shall also be able to provide one year's supply of water, which is the average yearly demand.**

Average yearly and peak day demand estimates for the existing and future irrigation system are identified in Chapter 3 and are summarized in Table 4-1. In order to meet the requirements set forth in the State Code, sources for the Ivins City Irrigation system will need to be legally and physically capable of meeting these annual and peak day demands. Demands shown in Table 4-1 are for the entire proposed irrigation system service area at the given point in time.

Table 4-1
Summary of Project Irrigation System Demands

Year	Annual Irrigation Demand (AF/Year)	Peak Day Demand (gpm)
2016	1,096	1,638
2020	1,374	2,054
2026	1,766	2,640
2030	2,114	3,161
2036	2,647	3,958
2040	2,898	4,334
2046	3,217	4,810

EXISTING IRRIGATION SUPPLY SOURCES

Water sources for the irrigation system will come in part through a combination of existing shares in the St. George Clara Irrigation Company, Ivins Irrigation Company, and Santa Clara Irrigation Company. Existing water rights available from each of these irrigation companies is shown in Table 4-2.

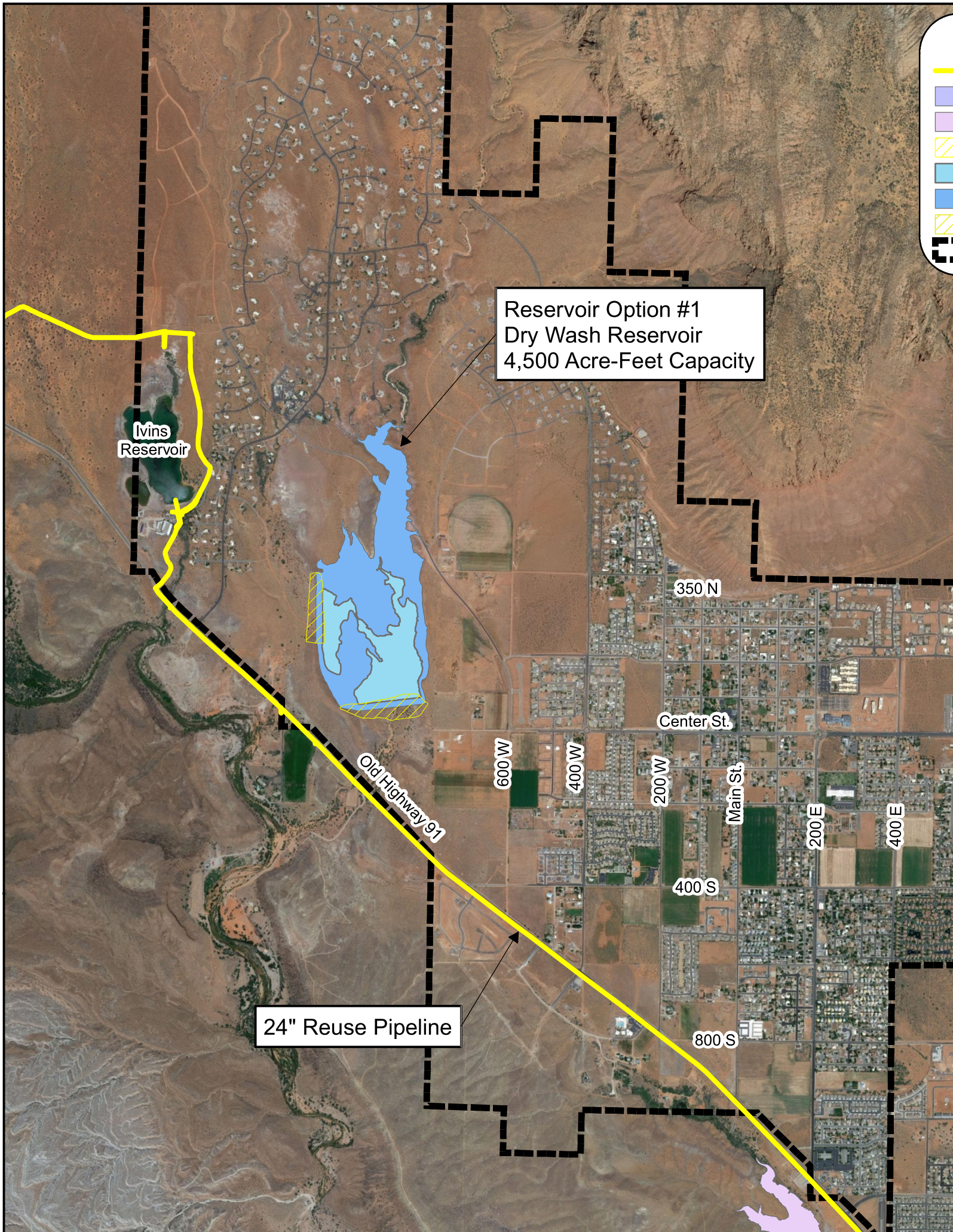
Table 4-2
Existing Irrigation Company Shares Owned by Ivins City

Source	Water Right No. or Number of Shares	Max. Allowable Flow (cfs)	Total Annaul Volume (ac-ft)
St. George Clara Irrigation Company	47.5 shares @ 4.08 ac-ft/share (WR 81-203)	No Restriction	193.8
Ivins Irrigation Company	103.69 shares @ 1 ac-ft/share	No Restriction	103.69
Santa Clara Irrigation Company	11 shares @ 4.51 ac-ft/share	No Restriction	49.6
			347.09

POTENTIAL IRRIGATION SUPPLY SOURCES

The City's existing irrigation source capacity of 347 acre-feet per year is enough to satisfy the demand of about 900 residences in Ivins (or an equivalent number of parks, schools, churches, etc.) which will be used to develop the first phase of system. Additional sources will be needed to expand the system to all of the existing City as well as supply future development. The following are potential additional sources which the City could use as part of the irrigation system:

- **St. George WRF Reuse Water** – One of the more likely sources of future irrigation water capacity for Ivins City is the St. George WRF Reuse Facility. This facility, which currently has a capacity of 7 MGD (with room to add an additional 3.5 MGD) treats water from St. George's wastewater treatment plant to Type 1 reuse water standards, meaning it can be used to irrigate residential landscaping. A 24" pipeline and pump stations can deliver water to a number of locations, including Ivins. During the summer months, the pipeline runs at full capacity meeting golf course and other irrigation needs. In order for Ivins to potentially gain access to reuse water, a storage reservoir would be required that could allow the reuse plant to operate year round (by providing a location to store treated water in the winter when there is little to no irrigation demand). The City of St. George has identified two potential reservoir locations on the west side of the County, one of which is located in Ivins. Figure 4-1 displays the location of two potential reservoir sites identified by St. George City. "Dry Wash Reservoir" would provide up to 4,500 acre-feet of storage, while "Graveyard Wash Reservoir" would provide around 2,000 acre-feet of storage. Either of these reservoirs could potentially provide Ivins with a significant amount of water to be used in the secondary irrigation system. Ideally, Ivins City would be able to purchase reuse water from St. George and exchange it for water in Gunlock Reservoir with other users downstream, taking


Reservoir Option #1
Dry Wash Reservoir
4,500 Acre-Feet Capacity
Ivins Reservoir
350 N
Center St.
600 W
400 W
200 W
Main St.
200 E
400 E
400 S
800 S
Old Highway 91
24" Reuse Pipeline

advantage of the natural elevation of Gunlock to provide needed pressures for the system. However, since reuse water may be slightly lower quality (higher in dissolved solids and other constituents) than the water in Gunlock Reservoir, this exchange may not be simple or even possible. For the purpose of this master plan, it has been assumed that the Dry Wash Reservoir will be constructed and that Ivins will need a pump station at the reservoir to deliver water from the reservoir to the elevated storage tanks in the irrigation system.

- **Ivins Irrigation Company Water Shares** – As the agricultural/green field areas of Ivins City develop, irrigation shares in the Ivins Irrigation Company may become available. Ivins Irrigation Company holds a total of 984 water shares, which equates to approximately 1,500 AF per year. It should be noted that these shares are subject to cuts in dry years and may not be available during times of drought. Ivins City should, if possible, plan to acquire these irrigation shares as and if they become available.
- **Ence Well/Additional Well** – Washington County Water Conservancy District has an 880 acre-foot water right from 2 wells near the Santa Clara River (Ence Wells). From this source, there appears to be approximately 380 acre-feet available for use (that is not already being used or reserved for another user). Although some users have reported issues with odor and taste with Ence Well water, the source does meet drinking water standards and can be used to meet culinary water demands. The source could also be used in the secondary irrigation system.
- **Gunlock Reservoir** – As development continues on the west side of the County, irrigation shares in Gunlock Reservoir (other than those owned by the Ivins Irrigation Company) may become available as green field areas are replaced by homes, businesses, etc. Ivins should monitor these water shares and plan to acquire them if they become available.
- **Beaver Dam Wash Water Development –** The WCWCD 2006 Capital Facilities Plan had plans for a reservoir in the Beaver Dam Wash and a pipeline into the Santa Clara River system that could supply up to an additional 4,000 gpm or 6,500 acre-feet annually. However, recent discussions with the District have indicated that this project may ultimately not be feasible.
- **Wastewater Scalping Plant in Ivins City –** BC&A completed a sewer master plan for Ivins City in 2016. As part of this study, BC&A looked at the feasibility of a scalping plant in Ivins City which would collect and treat a portion of wastewater prior to leaving the City for use in the secondary irrigation system. The high capital cost and lack of storage available to operate the facility year-round made the project difficult to justify. However, as sources for the irrigation system were further evaluated, it became apparent that a reservoir would be needed in order to meet the needs of the system. This considered, Ivins should plan to re-evaluate the feasibility of a wastewater scalping plant as the irrigation system progresses, particularly as plans for a reservoir are solidified. Instead of allowing wastewater to flow miles away to the St. George WRF to be treated and pumped back up to Ivins, the water could be scalped and treated in Ivins and sent to the reservoir for use.

Table 4-3 provides a summary of the estimated source capacity which is potentially available for the Ivins secondary irrigation system. Figure 4-2 provides a visual reference for the location of each potential source.

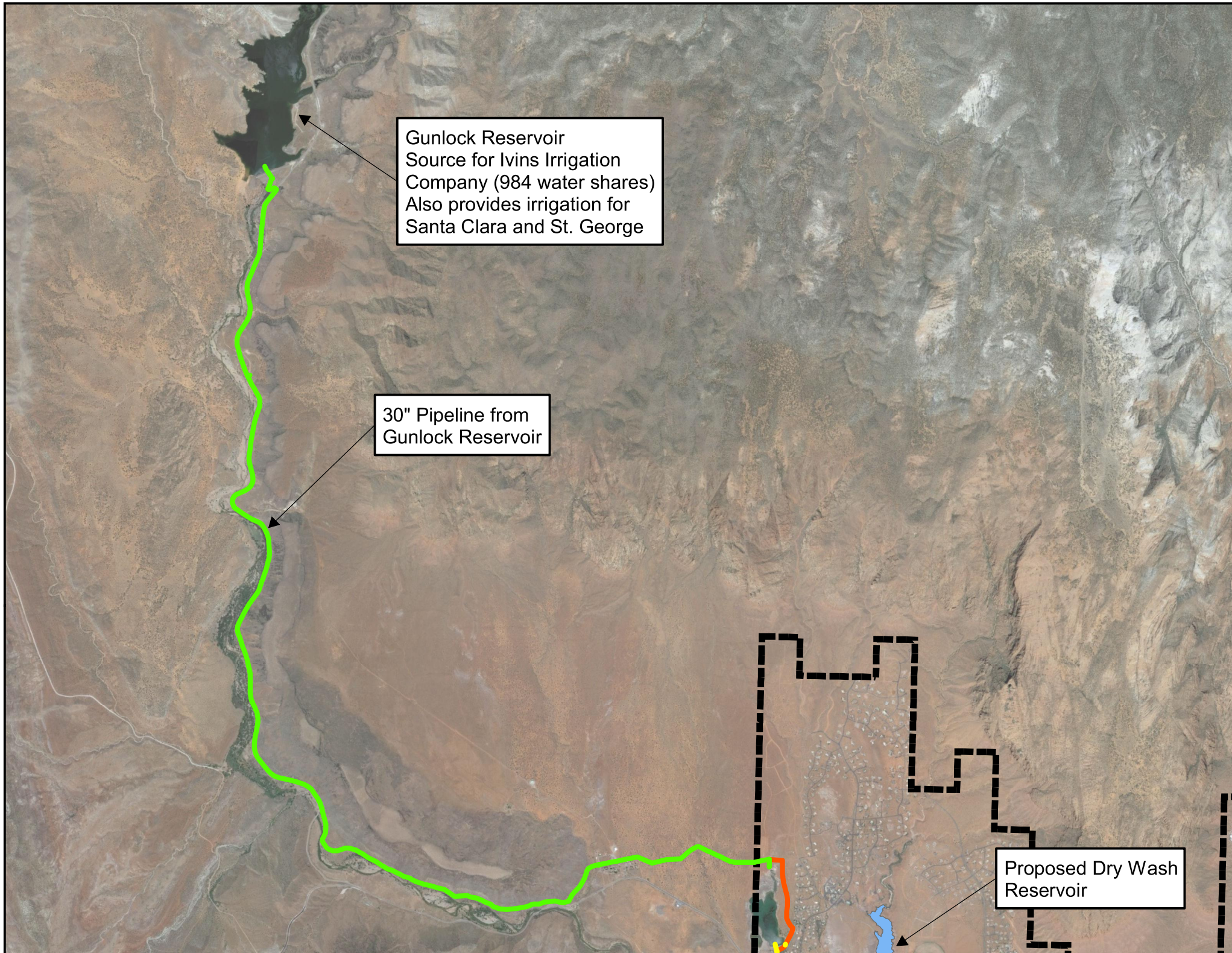

Gunlock Reservoir
Source for Ivins Irrigation Company (984 water shares)
Also provides irrigation for Santa Clara and St. George
30" Pipeline from Gunlock Reservoir
Proposed Dry Wash Reservoir

Table 4-3
Potential Irrigation System Sources

Source	Potential Source Capacity
St. George Reuse Facility[1]	Based on Volume of Storage Reservoir (up to 4,500 acre-feet, filled in off season, drained during irrigation season)
Ivins Irrigation Company Shares	984 shares (approximately 1,500 AF)
Ence Well/Additional Well near Santa Clara River	380 acre-feet[2]
Gunlock Reservoir	Unknown Availability

[1]Water from the St. George Reuse Facility may be supplemented by a wastewater scalping plant in Ivins. A scalping plant in Ivins would need to be preceded by the construction of Dry Wash Reservoir or another equivalent storage reservoir.
[2]Water from Ence Well meets drinking water standards and may be utilized in the culinary water system.

CHAPTER 5
STORAGE REQUIREMENTS

INTRODUCTION

Storage facilities play an important role is a water delivery system. Storage facilities provide a buffer between water sources and the distribution system. Storage for the irrigation system provides two primary function: equalization (operational) storage and emergency storage. Equalization storage is used to satisfy peak system demands at times when demand exceeds the production capacity of sources. Emergency storage allows system demands to be met temporarily in the event of an unexpected situation such as a line break, pump shutdown, etc. This chapter outlines the required volume of storage needed to meet the demands of the proposed irrigation system under existing and future demands. This chapter also identifies potential storage facility locations for the proposed irrigation system.

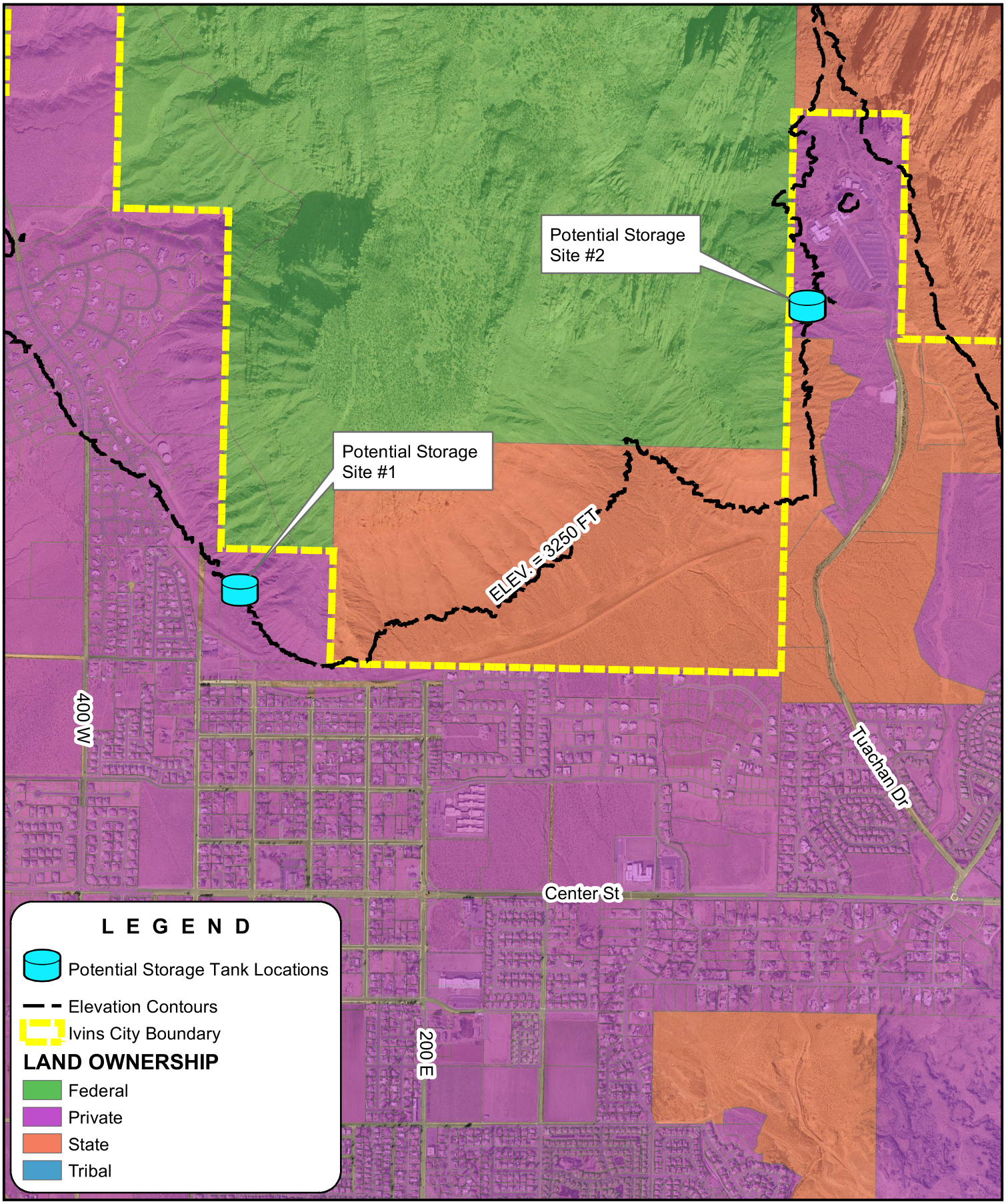
REQUIRED STORAGE VOLUME

Storage volume requirements are specific to the type of system being operated. For a culinary water system, storage facilities must include operational storage (also referred to as equalization storage), emergency storage, and fire flow storage. However, secondary irrigation systems are not required to maintain fire flow storage. Rule R309-510 from the Utah Administrative Code outlines the storage requirements for a system which supplies water for outdoor use. As previously discussed, this State Rule governs *culinary* water systems, but provides a good basis for evaluation of a secondary irrigation system. The storage requirement is based on the geographical location of the system, and warmer climates have a higher storage requirement. These requirements are summarized in Table 5-1 below.

Table 5-1
R309-510 Storage Sizing Requirements

Map Zone	Volume Required (gallons/irrigated acre)
1	1,782
2	1,873
3	2,528
4	2,848
5	4,081
6	4,964

Ivins City is located within Map Zone 6. Based on the requirements shown in Table 5-1, Table 5-2 contains the minimum required storage for the proposed irrigation system for existing and future growth conditions.



BOWEN COLLINS & ASSOCIATES

POTENTIAL IRRIGATION STORAGE LOCATIONS

Ivins City

SECONDARY IRRIGATION MASTER PLAN

NORTH:

NORTH

SCALE:

0 750 1,500

Feet

FIGURE NO.

5-1

S:\Ivins\235-16-01 Sewer, Irr, and Rate Study\4.0 GIS\4.4 Figures\Irrigation MP Figures\Figure 5-1 - Potential Storage Locations.mxd aanderson 1/30/2019

Table 5-2
Minimum Storage Requirement for Proposed Secondary Irrigation System

Year	Residential Irrigated Acres	Non-Residential Irrigated Acres	Total Irrigated Acres	Volume Required
2016[1]	289	38	327	1,623,228
2020	365	45	410	2,035,240
2026	453	74	527	2,616,028
2030	537	94	631	3,132,284
2036	673	117	790	3,921,560
2040	741	124	865	4,293,860
2046	826	134	960	4,765,440

[1]Storage volume shown is that for all developed areas within the existing system that reside within the service area of the irrigation system (i.e required storage if all users within service area were currently on the system). Since the new system will be built in phases, this table does not reflect the actual volume of storage that the City will need for a given point in time. Detailed recommendations on storage facilities is found in the implementation plan found in Chapter 8 of this report.

POTENTIAL STORAGE FACILITY LOCATIONS

Potential locations for storage facilities have been discussed with Ivins City management. Two potential sites have been identified as ideal locations for storage facilities. The recommended locations are within close proximity of existing Ivins City culinary water tanks. This is for two reasons:

1. Land Availability – A good portion of the land surrounding Ivins City is State and Federal Land, so land at the proper elevation for a storage facility is relatively limited.

2. Interaction with Culinary Water System – When operating a culinary and secondary irrigation water system, accidental cross connections may occur. If the line pressure in the secondary line is greater than the culinary line at the point of interconnection, the culinary system may become contaminated with untreated water not suitable for human consumption. For this reason, it is advantageous that the secondary system operate at a lower pressure than the adjacent culinary system.

The ideal location for the City's irrigation storage facilities are shown in Figure 5-1. Ultimately, the location of a new storage facility may be limited by land availability and/or the price of land acquisition.

CHAPTER 6
HYDRAULIC MODELING

WATER SYSTEM MODEL

Computer Modeling

A hydraulic computer model is a digital representation of physical features and characteristics of the water system, including pipes, valves, storage tanks and pumps. Key physical components of a water system are represented by a set of user-defined parameters that represent the characteristics of the system. Computer model output includes information such as system pressure and flow rate for each pipe in the water system. There are several well-known computer programs for modeling water distribution systems. InfoWater developed by Innovyze was used for this Master Plan. This program uses the EPANET computing engine.

The City's proposed irrigation system model was developed for this study using available GIS data in conjunction with the demand estimates developed in Chapter 3. The model was set up to run a "steady state" simulation, and is primarily intended to optimize the layout of the system under existing and future conditions. The steady state model does not track dynamic, time dependent variables such as water depth in a storage tank or reservoir over the course of a day of operation.

GIS Data

The GIS data used to create the irrigation system model include:

- Pipeline locations, diameters, and lengths
- Proposed storage tank locations and elevations
- Irrigation system valves
- Elevation contours from the LIDAR data collected by Washington County in 2012.

Model Demands and Demand Distribution

A key component in hydraulic modeling is the development of system demands. There are two components to consider when developing the demands for the model: total system demands and distribution of demands. Total system demands are discussed in Chapter 3 of this report, and for modeling purposes, the demand scenarios of most concern are those that represent the highest flow demands on the system. These scenarios are peak day demand and peak hour demand.

System demands were distributed evenly throughout the City in the hydraulic model. Although irrigation demand differs from user to user, this method of demand distribution was determined to be reasonable for the application of this master plan.

CHAPTER 7
TRANSMISSION AND DISTRIBUTION SYSTEM EVALUATION

INTRODUCTION

The Ivins City secondary water system is not in operation, but a network of irrigation pipes owned by the City, IIC, and private HOAs is currently in place. This chapter provides a hydraulic evaluation of the proposed irrigation system under existing and future conditions.

EXISTING IRRIGATION PIPING

While Ivins City currently does not operate a secondary irrigation system, the City does have a substantial amount of piping infrastructure in place, particularly in the newer developments within the City. The Ivins Irrigation Company (IIC) operates its own irrigation system within the City which delivers irrigation water to shareholders, the majority of which are large, agricultural users. While previous plans for the Ivins City irrigation system included at least a partial incorporation of the Ivins Irrigation Company system, this option provides some significant challenges:

1. **Condition of IIC System:** The majority of the Ivins Irrigation Company system is composed of DR51 plastic irrigation pipe (PIP) with a pressure rating of 80 psi. Recent observation of the system revealed several pipes leaks in the system (manifested by visible puddles forming at the ground surface along the pipe alignment), and while the condition of the system as a whole is unknown, it is reasonable to assume that the majority of the system is in a state of disrepair.

2. **Available Capacity in IIC System:** The IIC operator reported that the system flows up to 2,200 gpm under peak usage periods. Based on the IIC pipe diameters on record, this flow would put the majority of the system at or near its peak capacity. Since the IIC will require that its users get priority water delivery from its system, it is probable that the system will not have adequate capacity for the Ivins City system to merit the union.

3. **Location of Existing IIC System:** As shown in Figure 2-3 of Chapter 2, a portion of the IIC system is located at the center of City blocks or behind lot lines and would not be ideal for use in the Ivins City system.

For these reasons, it is not recommended that Ivins City plan to use the IIC system as a significant part of the City's irrigation system. There are a few reaches of pipe currently used by the IIC that were recently replaced with C900 PVC pipe which could be used as part of Ivins City system. While most of the IIC system is not recommended to be used at this time, this is not to say that the IIC distribution system will provide no use to Ivins City over the long term. As development continues in Ivins and the large plots of land currently being used for agriculture are developed, demand on the IIC system will continue to decrease. As this occurs, the City may decide to inspect some of the more potentially valuable reaches of the IIC system and incorporate them into the City's system if they are found to be in good working condition.

Considering these points, Figure 7-1 displays the existing "recommended useable" infrastructure which has been evaluated for planning purposes.

DISTRIBUTION SYSTEM EVALUATION CRITERIA

The proposed Ivins City secondary irrigation system was laid out using the minimum pressure requirements established by Utah Administrative Code R309-105 "Administration: General Responsibilities of Public Water Systems". As previously mentioned, secondary irrigation systems are not governed by R309-105, but this code serves as a good guideline for system design. Per this code, the system should aim to meet the following minimum pressures:

- **30 psi** under peak hour (instantaneous) demand
- **40 psi** under peak day demand

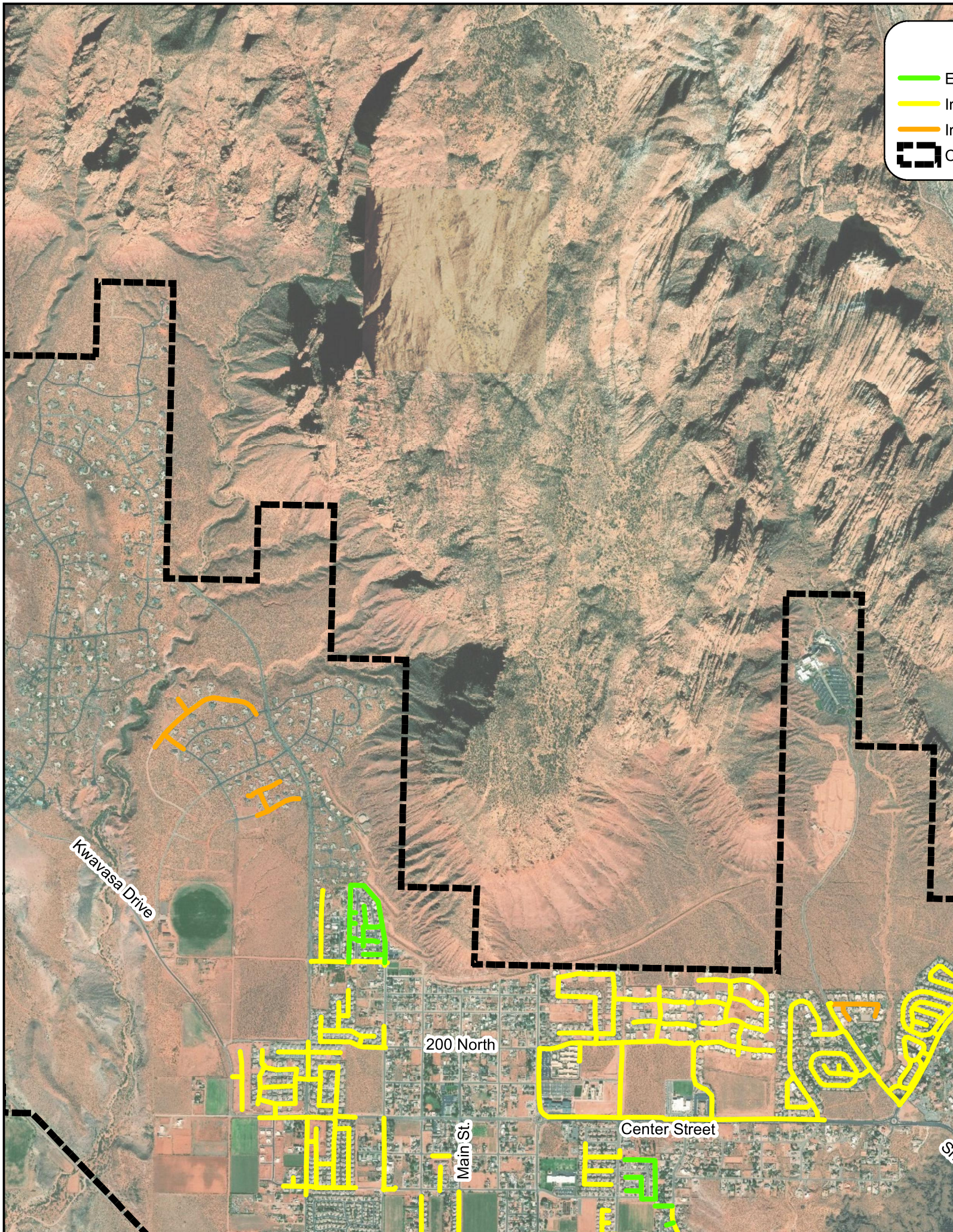
Ideally, the system would be able to meet these minimum pressures, but areas that do not meet these minimums should not necessarily be excluded from the system. However, areas that drop significantly below these guidelines will not provide reliable service to customers and should be excluded from the system.

In addition, peak pipe velocities should be limited to 8 feet per second (fps) in order to limit friction losses and potential damage to pipes.

CROSS CONNECTION PREVENTION AND PROTECTION

When a culinary and secondary water distribution system are operated side by side, there is a risk of possible inadvertent cross connections occurring between the two systems. Such cross connections can lead to contamination of the culinary water system. Good connection and inspection practices enforced by the City will greatly reduce the risk of the occurrence of cross connections.

In order to further reduce the risk of cross contamination of the two systems, it is a common design practice to run the secondary irrigation system at a lower pressure than the adjacent culinary water system, which will help prevent secondary water from being able to flow into the culinary system in the case of a cross connection. This considered, the elevation of the proposed storage tank(s) for the system should be set below the elevation of the culinary water tanks serving the same respective area. For the purposes of this master plan, it has been assumed that the secondary water tank(s) will sit 20 feet lower than the culinary water tanks. This will result in a consistently lower system pressure in the secondary water system than the culinary water system. However, planning to the construct the tank at this elevation will slightly reduce the amount of the City that can be served reliably by the system. This tank elevation will not be able to serve some of the higher elevation areas of the City.


Kwavasa Drive
200 North
Main St.
Center Street

DISTRIBUTION SYSTEM EVALUATION RESULTS

The results presented in this section are for two system conditions: existing conditions and buildout conditions. Chapter 8 presents a detailed implementation plan which identifies a number of project phases which bridge between these scenarios.

Existing System

A hydraulic model was developed which simulates the operation of the pressurized irrigation system serving all existing users within the proposed system service area. The following is a discussion of the results of the hydraulic model simulations for an "existing" system. The layout of this system is shown in Figure 7-2. Note that the layout show in Figure 7-2 represents the system that would be needed to service the "existing" areas of the City. The actual location and sizes of pipes that are recommended to be installed will have more capacity than what would be needed under an existing scenario (in order to provide service for future conditions). Therefore, the actual recommended pipe sizes to be constructed are shown in Figure 7-6 and outlined in the implementation plan in Chapter 8 of this report.

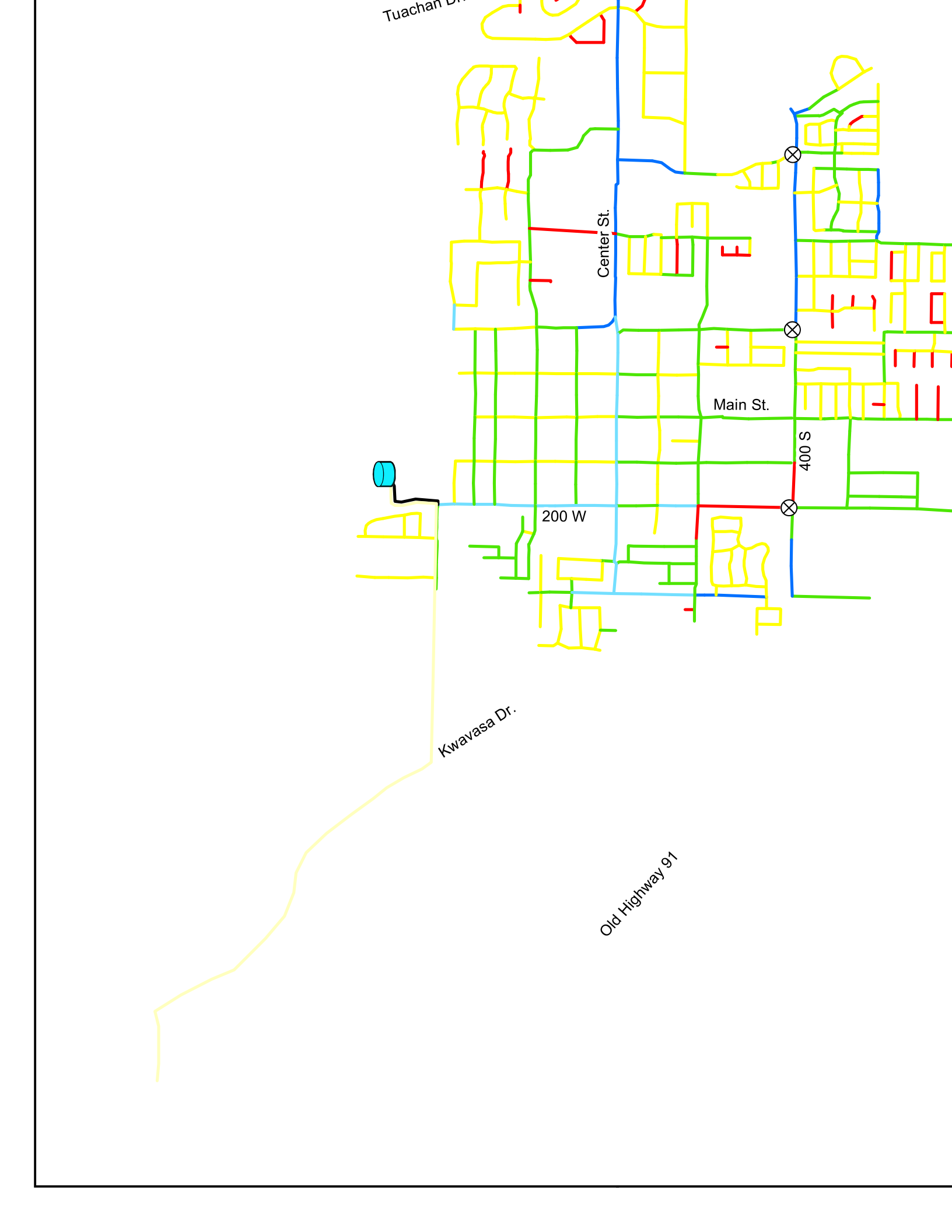
Existing Static Demand Conditions

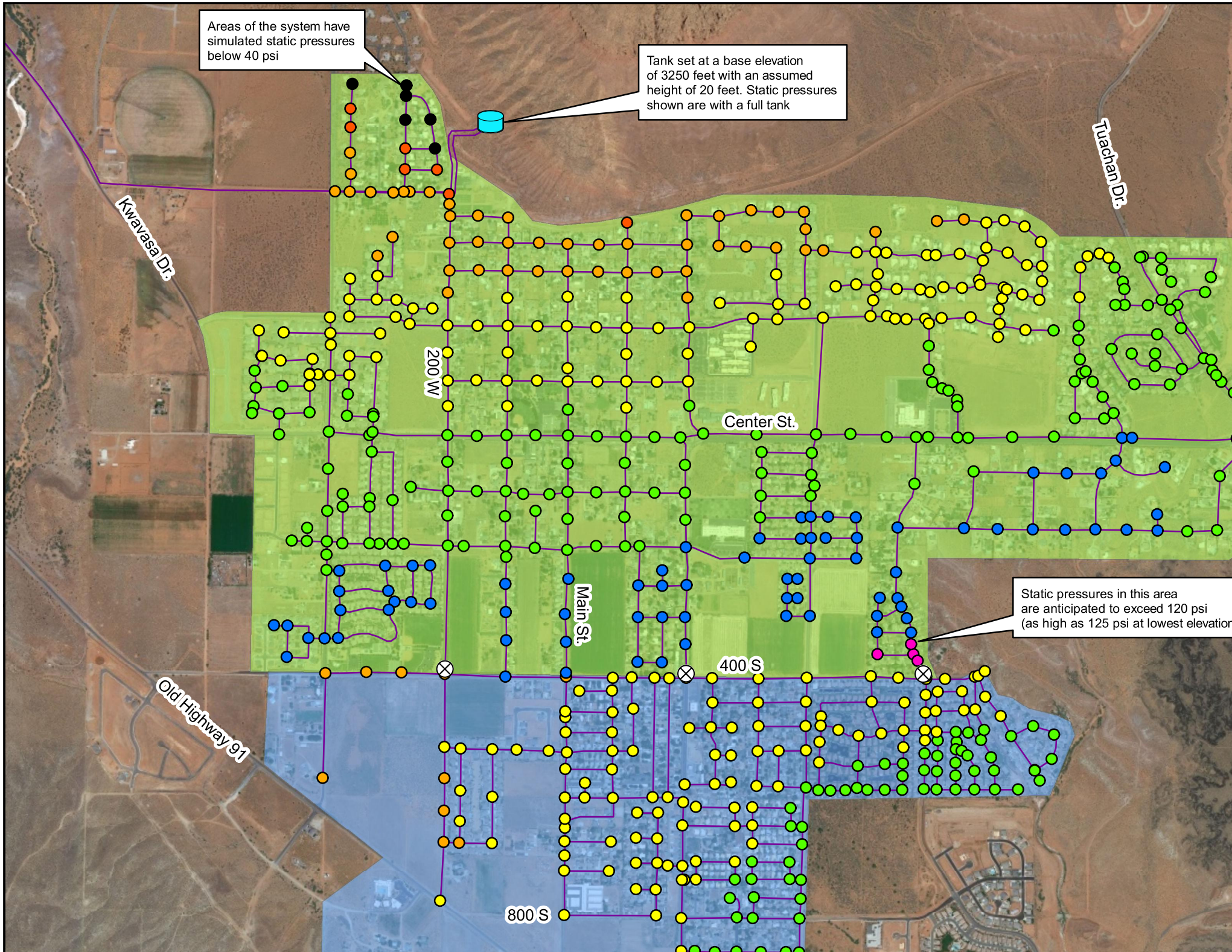
Figure 7-3 displays the anticipated system pressures under a static (low demand) scenario. Static pressures represent the highest pressure that the system will experience.

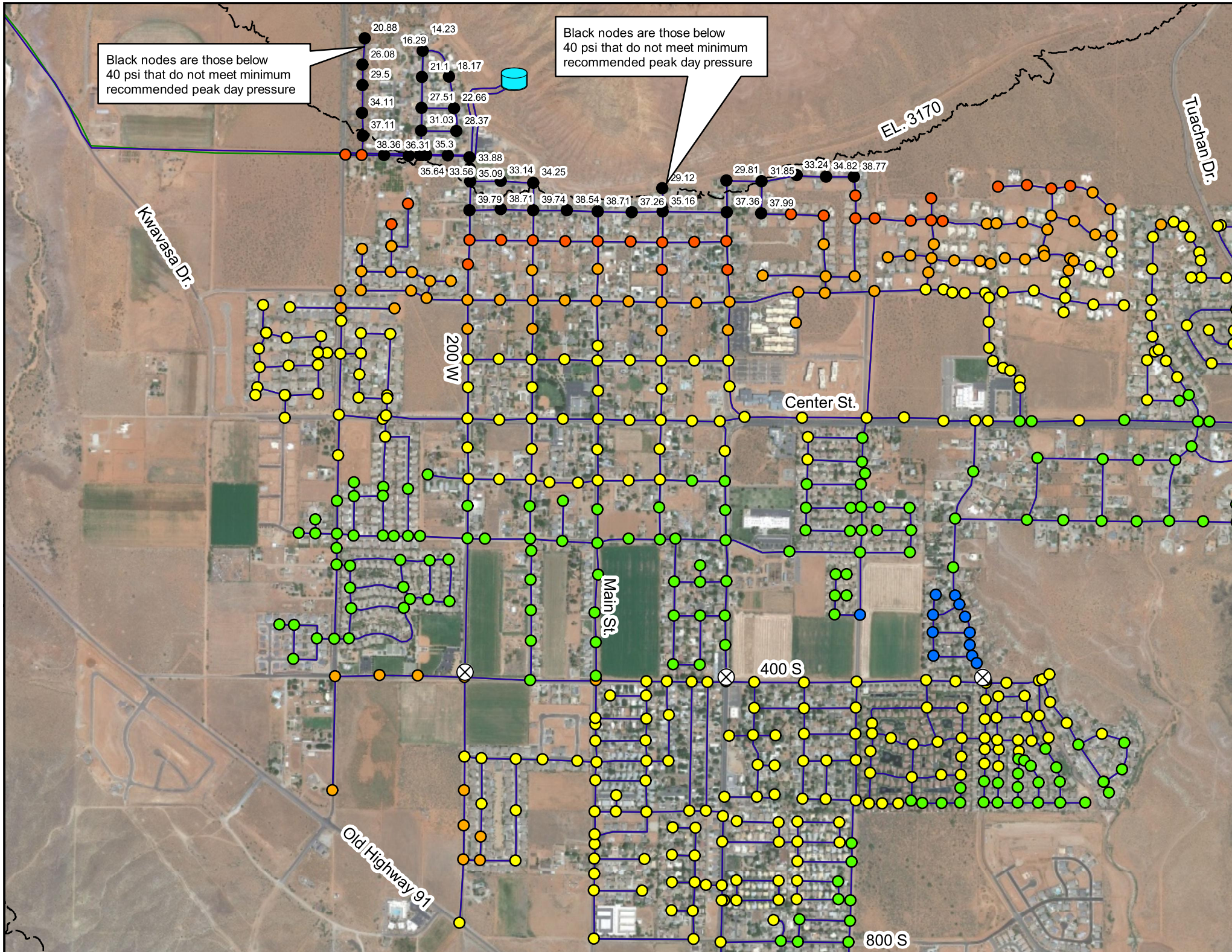
As previously discussed, the system has been laid out to operate at a lower pressure than the culinary water system. Therefore, irrigation system pressure reducing valves are located generally in the same location as the culinary system, establishing two pressure zones which closely match those of the culinary water system. In essence, the hydraulic grade line (HGL) of the irrigation system will be slightly lower and parallel to the culinary water system HGL. As shown in the figure, the majority of the lots in the northwest region of the City north of 400 N are at too high of an elevation to meet minimum pressures. Another area, located off of S Puerto Dr. just north of 400 South, is anticipated to experience static pressures in excess of 120 psi. While the distribution system can function under high pressures, there is an increased risk of line breaks with high line pressure. The material of existing dry irrigation lines in this area is uncertain, but the City should assure that this area of the system can safely handle higher static pressures (by installing higher pressure class pipe and replacing existing pipes that do not meet pressure class requirements).

Existing Peak Day Demand

The results of the peak day demand model simulation are shown in Figure 7-4. As shown in the figure, an area on the north side of the City has simulated pressures below 40 psi and does not meet the recommended system pressure. Generally speaking, homes above an elevation of 3,170 feet will not meet this minimum pressure. Based on these results, it is recommended that the area to the west of 200 W and north of 450 N should not be included in the secondary water service area. Because pressures in this area drop well below 40 psi (and even below 20 psi in some areas), it will not provide reliable service for customers. It is recommended that the areas along 400 N and 350 N that are shown as being below 40 psi be included in the service area.


Tuachan Dr.
Center St.
Main St.
400 S
200 W
Kwavasa Dr.
Old Highway 91


Areas of the system have simulated static pressures below 40 psi
Tank set at a base elevation of 3250 feet with an assumed height of 20 feet. Static pressures shown are with a full tank
Kwavasa Dr.
Tuachan Dr.
200 W
Center St.
Main St.
Static pressures in this area are anticipated to exceed 120 psi (as high as 125 psi at lowest elevation
400 S
Old Highway 91
800 S


Black nodes are those below 40 psi that do not meet minimum recommended peak day pressure
Black nodes are those below 40 psi that do not meet minimum recommended peak day pressure
20.88
14.23
16.29
26.08
21.1
18.17
29.5
27.51
22.66
34.11
31.03
28.37
37.11
38.36
36.31
35.3
33.88
35.64
33.56
35.09
33.14
34.25
29.12
29.81
31.85
33.24
34.82
38.77
39.79
38.71
39.74
38.54
38.71
37.26
35.16
37.36
37.99
EL. 3170
Tuachan Dr.
Kwavasa Dr.
200 W
Center St.
Main St.
400 S
Old Highway 91
800 S

Existing Peak Hour Demand

The results of the model simulations for peak hour demand are shown in Figure 7-5. Similar to the static and peak day demand scenarios, a portion of the north/northwest side of the City shows pressures below the minimum 30 psi requirement. These results further support the need to exclude the area west of 200 W and north of 450 N from the service area.

Buildout System

Along with the hydraulic model of the proposed secondary irrigation system under "existing conditions", a model of the system at full buildout was developed. The alignment of new pressurized irrigation pipes to service currently undeveloped areas follow the general planned alignment of future culinary water lines per the 2013 Ivins City Culinary Water Master Plan. The results of the hydraulic model are discussed in the following paragraphs.

Conceptual Layout of Buildout System

The conceptual layout of the buildout secondary irrigation system is shown in Figure 7-6. New pipes shown running through areas of the City that are currently undeveloped represent main distribution lines; small improvements needed to service individual developments are not shown (due to the uncertainty of the actual location and type of future development).

Buildout Static Demand Pressures

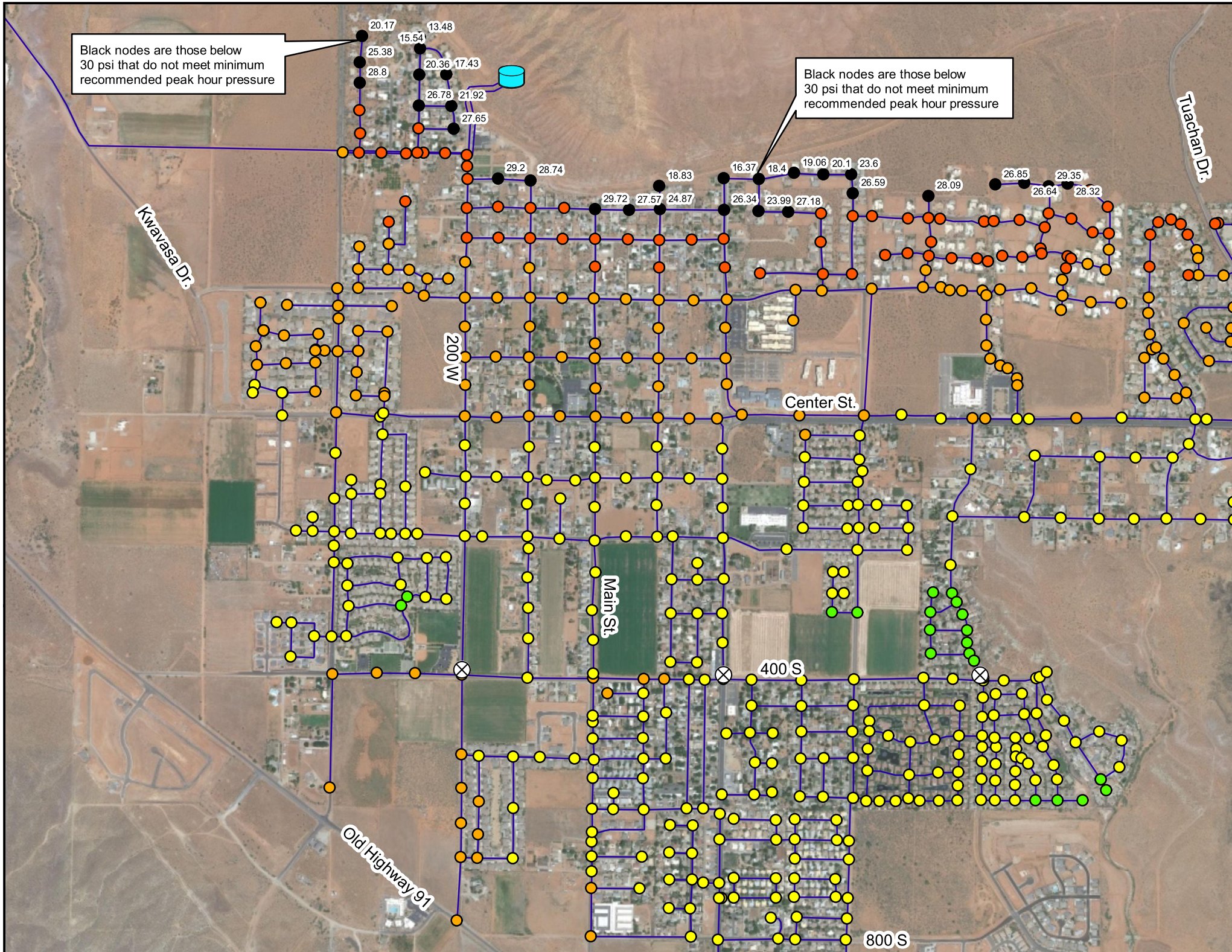
Similar to the results of the static demand simulation under existing conditions, while the majority of the system is shown to be within the optimal range of static pressures, there is one area of the system with excessively low static pressures and one with excessively high static pressures. As shown in Figure 7-7, the area in the northwest region of the City between 450 N and 400 W (near the border of Kayenta) shows static pressure below 40 psi. This area will likely not be serviceable with the storage tank at an elevation of 3,250 feet. Conversely, the area along S Puerto Dr. north of 400 S is simulated to have static pressure greater than 120 psi. As discussed previously, the system can adequately function under high pressure. However, there is an increased risk of line breaks when pipes are exposed to higher internal pressure.

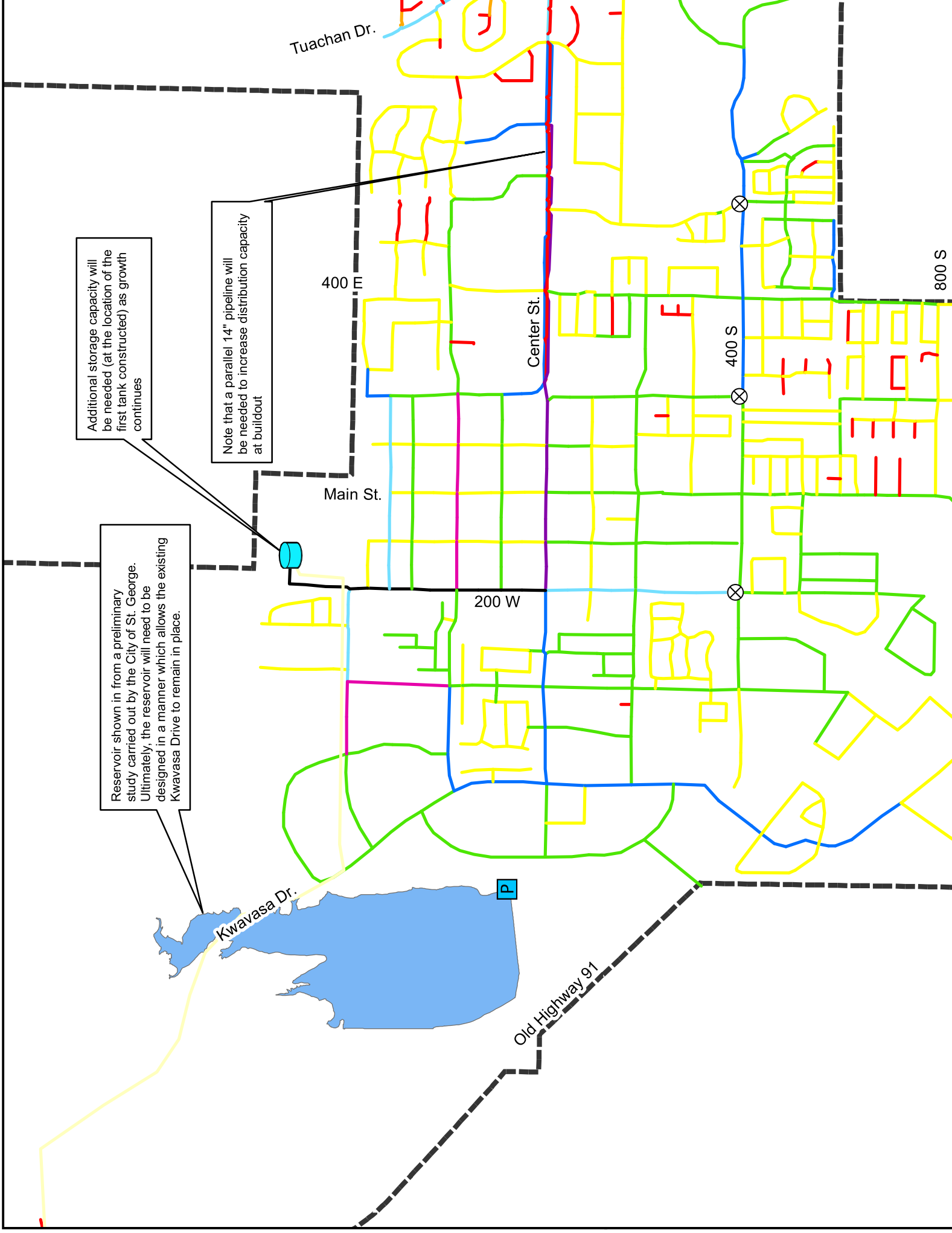
Buildout Peak Day Demand

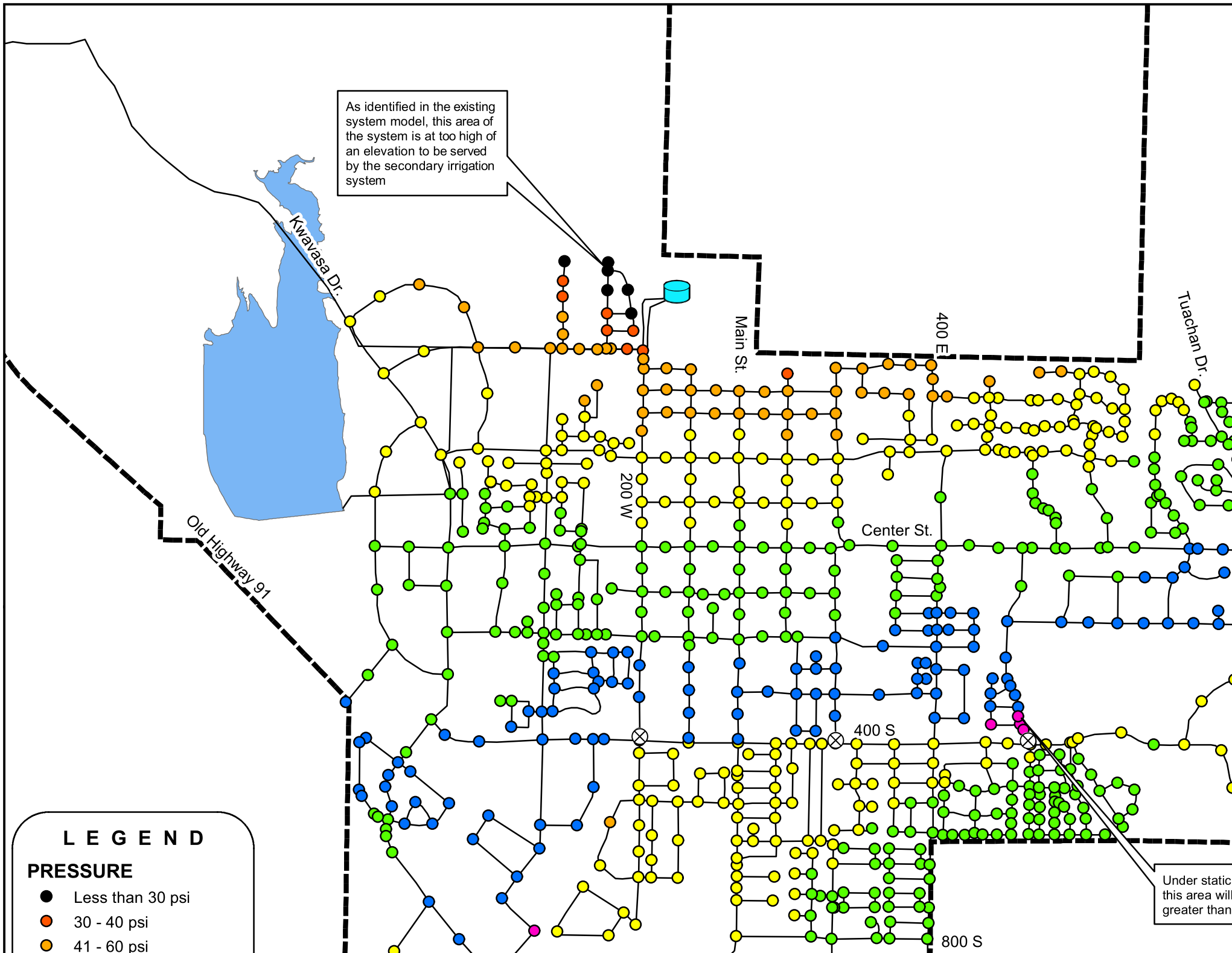
As shown in Figure 7-8, the majority of the system can maintain the minimum 40 psi pressure under peak day demand. A few areas of the system are simulated to have peak day pressures below 40 psi (same areas previously identified). One additional area on the south side of the City (Comanche Cliffs) may not be serviceable by the secondary irrigation system.

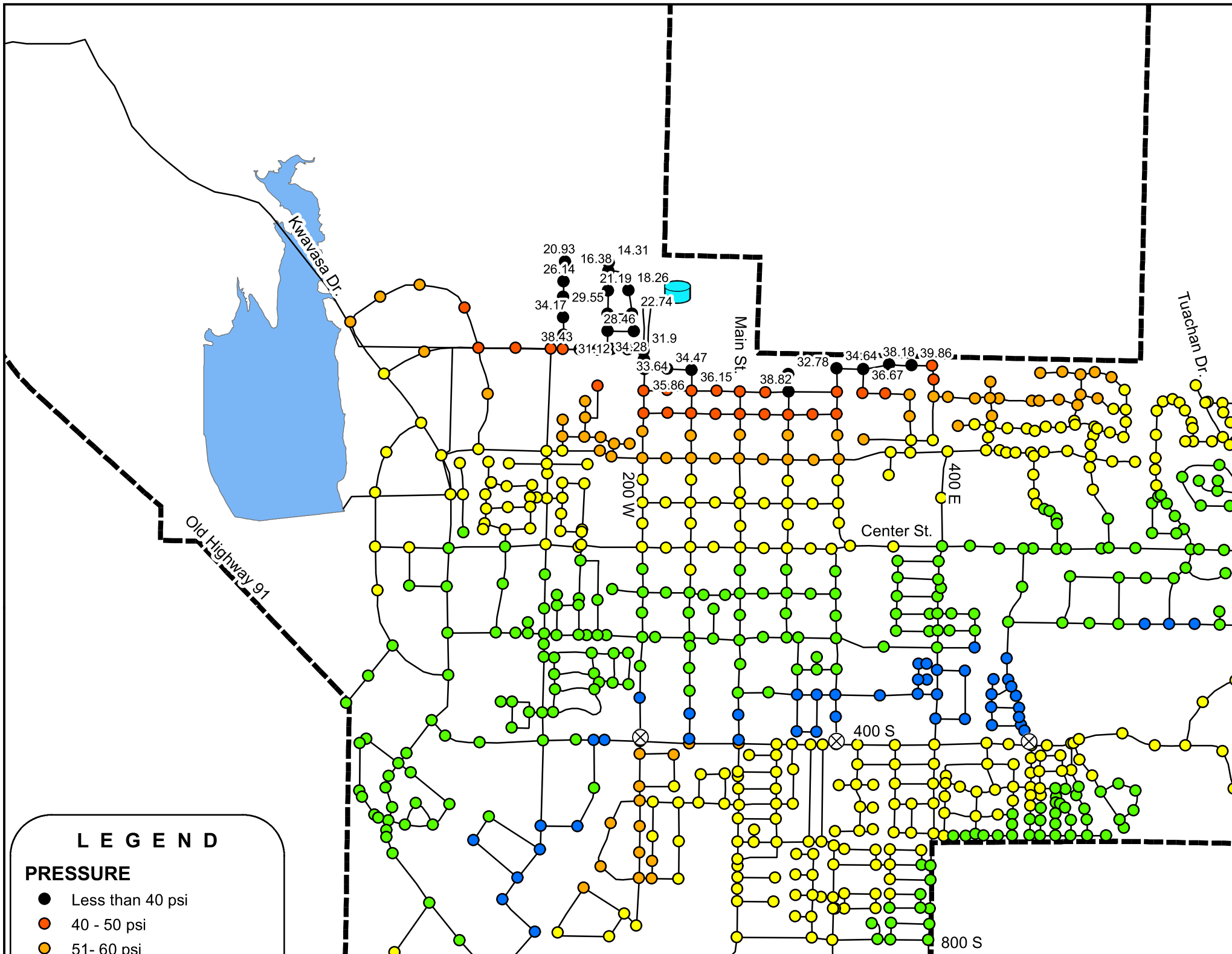
Buildout Peak Hour Demand

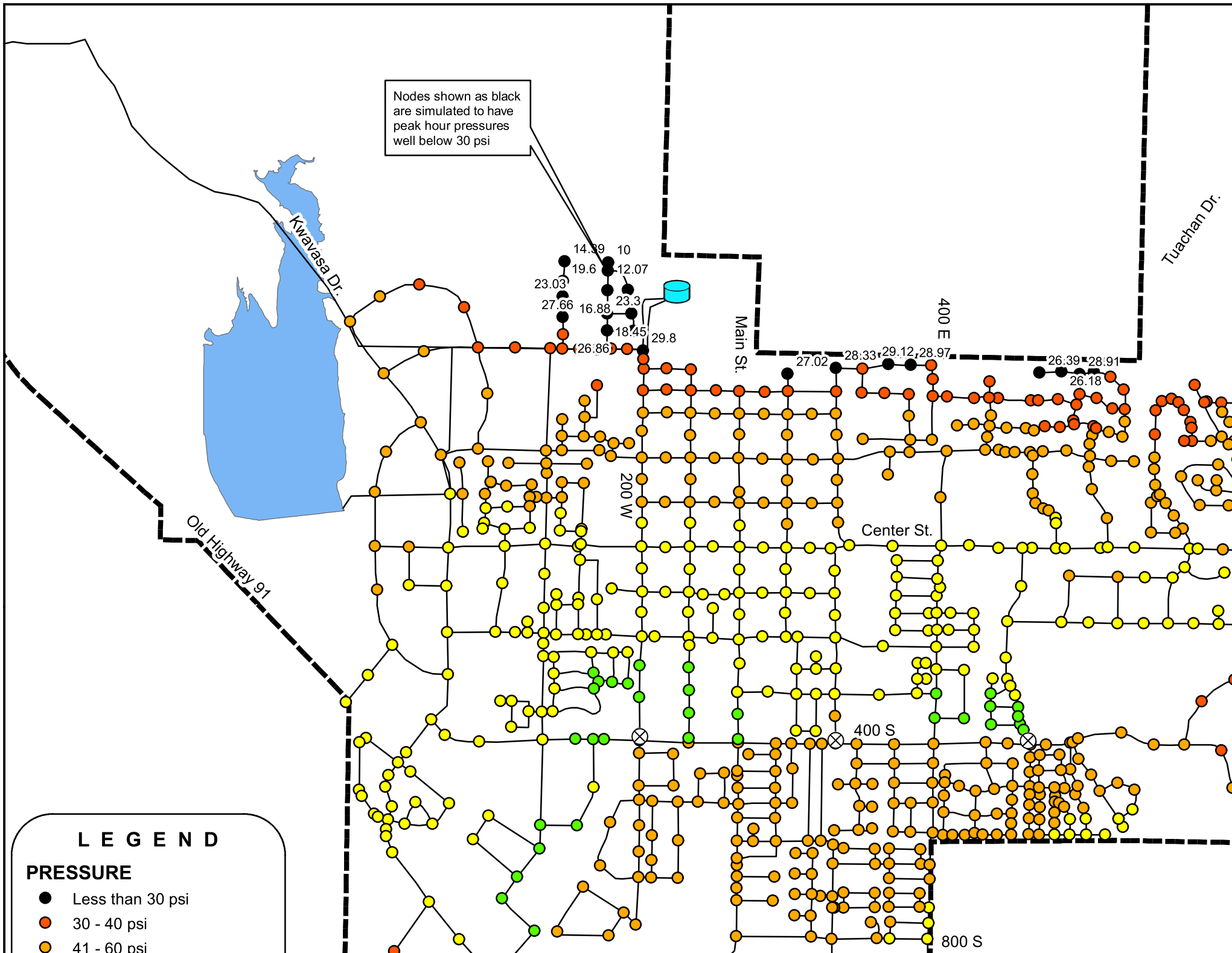
Simulated system pressure for the buildout system under peak day demand is shown in Figure 7-9. The results indicate that, while the majority of the system can meet the 30 psi minimum system pressure, some areas do not meet this requirement (same areas previously identified).


Black nodes are those below 30 psi that do not meet minimum recommended peak hour pressure
Black nodes are those below 30 psi that do not meet minimum recommended peak hour pressure
20.17
13.48
15.54
25.38
20.36
17.43
28.8
26.78
21.92
27.65
29.2
28.74
18.83
16.37
18.4
19.06
20.1
23.6
26.59
29.72
27.57
24.87
26.34
23.99
27.18
28.09
26.85
29.35
26.64
28.32
Kwavasa Dr.
Tuachan Dr.
200 W
Center St.
Main St.
400 S
Old Highway 91
800 S


Tuachan Dr.
400 E
Center St.
400 S
800 S
Main St.
200 W
Kwavasa Dr.
Old Highway 91
P
Additional storage capacity will be needed (at the location of the first tank constructed) as growth continues
Note that a parallel 14" pipeline will be needed to increase distribution capacity at buildout
Reservoir shown in from a preliminary study carried out by the City of St. George. Ultimately, the reservoir will need to be designed in a manner which allows the existing Kwavasa Drive to remain in place.


As identified in the existing system model, this area of the system is at too high of an elevation to be served by the secondary irrigation system
Kwavasa Dr.
Old Highway 91
Main St.
200 W
400 E
Tuachan Dr.
Center St.
400 S
800 S
Under static
this area will
greater than
LEGEND
PRESSURE
Less than 30 psi
30 - 40 psi
41 - 60 psi


Kwavasa Dr.
Old Highway 91
Main St.
200 W
400 E
Center St.
400 S
800 S
Tuachan Dr.
20.93
26.14
34.17
38.43
16.38
21.19
29.55
28.46
14.31
18.26
22.74
31.9
34.28
33.64
34.47
36.15
35.86
38.82
32.78
34.64
36.67
38.18
39.86
LEGEND
PRESSURE
Less than 40 psi
40 - 50 psi
51- 60 psi


Nodes shown as black are simulated to have peak hour pressures well below 30 psi
Kwavasa Dr.
Old Highway 91
Main St.
200 W
400 E
Center St.
400 S
800 S
Tuachan Dr.
14.39
10
19.6
12.07
23.03
27.66
16.88
23.3
18.45
29.8
26.86
27.02
28.33
29.12
28.97
26.39
28.91
26.18
LEGEND
PRESSURE
Less than 30 psi
30 - 40 psi
41 - 60 psi

CHAPTER 8
IRRIGATION SYSTEM IMPLEMENTATION PLAN

To this point, the proposed irrigation system has been evaluated for two major scenarios: providing service to all existing users and providing service to the system at full buildout. Because building the entire system all at once is not financially viable, the system will need to be built in phases. This chapter presents the recommended implementation plan for the City's secondary irrigation system. It should be noted that the information provided in this implementation plan should be used as a guideline; changes can and should be made to the plan if development patterns support the need to do so. All future development should continue to construct irrigation lines to allow for easy connection in the future.

Phase 1 (2019-2021)
Source: Existing Ivins City Irrigation Shares (Ivins Irrigation Company, St. George Clara Irrigation Company, Santa Clara Irrigation Company
Irrigated Acres: 79
Supply Capacity: 347 AF
Required Storage: 393,000 gallons
Annual Demand: 326 AF
Peak Day Demand: 394 gpm
Peak Hour Demand: 788 gpm

The first phase of the implementation plan utilizes the City's existing irrigation shares to provide irrigation water to a select number of non-residential and residential units. The recommended Phase 1 improvement projects are shown in Figure 8-1. The initial construction phase will bring irrigation water to the majority of the City's parks, schools, and large non-residential locations with high outdoor water demands. The system will also provide service to 415 residential units. Table 8-1 summarizes the areas and demands included in the initial construction phase. The recommended Phase 1 improvement projects are shown in Table 8-2. Note that Phase 1 of the irrigation system assumes that Ivins will consolidate its existing irrigation shares from various irrigation companies into a single point of diversion in the Gunlock pipeline.

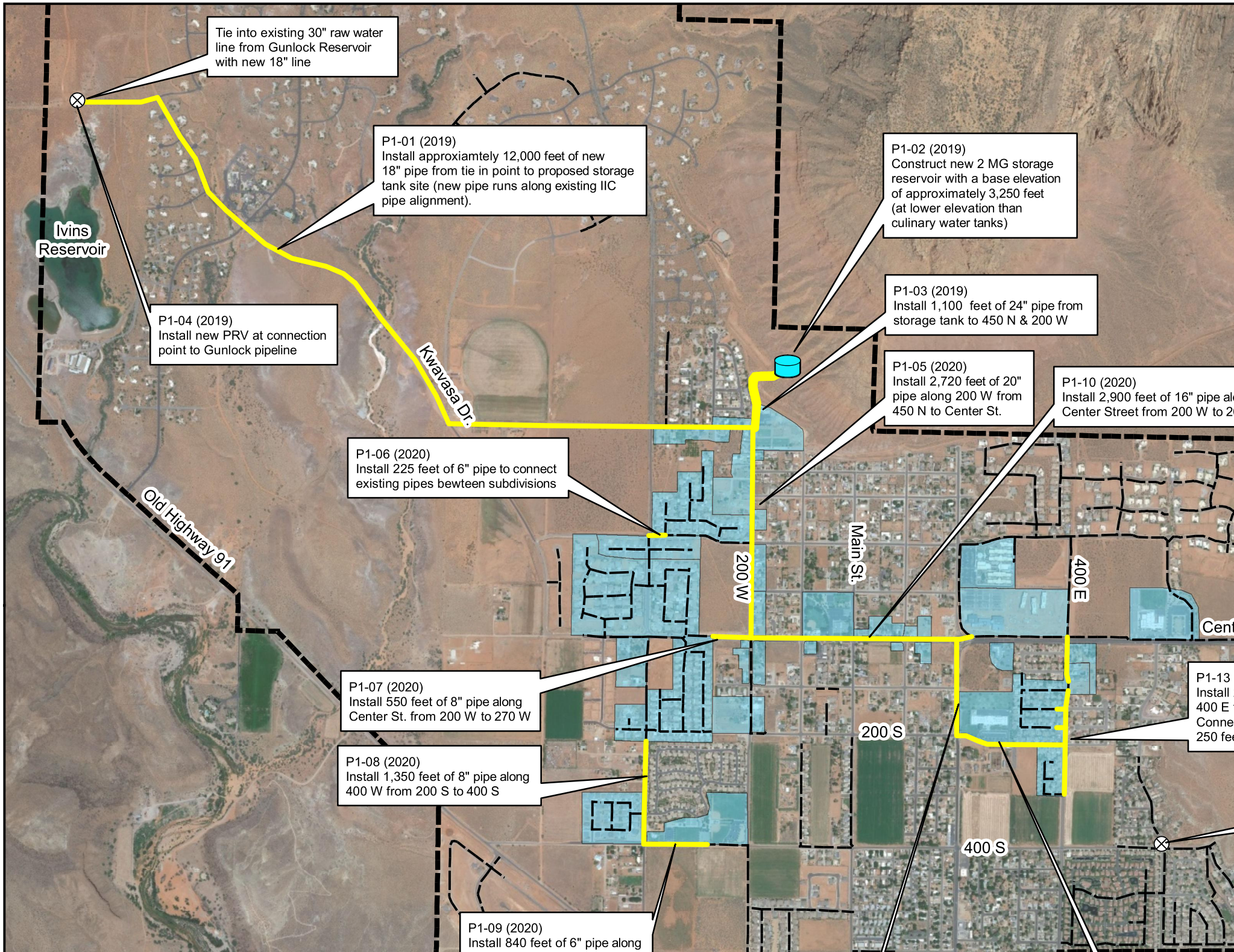

Tie into existing 30" raw water line from Gunlock Reservoir with new 18" line
P1-01 (2019)
Install approxiamtely 12,000 feet of new 18" pipe from tie in point to proposed storage tank site (new pipe runs along existing IIC pipe alignment).
P1-02 (2019)
Construct new 2 MG storage reservoir with a base elevation of approximately 3,250 feet (at lower elevation than culinary water tanks)
Ivins Reservoir
P1-04 (2019)
Install new PRV at connection point to Gunlock pipeline
P1-03 (2019)
Install 1,100 feet of 24" pipe from storage tank to 450 N & 200 W
Kwavasa Dr.
P1-05 (2020)
Install 2,720 feet of 20" pipe along 200 W from 450 N to Center St.
P1-10 (2020)
Install 2,900 feet of 16" pipe al
Center Street from 200 W to 2
P1-06 (2020)
Install 225 feet of 6" pipe to connect existing pipes bewteen subdivisions
Old Highway 91
200 W
Main St.
400 E
Cent
P1-07 (2020)
Install 550 feet of 8" pipe along Center St. from 200 W to 270 W
P1-13
Install
400 E
Conne
250 fe
200 S
P1-08 (2020)
Install 1,350 feet of 8" pipe along 400 W from 200 S to 400 S
400 S
P1-09 (2020)
Install 840 feet of 6" pipe along

Table 8-1
Phase 1 Demand Summary

Location	# of Connections	Irrigated Acres	Annual Demand (acre-feet)	Peak Day Demand (gpm)
UNITY Park	1	9	47.7	45
Ivins Cemetery	1	2.5	13.25	12.5
City Office/	1	4	21.2	20
Red Mountain Elem	1	5	26.5	25
LDS Church Main Street	1	0.5	2.65	2.5
Rocky Vista University	1	2	10.6	10
Veterans Home	1	2	10.6	10
Vista School	1	2	10.6	10
LDS Church Center St.	1	0.5	2.65	2.5
Red Mountain Resort	1	4	21.2	20
Snow Canyon Medical	1	0.5	2.65	2.5
Residential Service Connections (see Fig. 8-1)	415	46.7*	156.45	234
Total	**426**	**78.7**	**326**	**394**

*Composite irrigated acreage which includes turf grass, shrubs, trees, etc. See Chapter 3. Demand on non-residential connections assumes all irrigation is turf grass.

Table 8-2
Phase 1 Recommended Project Schedule

Project ID	Project Year	Project Description	Unit Cost	Quantity	Total Estimated Cost (2017 Dollars)
P1-01	2019	Install approximately 12,000 feet of 18-inch pipe from Gunlock Pipeline to proposed storage tank site	$150.00	12,000	$1,800,000
P1-02	2019	Construct new 2 MG irrigation water storage facility	$1.00	2,000,000	$2,000,000
P1-03	2019	Install 1,100 feet of 24-inch pipe from new storage facility to 450 N	$175.00	1,100	$192,500
P1-04	2019	Install PRV at connection to Gunlock Pipeline	$60,000	1	60,000
P1-05	2020	Install 2,720 feet of 20-inch pipe along 200 W from 450 N to Center Street	$170.00	2,720	$462,400
P1-06	2020	Install 225 feet of 6-inch near intersection of 400 W and 200 N	$100.00	225	$22,500
P1-07	2020	Install 550 feet of 8-inch pipe along Center St. from 200 W to 270 W	$110.00	550	$60,500
P1-08	2020	Install 1,350 feet of 8-inch pipe along 400 W from 200 S to 400 S	$110.00	1,350	$148,500
P1-09	2020	Install 840 feet of 6-inch pipe along 400 S from 400 W to 300 W	$100.00	840	$84,000
P1-10	2020	Install 2,900 feet of 16-inch along Center St. from 200 W to 200 E	$165.00	2,900	$478,500
P1-11	2021	Install 1,250 feet of 6-inch pipe along 200 E from Center St. to 200 S	$100.00	1,250	$125,000
P1-12	2021	Install 1,450 feet of 6-inch pipe along 200 S from 200 E to 400 E	$100.00	1,450	$145,000
P1-13	2021	Install 2,100 feet of 8-inch pipe along 400 E from Center St. to 300 S and 250 feet of 4-inch pipe to connect to existing piping	$110.00	2,100	$231,000
P1-14	2021	Install PRV on Puerto Drive	$60,000	1	$60,000
M1-1	2019-2021	Meter Installation/Connection Cost	$1,500.00	426	$639,000
				Total	**$6,508,900**

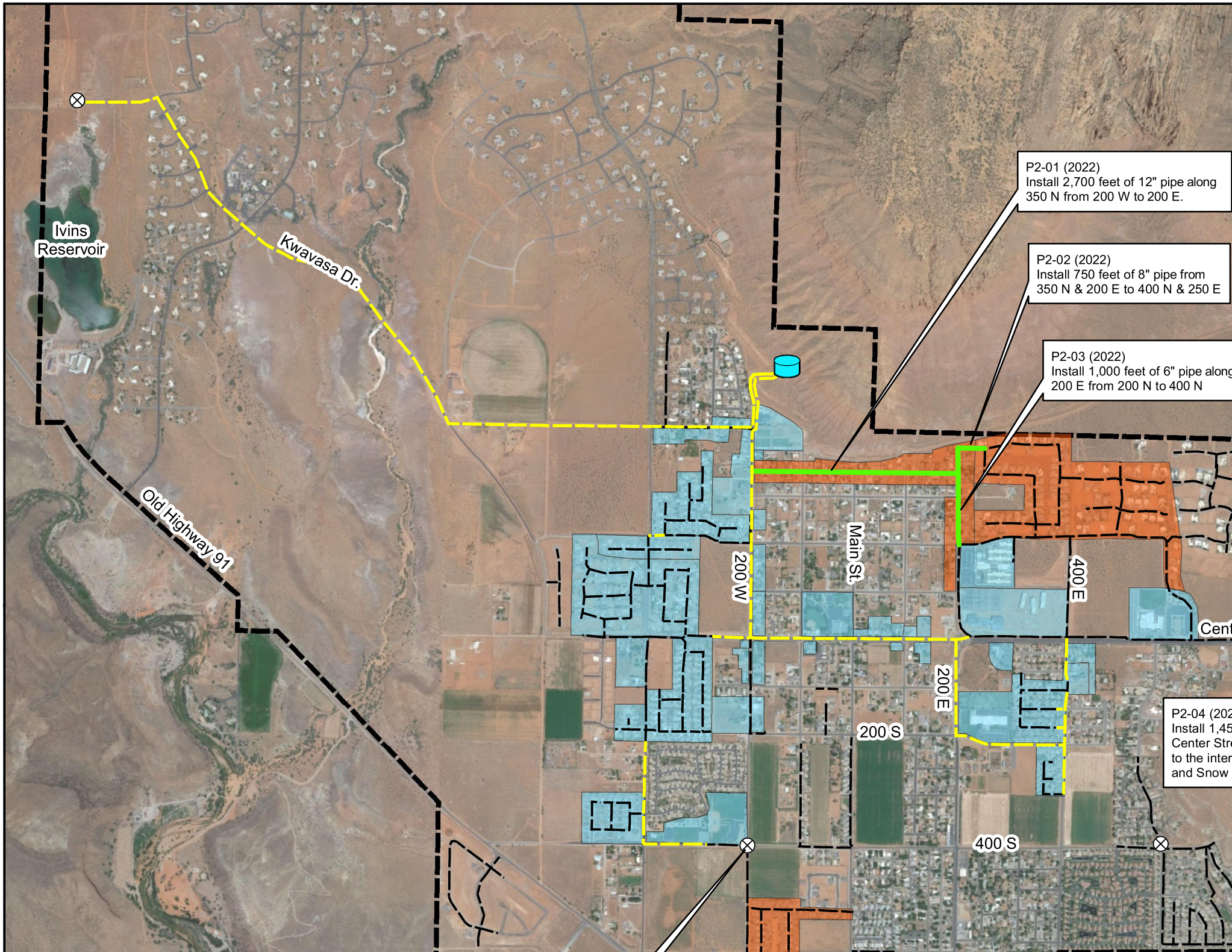
The improvement projects included in Phase 1 will connect the piping network to an extent beyond which water supply is available, but as additional water become available, these areas will be able to be put into service immediately.

Phase 2 (2023 – 2027)
Source: Remaining shares in irrigation companies, irrigation shares/well water from WCWCD
Irrigated Acres: 71 (150 total)
Supply Capacity: 217 AF
Required Storage: 353,000 gallons (746,000 gallons total)
Annual Demand: 238 AF (564 AF total)
Peak Day Demand: 355 gpm (749 gpm total)
Peak Hour Demand: 710 gpm (1,498 gpm total)

Phase 2 of the implementation plan, as shown in Figure 8-2, extends irrigation service to additional locations in the City. This phase extends secondary irrigation service to approximately 570 residential units. The source of water for this phase will come through a combination of the City's remaining irrigation shares and water provided by WCWCD from Gunlock. Phase 2 improvement projects and cost estimates are shown in Table 8-3.

Table 8-3
Phase 2 Recommended Project Schedule

Project ID	Project Year	Project Description	Unit Cost	Quantity	Total Estimated Cost (2017 Dollars)
P2-01	2022	Install 2,700 feet of 12-inch pipe along 350 N from 200 W to 200 E	$130.00	2,700	$351,000
P2-02	2022	Install 700 feet of 8-inch pipe from 350 N & 200 E to 400 N & 250 E	$110.00	750	$82,500
P2-03	2022	Install 1,000 feet of 6-inch pipe along 200 E from 200 N to 400 N	$100.00	1,000	$100,000
P2-04	2023	Install 1,450 feet of 12-inch pipe along Center St. from Painted Hills Dr. to the intersection of Tuachan Dr. and Snow Canyon Dr.	$150.00	1,450	$217,500
P2-05	2023	Install 50 feet of 2-inch pipe to loop existing piping	$60.00	50	$3,000
P2-06	2023	Install 150 feet of 6-inch pipe to connect existing piping in The Springs subdivision	$100.00	150	$15,000
P2-07	2023	Install PRV at 200 W and 400 S	$60,000	1	$60,000
M-2	2022-2023	Meter Installation/Connection Cost	$1,500	570	$855,000
				Total	**$1,684,000**


Ivins Reservoir
Kwavasa Dr.
Old Highway 91
P2-01 (2022)
Install 2,700 feet of 12" pipe along 350 N from 200 W to 200 E.
P2-02 (2022)
Install 750 feet of 8" pipe from 350 N & 200 E to 400 N & 250 E
P2-03 (2022)
Install 1,000 feet of 6" pipe along 200 E from 200 N to 400 N
200 W
Main St.
400 E
200 E
200 S
400 S
Cent
P2-04 (202
Install 1,45
Center Str
to the inter
and Snow

Phase 3 (2027+)
Source: St. George Reuse Water Facility/Dry Creek Reservoir or IIC Water Shares
Irrigated Acres: 44 (194 total)
Supply Capacity: Up to 2,700 AF from reservoir and/or 984 AF from IIC shares
Required Storage: 219,000 gallons **(**965,000 gallons total)
Annual Demand: 148 AF (712 AF total)
Peak Day Demand: 221 gpm (970 gpm total)
Peak Hour Demand: 442 gpm (1,940 gpm total)

Phase 3 continues the expansion of the system to additional areas of the City, providing water to approximately 500 residences in the City. The timing of Phase 3 will be driven by the availability of irrigation water to the City. The construction of Dry Creek Reservoir has the potential to provide Ivins City with enough irrigation water to meet its needs through full build-out. Based on current projections, Ivins could use as much as 2,700 acre-feet of reservoir storage at buildout. This quantity is based on the following assumptions:

- Secondary irrigation service is extended to the entirety of the proposed service area, which includes extending service into existing areas of the City that do not currently have dry irrigation lines in place.
- The reuse pipeline is currently at capacity during the irrigation season, meaning that the City needs to rely on reservoir capacity to meet irrigation demands (i.e. the reservoir is filled during the winter and drained during the irrigation season).

It is uncertain at this point how the reservoir will be funded. Ideally, the reservoir would be funded and managed by WCWCD, who could then sell allotments or "shares" of the reservoir capacity to Ivins and other users. If this option is not viable, the City could explore the option of going in on the project together with the City of St. George and/or City of Santa Clara. At an estimated cost of $17 million, it may not be feasible for Ivins to fund the project alone.

If the reservoir project is delayed or ultimately not constructed, the City will need to seek other sources of future irrigation water (which at this point in time are very limited, if not non-existent). The estimated construction cost for this phase is shown in Table 8-4.

In addition to the capital facilities projects shown in Table 8-4, the City will also need to budget for the purchase of water from the reuse facility. At a minimum, Ivins will need to pay for the operational costs for water treatment and conveyance (there are three pumps stations between the Reuse Facility and Ivins). The exact water purchase price will ultimately need to be negotiated with the City of St. George, but for planning purposes, it has been assumed that the purchase price for reuse water will be $1.30/1,000 gallons. **Based on this estimate, the annual water purchase price for Phase 3 for reuse water is $63,000/year (148 AF of reuse water).**

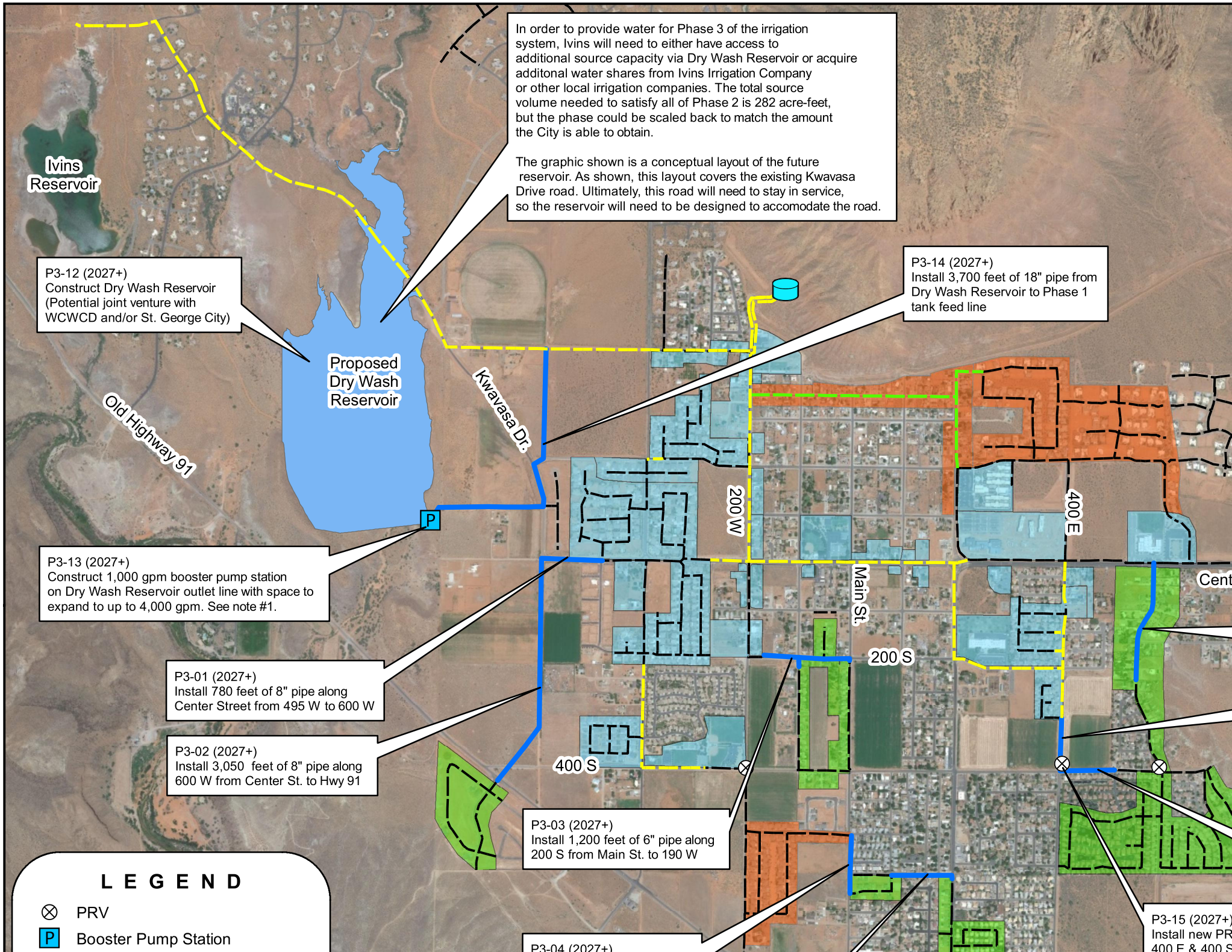

In order to provide water for Phase 3 of the irrigation system, Ivins will need to either have access to additional source capacity via Dry Wash Reservoir or acquire additonal water shares from Ivins Irrigation Company or other local irrigation companies. The total source volume needed to satisfy all of Phase 2 is 282 acre-feet, but the phase could be scaled back to match the amount the City is able to obtain.
The graphic shown is a conceptual layout of the future reservoir. As shown, this layout covers the existing Kwavasa Drive road. Ultimately, this road will need to stay in service, so the reservoir will need to be designed to accomodate the road.
Ivins Reservoir
P3-12 (2027+)
Construct Dry Wash Reservoir (Potential joint venture with WCWCD and/or St. George City)
Proposed Dry Wash Reservoir
Kwavasa Dr.
Old Highway 91
P3-14 (2027+)
Install 3,700 feet of 18" pipe from Dry Wash Reservoir to Phase 1 tank feed line
P
P3-13 (2027+)
Construct 1,000 gpm booster pump station on Dry Wash Reservoir outlet line with space to expand to up to 4,000 gpm. See note #1.
200 W
400 E
Main St.
200 S
400 S
P3-01 (2027+)
Install 780 feet of 8" pipe along Center Street from 495 W to 600 W
P3-02 (2027+)
Install 3,050 feet of 8" pipe along 600 W from Center St. to Hwy 91
P3-03 (2027+)
Install 1,200 feet of 6" pipe along 200 S from Main St. to 190 W
P3-15 (2027+)
LEGEND
PRV
Booster Pump Station

Table 8-4
Phase 3 Recommended Project Schedule

Project ID	Project Year	Project Description	Unit Cost	Quantity	Total Estimated Cost (2017 Dollars)
P3-01	2027+	Install 780 feet of 8-inch pipe along Center St. from 495 W to 600 W	$110.00	780	$85,800
P3-02	2027+	Install 3,050 feet of 8-inch pipe along 600 W from Center St. to Highway 91	$110.00	3,050	$335,500
P3-03	2027+	Install 1,200 feet of 6-inch pipe along 200 S from Main St. to 190 W	$100.00	1,200	$120,000
P3-04	2027+	Install 800 feet of 6-inch pipe along Main St. from 520 S to 650 S	$100.00	800	$80,000
P3-05	2027+	Install 800 feet of 6-inch pipe along 600 S from 75 E to 200 E	$100.00	800	$80,000
P3-06	2027+	Install 1,260 feet of 6-inch pipe along 200 E from 800 S to 1000 S	$100.00	1,260	$126,000
P3-07	2027+	Install 350 feet of 8-inch pie along 400 E from Desert Rose Ln. to Tuscany Dr. to connect existing piping	$110.00	350	$38,500
P3-08	2027+	Install 230 feet of 4-inch pipe along 400 E near 1100 S to connect existing piping	$90.00	230	$20,700
P3-09	2027+	Install 1,600 feet of 6-inch piping along S. Pierto Dr. from Center St. to 200 S	$100.00	1,600	$160,000
P3-10	2027+	Install 700 feet of 6-inch along 400 E from 300 S to 400 S	$100.00	700	$70,000
P3-11	2027+	Install 700 feet of 8-inch pipe along 400 S fom 400 E to 500 E	$110.00	700	$77,000
P3-12	2027+	*Construct Dry Wash Storage Reservoir**	*$17,000,000.00*	*1*	*$17,000,000*
P3-13	2027+	Construct 1,000 gpm Booster Pump Station on Dry Wash Reservoir	$1,500,000.00	1	$1,500,000
P3-14	2027+	Install 3,700 feet of 18” pipe from Dry Wash Reservoir to Phase 1 tank feed line	$150.00	3,700	$555,000
P3-15	2027+	Install PRV on 400 E & 400 S	$60,000	1	$60,000
M-3	2027+	Meter Installation/Connection Cost	$1,500	500	750,000
				Total	**$4,058,500**

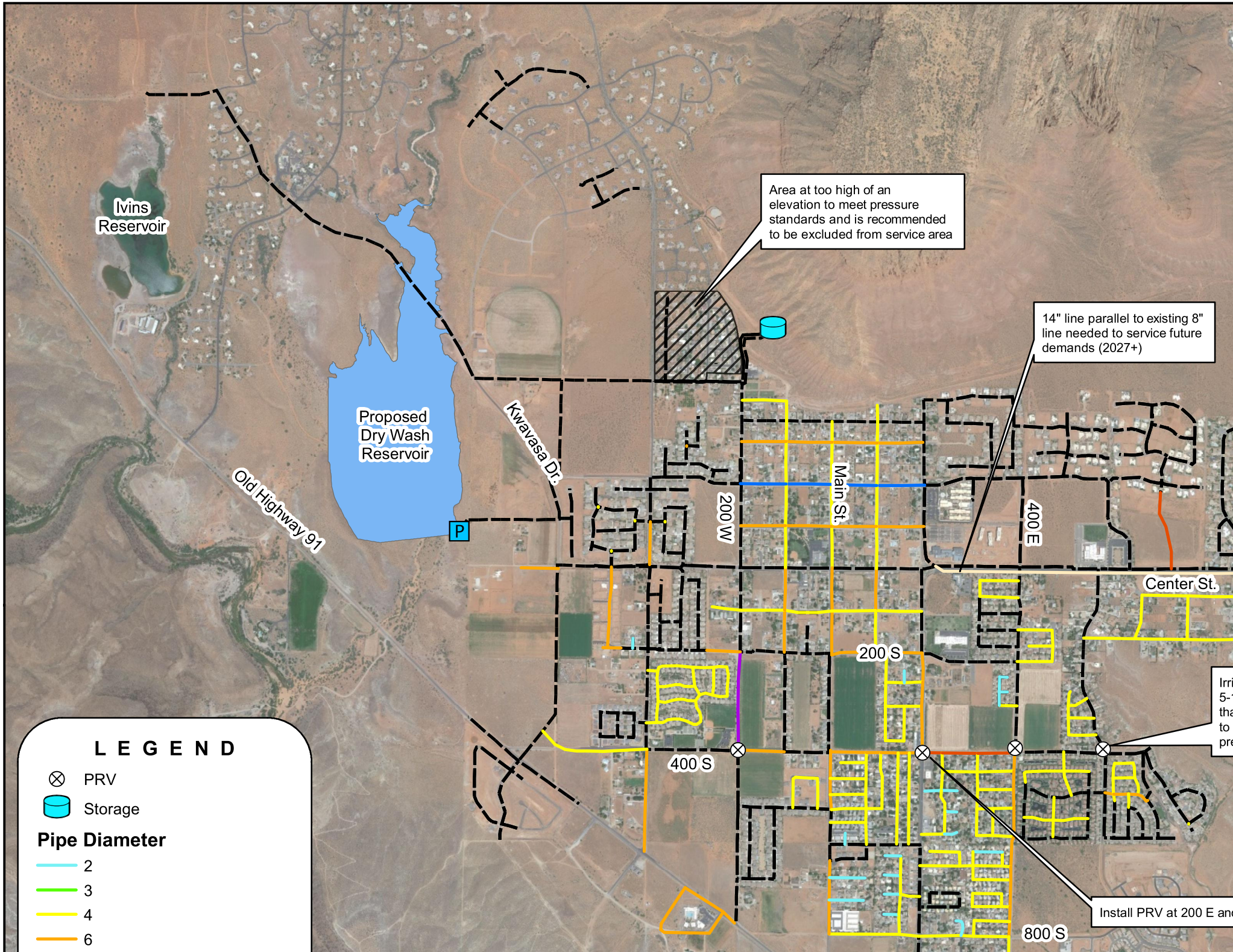
*It is uncertain at this time how Dry Creek Reservoir will be funded. It will likely be a multi-agency project including multiple cities and/or WCWCD

Phase 4 (2027+)
Source: St. George Reuse Water Facility/Dry Creek Reservoir or IIC Water Shares
Irrigated Acres: 143 (337 total)
Supply Capacity: Up to 2,700 AF from reservoir and/or 984 AF from IIC shares
Required Storage: 710,000 gallons (1,675,000 gallons total)
Annual Demand: 480 AF (1,192 AF total)
Peak Day Demand: 716 gpm (1,686 gpm total)
Peak Hour Demand: 1,433 gpm (3,373 gpm total)

Phase 4 encompasses the improvements required to extend service to the remainder of currently developed lots of the City. Figure 8-4 displays the location and size of the recommended system improvements, and Table 8-5 provides the estimated construction cost for capital projects. **The estimated annual purchase price for reuse water added with this phase is $204,000/year ($267,000/ year total).**

Table 8-5
Phase 4 Recommended Projects

Transmission and Distribution Improvements			
Diameter (in.)	**Length (ft)**	**Unit Cost**	**Total Estimated Cost (2017 Dollars)**
2	7,560	$70.00	$529,200
4	77,980	$90.00	$7,018,200
6	26,080	$100.00	$2,608,000
8	6,475	$110.00	$712,250
10	2,810	$120.00	$337,200
12	1,440	$130.00	$187,200
14	4,750	$160.00	$760,000
		Subtotal	**$12,152,050**
PRVs			
	Quantity	Unit Cost	Total Estimated Cost (2017 Dollars)
	2	$60,000	$120,000
Meter Installation			
	# Meters	Unit Price	Total Estimated Cost (2017 Dollars)
	1,420	$1,500.00	$2,130,000
		Total	**$14,402,050**


Ivins Reservoir
Proposed Dry Wash Reservoir
Old Highway 91
Kwavasa Dr.
P
Area at too high of an elevation to meet pressure standards and is recommended to be excluded from service area
14" line parallel to existing 8" line needed to service future demands (2027+)
200 W
Main St.
400 E
Center St.
200 S
400 S
800 S
Install PRV at 200 E and
LEGEND
PRV
Storage
Pipe Diameter
2
3
4
6

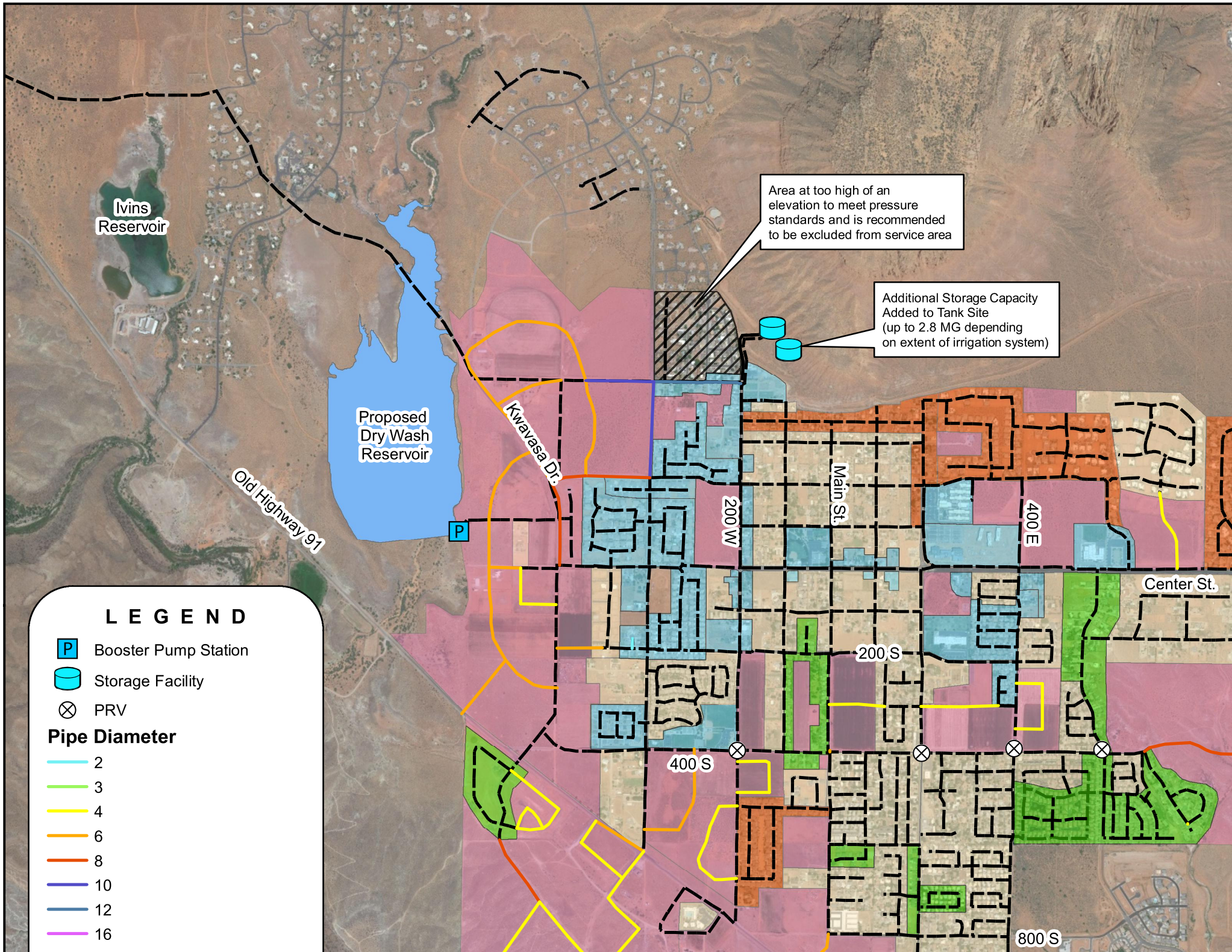
Phase 5 (2018-Buildout)
Source: St. George Reuse Water Facility/Dry Creek Reservoir or IIC Water Shares
Irrigated Acres: 960 acres (total)
Supply Capacity: Up to 2,700 AF from reservoir and/or 984 AF from IIC shares
Required Storage: 4,800,000 gallons (total storage)
Annual Demand: 3,216 AF (total demand)
Peak Day Demand: 4,810 gpm (total demand)
Peak Hour Demand: 9,620 gpm (total demand)

Phase 5 outlines the infrastructure needed to service the full build-out secondary irrigation system, and includes all projects needed to extend service to currently undeveloped parts of the City as well as infill areas in partially developed areas of Phases 1-4. **All Phase 5 pipelines under 6-inch diameter will be considered "project level" improvements (paid for by the developer), while all pipelines 8-inch and greater are "system level" improvements paid for by the City**. Phase 5 is open-ended in the sense that many of these projects will likely be completed prior to the completion of projects from previous phases. As the City continues to grow, so will the areas in which irrigation water can be used. Whether the irrigation water is used to service an existing or future user has the same demand-reducing effect on the culinary water system. In the end, the City has some flexibility as to how they expand the system, and as previously stated, many of the projects outlined in Phase 5 may be completed during Phases 1-4. Figure 8-5 displays the location and size of future irrigation pipes, and the summary of the cost of these projects is shown in Table 8-6. **Assuming that the water for the Ivins irrigation system will come from the St. George Reuse Facility, the estimated annual reuse water purchase price at buildout is $1.12 million/year.**

Table 8-6
Recommended Phase 5 Improvement Projects

Transmission and Distribution Projects			
Diameter (in)	**Length (ft)**	**Unit Cost**	**Total Construction Cost (2017 Dollars)**
2	146	$70.00	$10,205
4	20,193	$90.00	$1,817,361
6	33,105	$100.00	$3,310,512
8	5,555	$110.00	$611,021
10	2,410	$120.00	$289,252
12	1,285	$130.00	$167,073
		Subtotal	**$6,205,425**
Storage Facilities			
	Volume	Unit Cost	**Total Construction Cost (2017 Dollars)**
	2,800,000	$1.00	$2,800,000
		Total	**$9,005,425**

*Meters for new homes installed at the cost of developer


Ivins Reservoir
Area at too high of an elevation to meet pressure standards and is recommended to be excluded from service area
Additional Storage Capacity Added to Tank Site (up to 2.8 MG depending on extent of irrigation system)
Proposed Dry Wash Reservoir
Kwavasa Dr.
Old Highway 91
P
200 W
Main St.
400 E
Center St.
200 S
400 S
800 S
LEGEND
P Booster Pump Station
Storage Facility
PRV
Pipe Diameter
2
3
4
6
8
10
12
16

CHAPTER 9
10-YEAR CAPITAL FACILITIES PLAN

INTRODUCTION

In coordination with Ivins City staff, a Capital Facilities Plan has been developed to serve as a guideline for the budgeting and implementation of recommended system improvements over the next 10 years. The purpose of this chapter is to present recommendations regarding levels of funding for secondary irrigation system improvements through the 10-year planning window.

RECOMMENDED 10-YEAR CAPITAL FACILITIES PLAN

Chapter 8 of this report provides the recommended implementation plan for the City's secondary irrigation system, outlining the recommended phasing and timing of capital improvement projects. The 10-year capital facilities plan takes a closer look at the financing and timing of projects to occur within the next 10 years. Table 9-1 provides a detailed description of the recommended 10-year capital facilities plan. The capital facilities plan covers the cost of capital projects associated with the irrigation system.

As shown in Table 9-1, the total inflated cost of projects over the next 10 years is estimated to be approximately $8.8 million. Phase 1 and Phase 2 capital improvement projects are planned to take place over the next 5-6 years, with the following years being left open to rebuild reserve funds or continue funding additional improvements at the City's discretion. Costs shown in the table have assumed a 3% annual inflation rate.

Table 9-1
Recommended Capital Facilities Plan

Project Identifier	Project Description	Estimated Total Cost (2017 Dollars)	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
P1-01	Install approximately 12,000 feet of 18-inch pipe from Gunlock Pipeline to proposed storage tank site	$1,800,000	$250,000	$1,596,500			
P1-02	Construct new 2 MG irrigation water storage facility	$2,000,000		$2,122,000			
P1-03	Install 1,100 feet of 24-inch pipe from new storage facility to 450 N	$192,500		$204,000			
P1-04	Install New PRV/Vault at connection point to Gunlock Pipeline	$60,000	$61,800.00				
P1-05	Install 2,720 feet of 16-inch pipe along 200 W from 450 N to Center Street	$448,800			$490,000		
P1-06	Install 225 feet of 6-inch near intersection of 300 W and 200 N	$22,500			$25,000		
P1-07	Install 550 feet of 8-inch pipe along Center St. from 400 W to 495 W	$60,500			$66,000		
P1-08	Install 1,350 feet of 8-inch pipe along 400 W from 200 S to 400 S	$148,500			$162,000		
P1-09	Install 840 feet of 6-inch pipe along 400 S from 400 W to 300 W	$84,000			$92,000		
P1-10	Install 2,900 feet of 16-inch along Center St. from 200 W to 200 E	$478,500			$523,000		
P1-11	Install 1,250 feet of 6-inch pipe along 200 E from Center St. to 200 S	$125,000				$141,000	
P1-12	Install 1,450 feet of 6-inch pipe along 200 S from 200 E to 400 E	$145,000				$163,000	
P1-13	Install 2,100 feet of 8-inch along 400 E from Center St. to 300 S and 250 feet of 4-inch pipe to connect to existing piping	$231,000				$260,000	
P1-14	Install PRV on Puerto Dr.	$60,000			$66,000.00		
M-1	Phase 1 Meter Installation/Connection Cost	$639,000		$320,000	$379,000		
P2-01	Install 2,700 feet of 12-inch pipe along 350 N from 200 W to 200 E	$351,000					$407,000
P2-02	Install 700 feet of 8-inch pipe from 350 N & 200 E to 400 N & 250 E	$82,500					$96,000
P2-03	Install 1,000 feet of 6-inch pipe along 200 E from 200 N to 400 N	$100,000					$116,000
P2-04	Install 1,450 feet of 12-inch pipe along Center St. from Painted Hills Dr. to the intersection of Tuacahn Dr. and Snow Canyon Dr.	$217,500					
P2-05	Install 50 feet of 2-inch pipe to loop existing piping on Tuachan Dr.	$3,000					
	Install 150 feet of 6-inch pipe to connect existing piping in The						

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