PRESSURIZED IRRIGATION MASTER PLAN AND CAPITAL FACILITY PLAN

(HAL Project No.: 260.48.100)

DRAFT

March 2020

SPRINGVILLE CITY

PRESSURIZED IRRIGATION MASTER PLAN
AND CAPITAL FACILITIES PLAN

(HAL Project No.: 260.48.100)

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ABBREVIATIONS AND UNITS

ac	acre [area]
ac-ft	acre-foot (1 ac-ft = 325,851 gal) [volume]
CIP	Capital Improvement Plan
CFP	Capital Facilities Plan
CUWCD	Central Utah Water Conservancy District
CWP	Central Water Project
DBP	disinfection byproduct
EPA	U.S. Environmental Protection Agency
EPANET	EPA hydraulic network modeling software
ERC	Equivalent Residential Connection
ft	foot [length]
ft/s	feet per second [velocity]
gal	gallon [volume]
gpd	gallons per day [flow rate]
gpm	gallons per minute [flow rate]
HAL	Hansen, Allen & Luce, Inc.
hp	horsepower [power]
hr	hour [time]
IFA	Impact Fee Analysis
IFFP	Impact Fee Facilities Plan
in	inch [length]
irr-ac	irrigated acres
kgal	thousand gallons [volume]
kW	kilowatt [power]
kWh	kilowatt hour [energy]
MG	million gallons [volume]
mg/L	milligram per liter [concentration]
µg/L	microgram per liter [concentration]
mi	mile [length]
PI	Pressurized Irrigation
PRV	Pressure Reducing Valve
psi	pounds per square inch [pressure]
s	second [time]
SCADA	Supervisory Control And Data Acquisition
THM	trihalomethane
UV	ultraviolet radiation (disinfection method)
wsfu	water supply fixture unit
yr	year [time]

CHAPTER 1 INTRODUCTION

PURPOSE AND SCOPE

The purpose of this master plan is to provide direction to the City of Springville regarding decisions that will be made to provide an adequate pressurized irrigation (PI) water system for its customers at the most reasonable cost. Recommendations are based on demand data, growth projections, and standard engineering practices. The planning horizon for the master plan is approximately 2060. Buildout occurs beyond 2060 and refers to the time period when all parcels are developed within the annexation zone according to the current General Land Use Plan.

The master plan is a study of the City's PI water system and customer water use. The following topics are addressed herein: growth projections, source requirements, storage requirements, and distribution system requirements. Operational parameters for the City's PI water system were reviewed and optimized based on stability, ease of use, and cost. Based on this study, needed capital improvements have been identified and conceptual-level cost estimates for the recommended improvements have been provided. The master plan includes a Capital Facility Plan (CFP) to identify the PI facilities that are required to meet the demands placed on the system by future development for the 10-year and 20-year planning period.

The results of the study are limited by the accuracy of growth projections, data provided by the City, and other assumptions used in preparing the study. It is expected that the City will review and update this master plan every 5–10 years as new information about development, system performance, or water use becomes available.

BACKGROUND

Springville was originally settled in 1850 and had an estimated population of 33,294 in July 2017 (United States Census Bureau, 2017). It is located in central Utah County and has an area of 14.4 square miles. As a result of its location along the I-15 corridor and in the rapidly growing Provo-Orem metropolitan area, Springville is experiencing rapid growth and is expected to grow into the future. See population estimates in Figure 1-1. In 2011, Springville obtained nine million dollars of federal funding to build its PI system to service residents and businesses west of the railroad. By the end of 2018, the City provided PI water service to 825 connections. However, as the PI system was not available until approximately 2014, some sources (Daily Herald article: 1,566 possible connections in 2015) estimate there being nearly as many potential connections as existing connections.

The City maintains a PI water system for outdoor use in the newer, western portion of the City, approximately west of 400 West (see Figure 1-2). The drinking water system meets both indoor and outdoor demands in the portions of the system east of 400 West, and for some customers physically located in the PI system area that have not connected to the PI system yet. The drinking water system is addressed in a separate master plan.

In 2014, the City prepared a Capital Facilities Plan, Impact Fee Facilities Plan (IFFP), and Impact Fee Analysis (IFA) for its drinking and PI water systems. This master plan will provide the bases for updating those studies and provide a basic full system layout design to guide new development.

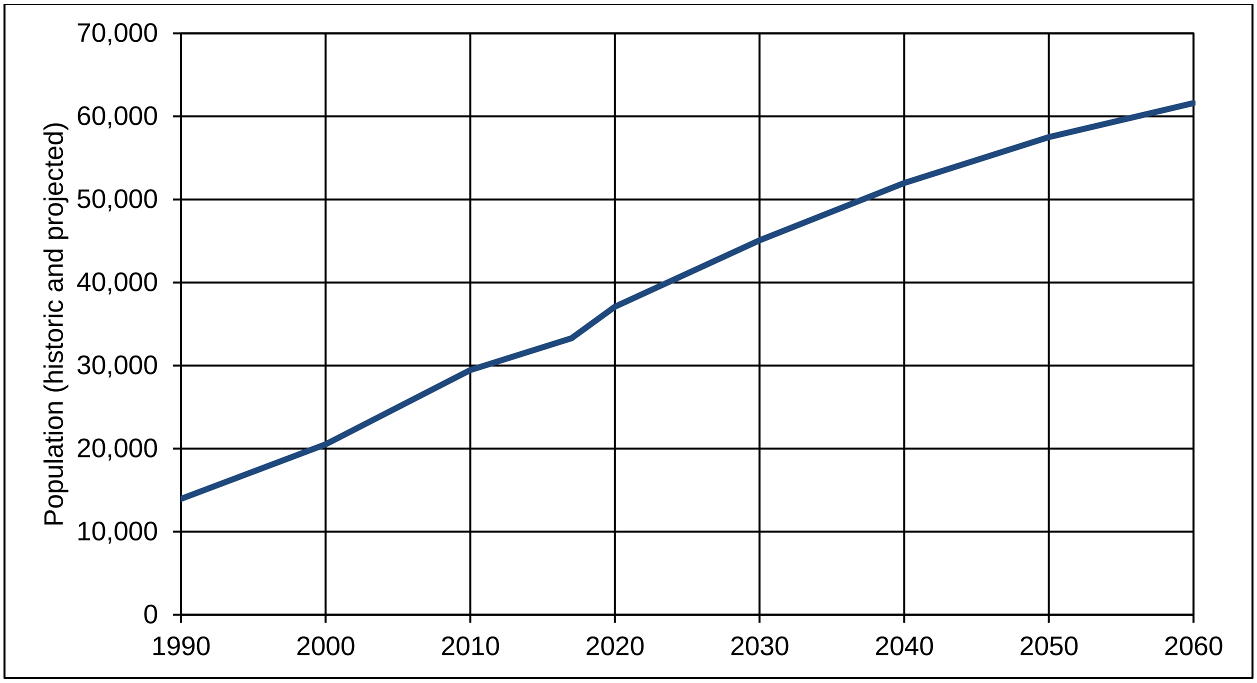

Figure 1-1: Springville Historic and Projected Population
(U.S. Census Bureau 1990, 2000; GOMB 2017)

The system is serviced by Bartholomew Pond which is supplied by canyon water, and the North and South Springs. The existing PI water system includes a 36-inch transmission pipeline from the PI sources and pond approximately 3 miles long followed by a 30-inch diameter transmission pipeline for approximately another half a mile. The existing distribution system contains approximately 36 miles of wet pipe (currently in use) with diameters of 4 to 24 inches with another approximately 13 miles of pipe disconnected to the system. The current PI system has one pressure zone. The City recognizes that its continued growth necessitates proactively planning additional PI water facilities to maintain the current level of service for outdoor water use.

MASTER PLANNING METHODOLOGY

PI water systems consist of water sources, storage facilities, distribution pipes, pump stations, and other components. Design and operation of the individual components must be coordinated so that they operate efficiently under a range of demands and conditions. The system must be capable of responding to daily variations in demand.

Identifying present and future water system needs is essential in the management and planning of a water system. For this study, existing water demands are based on billing data and the level of service established by the City. The report addresses water sources, storage, distribution, minimum pressures, hydraulic modeling, capital improvements, and other topics pertinent to Springville's PI water system.

Computer models of the City's PI water system were prepared to simulate the performance of facilities under existing and future conditions. System improvement recommendations were prepared from the analysis and are presented in this report.

LEVEL OF SERVICE

To propose a level of service for the secondary water system, HAL analyzed production and billing data provided by Springville City for the previous three years. Once water production and demand patterns were well understood, HAL and the City met to discuss an appropriate level of service considering the water use data, variability and uncertainty within this data, standard engineering practices, and anticipated future conservation. The City ultimately selected a level of service which is below current usage, but which is sufficient for landscape irrigation including losses and inefficiencies. The City anticipates that water use will decrease as it continues to promote conservation. A summary of the level of service selected by the City is included in Table 1-1.

Table 1-1
System Level of Service

Criteria	Level of Service Per Irrigated Acre
Average Yearly Demand	4.0 ac-ft
Peak Day Demand	8.5 gpm
Peak Instantaneous Demand	17.0 gpm
Storage	6,120 gal

The level of service provides 0.15 irrigated acres for each single-family lot ¼-acre or larger.

DESIGN AND PERFORMANCE CRITERIA

Summaries of the key design criteria and demand requirements for the PI water system are included in Table 1-2. The design criteria were used in evaluating system performance and in recommending future improvements. Criteria development is described in later chapters.

Table 1-2
Key System Design Criteria

	Criteria	Existing Requirements	Estimated Requirements		
			10-year	20-year	2060
Acreage Irrigated by PI System	Existing and Planned Irrigated acreage	434.0	642	835	991
Source					
Peak Day Demand	Level of Service	3,689 gpm	5,457 gpm	7,098 gpm	8,424 gpm
Average Yearly Demand	Level of Service	1,736 acre-ft	2,568 ac-ft	3,340 ac-ft	3,964 ac-ft
Storage	Level of Service	8.2 ac-ft	12.1 ac-ft	15.7 ac-ft	18.6 ac-ft
Distribution					
Peak Instantaneous	2.0 × Pk Day demand	7,378 gpm	10,900 gpm	14,200 gpm	16,800 gpm
Max. Operating Pressure	Level of Service	125 psi	125 psi	125 psi	125 psi
Min. Operating Pressure	Level of Service	50 psi	50 psi	50 psi	50 psi

CHAPTER 2 IRRIGATED ACREAGE

EXISTING IRRIGATED ACREAGE

Outdoor water demands are based on irrigated acreage (irr-ac). The existing irrigated acreage was analyzed using a remote sensing approach. The 2016 dataset that was used for this approach was the National Agricultural Imagery Program (NAIP) which is available through the Utah Automated Geographic Reference Center (AGRC). This imagery data allows for the identification of areas with healthy vegetation growth. Areas that received their water from other sources were subtracted out of the dataset to only include areas irrigated by the City's PI water system. The estimated area irrigated by the PI system in 2018 based on billing and imagery analysis totals approximately 138 acres. The potential area irrigated by the PI system based on the imagery and billing data if the customers were irrigating the full level of service irrigated area is approximately 286 acres. An estimated 434 acres could be irrigable by the PI system at the full level of service if including those currently connected to dry pipes. The City's irrigated acreage was then converted to demands and storage requirements based on the level of service established by the City. For typical single-family residential developments, irrigable acreage was calculated to be 28% of land being developed. Based on the remote sensing approach described above, the City's existing irrigated acreage totals approximately 137.7 acres.

Aerial imagery of Springville was used to analyze the percent of land irrigated in each of its zoning districts. Results from this analysis were used to forecast future irrigated acreage in currently undeveloped areas, assuming that they will develop similar to existing areas. Table 2-1 provides the average percentage of the lot that is typically irrigated, based on the data for Springville City.

Table 2-1
Irrigation Factors by Land Use Type

Land Use	Percent Irrigation Factor*
Agriculture (Assumed Future Residential/Mixed Use)	27%
Commercial	13%
Commercial / Residential Option	27%
Industrial Manufacturing	10%
Low-Density Residential	42%
Medium Density Residential	27%
Medium-High Density Residential	27%
Medium-Low Density Residential	35%
Medium-Low Density Residential / Commercial	27%
Mixed Use	25%
Parks	90%

* Based on existing development in Springville

FUTURE IRRIGATED ACREAGE

Future irrigated acreage was calculated by starting with the existing irrigated acreage and adding the area of additional land that is expected to be irrigated by the PI system by 2060. 2060 projections were based on the future land use plans. As described above, for each planned land use, an irrigation factor was calculated from the existing land use. The City selected a level of service to allow low density residential properties to irrigate 60 percent of their lot (0.15 irrigated acres per 0.25 acre lot). 42% of gross area was used to account for 30% of a development being streets. Table 2-1 presents the level of service irrigation factors used for each land use type.

Based on the future land use plan and the irrigation factors shown in Table 2-1, total 2060 irrigated acreage was calculated to be 947.2 acres. The acreage irrigated by the PI system in 2018 was calculated to be 137.7 acres; however, it was estimated that the drinking water system is used to irrigate 148.8 irrigated acres which could be irrigated by the PI system as well as an additional 147.5 acres that are adjacent to a PI pipeline that is planned to be in service within the next 10 years. These acres were added to the 2018 acreage irrigated by the PI system, for a total of 434.0 acres. It is recommended that all existing customers without a meter have a meter installed and all customers be billed for use with a tiered rate to conserve within the City's level of service.

GROWTH PROJECTIONS

The development of impact fees requires growth projections over the next ten years. In addition to impact fee projects this report will also highlight anticipated projects 10-20 years out in the Capital Facilities Plan section of this report. Growth projections for Springville were made as part of the City's strategic, general, and master planning efforts by HAL.

Growth rates were determined by establishing the areas that would be irrigated by the PI system for the existing, 10-year, 20-year, and 2060 horizons. The acreage that could be served by the PI system if they connected today and the acreage that is adjacent to dry PI pipes was added to the existing irrigated acreage. A best fit line was drawn through these four points and values were calculated for intermediate years. The projected irrigated acreages for each year from 2018 through 2060 can be found in Table 2-2.

Table 2-2

Growth Projections and Projected Irrigated Acreage

Year	Total Projected Irrigated Acres	Annual Growth
2018	434	-
2019	453	4.3%
2020	472	4.3%
2021	491	3.9%
2022	510	3.9%
2023	530	3.9%
2024	550	3.9%
2025	572	3.9%
2026	594	3.9%
2027	618	3.9%
2028	642	3.9%
2029	662	3.1%
2030	682	3.1%
2031	700	2.6%
2032	718	2.6%
2033	736	2.5%
2034	755	2.6%
2035	774	2.6%
2036	794	2.5%
2037	814	2.6%
2038	835	2.6%
2039	846	1.3%
2040	857	1.3%
2041	865	0.9%
2042	872	0.9%
2043	880	0.9%
2044	888	0.9%
2045	896	0.9%
2046	904	0.9%
2047	912	0.9%
2048	920	0.9%
2049	929	0.9%
2050	937	0.9%
2051	942	0.6%
2052	947	0.6%
2053	953	0.6%
2054	958	0.6%
2055	964	0.6%
2056	969	0.6%
2057	974	0.6%
2058	980	0.6%
2059	985	0.6%
2060	991	0.6%

CHAPTER 3 WATER SOURCES

Water sources need to be available to supply the PI system with enough volume of water for the entire irrigation season and to supply the PI system with enough volume of water to meet demands on the day of greatest water use. The PI water source requirements are based on irrigated acres. Though existing and 2060 irrigated acreage was calculated based on the percent irrigated for each land use, it is recommended that irrigation requirements for new development be calculated based on the amount of irrigated acreage proposed rather than on housing units or the percent irrigated for each land use type presented in Table 2-1.

EXISTING WATER SOURCES

The Springville City PI water system is supplied by water from Hobble Creek through the Highline Ditch and Springville Irrigation Ditch #1 (see Figure 1-2). The PI system is also supplied by water from Strawberry Reservoir (Strawberry water) through the Mapleton- Springville Strawberry Pipeline (see Figure 1-2). Burt Springs can supply water to the PI system when not being used in the drinking water system, but for this study it is considered a drinking water source. For planning purposes, the City has requested that the analysis consider the lowest flows on record as the reliable supply to plan for low water years. The flows from City owned PI sources presented in Table 3-1 represent water available in a 25-year low flow year. Minor water sources that cannot be relied on in a 25-year low flow year such as Bartholomew Pond Springs are not included in Table 3-1. It is important to note that capacity requires both the physical water and the water rights to be able to provide to the customer. Water rights are discussed in Chapter 6.

Table 3-1
Existing Pressurized Irrigation System Water Sources

Source	Flow Capacity (gpm)*	Flow Capacity (cfs)	Annual Capacity (ac-ft)*
Hobble Creek/ Highline Ditch	2,245	5	500
Springville Irrigation Ditch #1	0**	0*	5,000
Mapleton-Springville Strawberry Pipeline	5,835	13	1,600
Total	**8,080**	**18**	**7,100**

* Denotes physical facility capacity. See Chapter 6 for water rights capacity.
** Ditch #1 provides an important supply of water, but is typically dry by the time peak day demand occurs. As such, its peak day capacity was assumed to be 0.

EXISTING WATER SOURCE REQUIREMENTS

Existing Peak Day Demand

Peak day demand is the water demand on the day of the year with the highest water use. It is used to determine required source capacity under existing and future conditions. Since the drinking water system provides water for indoor use, only outdoor demand is allocated to the PI system.

Outdoor peak day demand was calculated based on a level of service of 8.5 gpm/irr-ac. Under existing conditions, the City serves about 138 irr-ac. Another approximately 149 irrigated acres are adjacent to a wet PI pipeline that could service the area if the property was connected to the PI system. Another approximately 99 irrigated acres are near dry PI pipelines that could be served by the PI system once a source is connected. Another 48 acres was added to adjust the existing measured acreage to the full level of service. This brings the total existing potential irrigated area to 434.0 acres. Per the City's level of service, the peak day PI water demand for 434 irr-ac is 3,689 gpm. It is recommended that the City consider revisions to their tiered rate schedule which will promote conservation and keep water use in line with the City's level of service. Table 3-2 is a summary the existing PI peak day water demands, peak day source capacity, and surplus.

Table 3-2
Existing PI Peak Day Water Demand
and Source Capacity

Parameter	Peak Day (gpm)
Demand	3,689
Capacity*	8,080
Surplus	**4,491**

* Denotes physical facility capacity. See Chapter 6 for water rights capacity.

Existing Average Yearly Demand

Average yearly demand is the volume of water used during an entire year, and is used to ensure the sources have enough annual volume to meet demand under existing and future conditions. Since the drinking water system provides water for indoor use, only outdoor demand in the PI system service area is allocated to the PI system. Average yearly demand was determined based on irrigated acreage and a level of service of 4.0 ac-ft/irr-ac.

Based on the existing irrigated acreage of 137.7, Springville's average yearly PI water demand is 550.8 ac-ft. Based on the potential existing irrigated acreage of 434.0, Springville's average yearly PI water requirement is 1,736 ac-ft. Table 3-3 is a summary the existing PI average yearly water demands, average yearly source capacity, and surplus.

Table 3-3
Existing PI Average Yearly Water Demand
and Source Capacity

Parameter	Average Yearly (ac-ft)
Demand	1,736
Capacity*	7,100
Surplus	**5,364**

* Denotes physical facility capacity. See Chapter 6 for water rights capacity.

FUTURE WATER SOURCE REQUIREMENTS

As with existing water source requirements, future water source requirements were evaluated on two criteria. First, sufficient water source capacity is needed to meet peak day flow. Second, the water sources must also be capable of supplying the average yearly demand.

Future Peak Day Demand

Following the methodology described for existing conditions and the City's selected level of service, projected irrigated acres and peak day demand was projected for 10 years, 20 years, and for the year 2060. Table 3-4 is a summary the future PI peak day water demands, peak day source capacity, and surplus.

Table 3-4
Future PI Peak Day Water Demand and Source Capacity

Time	Projected Irrigated Acres	Peak Day Demand (gpm)	Peak Day Capacity* (gpm)	Surplus/ Deficit (gpm)
10-years	642	5,457	8,080	2,623
20-years	835	7,098	8,080	983
2060	991	8,424	8,080	-344

* Denotes physical facility capacity. See Chapter 6 for water rights capacity.

Future Average Yearly Demand

Following the methodology described for existing conditions and the City's selected level of service, projected irrigated acres and average yearly demand was projected for 10 years, 20 years, and for the year 2060. Table 3-5 is a summary the future PI average yearly water demands, average yearly source capacity, and surplus.

Table 3-5
Future PI Average Day Water Demand and Source Capacity

Time	Projected Irrigated Acres	Average Yearly Demand (ac-ft)	Average Yearly Capacity* (ac-ft)	Surplus (ac-ft)
10-years	642	2,568	7,100	4,532
20-years	835	3,340	7,100	3,760
2060	991	3,964	7,100	3,136

* Denotes physical facility capacity. See Chapter 6 for water rights capacity.

WATER SOURCE RECOMMENDATIONS

As indicated in Tables 3-3 and 3-4, the City has a surplus average yearly PI source capacity through 2060 if all sources continue to remain available and to produce as they have in the past.

Peak day source capacity will be bolstered with the addition of ULS water as a supply. However, possible changes in water rights currently being adjudicated, transfer of water rights to the drinking water system, climate change, or other unforeseen circumstances could make it necessary to plan for additional water sources for the PI system much earlier than 2060. It is recommended that the City aggressively promote conservation, potentially within its tiered rate structure. The following is a list of potential water sources for the PI system. Locations are shown on Figure 3-1. These projects are not included in the capital improvement plan in this master plan because they are not projected to be needed within the next 20 years, but should be considered and pursued as resources allow and as they make sense.

- ULS Water – Springville City is obligated to purchase 4,945 ac-ft of Utah Lake Drainage Basin Water Delivery System of the Bonneville Unit of the Central Utah Project (ULS) water through a petition agreement between Central Utah Water Conservancy District (CUWCD) and South Utah Valley Municipal Water Association (SUVMWA). This is the amount remaining after the 1,500 ac-ft given back in order to fund the construction of the pressurized irrigation system. The pipeline to Springville is complete and the pipeline to the remaining SUVMWA cities could be completed as soon as 2025 at which time the City may be obligated to start paying for the pipeline. It is recommended that the City start planning for the payment and the use of the water. The City could delay payment per the terms of the agreement or look into the possibility of leasing this water to another water system. More detail on the ULS water is discussed in Chapter 6. The source capacity equates to a flow rate of at least 6,000 gpm.

- Piping the Highline Ditch – Piping the Highline Ditch would allow more efficient conveyance of Hobble Creek water to the PI system, especially in the high runoff season in the spring. This would also allow the City to save Strawberry water for use later in the irrigation season. No pumping would be required. Source capacity could be increased by as much as 1,300 gpm. However, the possibility of moving Hobble Creek water rights up to Bartholomew Springs to use in the drinking water system should be pursued first.

- Dry Creek Pump Station – Hobble Creek, Strawberry, underground drains, Fulmer Springs, Big Hollow Irrigation, Wash Creek, and Roundy Spring can all be diverted from Dry Creek. Also, a land owner in the Dry Creek area has a water right to use a portion of Spanish Fork City's wastewater effluent which is discharged into Dry Creek. Source capacity could be increased by as much as 2,000 gpm.

- Swenson Pump Station – Hobble Creek, Strawberry, Highline, Wheeler Springs can be pumped into the PI system at this location. Source capacity could be increased by as much as 3,000 gpm.

- Packard Pump Station – Coffman Springs, Wood Springs, Hobble Creek, and underground drains can be pumped into the PI system at this location. Source capacity could be increased by as much as 900 gpm.

- Reuse of Effluent – The City does not deplete all of its water rights because the City returns excess water to Hobble Creek through the effluent of the wastewater treatment plant. Using the excess water the City has the right to use, however, may be a costly and complicated process. The water would need to be pumped into the PI system adding additional ongoing cost. Developing other new sources of water first is recommended.

CHAPTER 4 WATER STORAGE

EXISTING WATER STORAGE

The purpose of water storage within the PI water system is to provide equalization for when peak demand exceeds the source supply and to provide operational redundancy. The City's existing PI water system includes one irrigation pond with a total capacity of 32 ac-ft (HAL 2014b, 2-7). The location of the existing pond is shown on Figure 1-2. The City is interested in maintaining a pond level fluctuation of between 4-6 feet to reduce the vegetation and improve water quality. Based on the design plans and stage-storage curve provided by the City, a six-foot drawdown would be approximately 17.1 acre-feet of storage. See Table 4-1.

Table 4-1
Existing Storage Capacity

Pond	Capacity (ac-ft)
Bartholomew Pond – total	32
Bartholomew Pond – 6 feet fluctuation	17.1

EXISTING WATER STORAGE REQUIREMENTS

Existing equalization storage requirements were based on irrigated acreage and the level of service of 6,120 gallons per irr-ac. Therefore, under existing conditions, with an existing irrigated acreage of 434.0 acres, the required storage is 8.2 ac-ft. A breakdown of the required equalization storage is shown in Table 4-2.

Table 4-2
Existing Storage Requirements

Irrigated Acreage	Storage Requirement (ac-ft)	Existing Capacity (ac-ft)	Surplus (ac-ft)
434.0	8.2	17.1	11.7

FUTURE WATER STORAGE REQUIREMENTS

Table 4-3 presents the 10-year, 20-year, and 2060 irrigation storage requirements based on irrigated acreage projections.

Table 4-3
Future Storage Requirements

Time	Irrigated Acreage	Storage Requirement (ac-ft)	Existing Capacity (ac-ft)	Deficiency (-) or Surplus (+) (ac-ft)
10-Years	642	12.1	17.1	+5.0
20-Years	835	15.7	17.1	+1.4
2060	991	18.6	17.1	-1.5

WATER STORAGE RECOMMENDATIONS

Based on the growth projections, level of service, pond stage-storage curve, and maximum pond drawdown assumptions, almost enough storage is already available to maintain the pond within 6 feet of full levels at 2060. Increasing the daily pond level fluctuations to 7.0 feet would increase the storage volume to 19.3 acre-feet. Another 1.0 feet would likely not affect recreation at the pond even during peak PI system usage hours. Utilizing the pond more would also reduce spillage from Bartholomew Springs.

An option beyond 2060 would be to create a separate pressure zone served by a new irrigation pond at an elevation of approximately 4730 feet. It could be supplied by new pumped water sources at lower elevations in the system, which would to reduce energy expenditures.

No storage projects are included in the capital improvement plan in this master plan because no additional storage is projected to be needed within the next 20 years.

CHAPTER 5 WATER DISTRIBUTION

PEAK WATER DISTRIBUTION SYSTEM DEMANDS

Springville's PI water distribution system consists of all pipelines, valves, fittings, and other appurtenances used to convey water from sources and storage to water users. The existing water system contains approximately 36 mi of wet pipelines (in use) with diameters of 6 to 36 inches with another approximately 13 miles of dry pipelines disconnected to the system. The PI system has one pressure zone (see Figure 1-2).

Existing Peak Instantaneous Demand

Peak instantaneous demand was calculated based on irrigated acreage and the level of service defined by analysis of usage data. The selected level of service was 17.0 gpm per irrigated acre; therefore, the total peak instantaneous is 3,689 gpm under existing conditions. This includes the 138 acres currently irrigated by the PI system, the 149 acres that could be connected to the PI system, the 99 acres adjacent to dry PI pipelines, and the 48 acres to adjust the existing measured acreage to the full level of service.

Future Peak Instantaneous Demand

Future peak instantaneous demand at 2060 was calculated based on the same level of service as defined for existing conditions. The total future irrigated acreage estimated at 2060 is 991 acres. Therefore, the future peak instantaneous demand was calculated as 16,800 gpm.

HYDRAULIC MODEL

Development

A computer model of the City's PI water distribution system was developed to analyze the performance of the existing and future distribution system and to prepare solutions for existing facilities not meeting the distribution system requirements. The model was developed with the software EPANET 2.0, published by the U.S. Environmental Protection Agency (EPA 2014; Rossman 2000). EPANET simulates the hydraulic behavior of pipe networks. Sources, pipes, tanks, valves, controls, and other data used to develop the model were obtained from GIS data of the city's PI water system and other updated information supplied by the City.

HAL developed models for two phases of PI water system development. The first phase was a model representing the existing system (existing model). This model was used to calibrate the model and identify deficiencies in the existing system. The second phase was a model representing future conditions and the improvements necessary to accommodate growth (future model).

Model Components

The two basic elements of the model are pipes and nodes. A pipe is described by its inside diameter, length, minor friction loss factors, and a roughness value associated with friction head losses. A pipe can contain elbows, bends, valves, pumps, and other operational elements. Nodes are the endpoints of a pipe and can be categorized as junction nodes or boundary nodes. A junction node is a point where two or more pipes meet, where a change in pipe diameter occurs, or where flow is added (source) or removed (demand). A boundary node is a point where the hydraulic grade is known (a reservoir, tank, or PRV). Other components include tanks, reservoirs, pumps, valves, and controls.

The model is not an exact replica of the actual water system. Pipeline locations used in the model are approximate and not every pipeline may be included in the model, although efforts were made to make the model as complete and accurate as possible. Moreover, it is not necessary to include all of the distribution system pipes in the model to accurately simulate its performance.

Pipe Network

The pipe network layout originated from GIS data provided by the City. HAL verified its accuracy by reviewing maps and drawings provided by the City, as well as a model prepared for the previous master plan. Elevation information was obtained from AGRC 0.5 Meter 2013-2014 LiDAR Data. Hazen-Williams roughness coefficients for pipes in this model ranged from 130 - 150, which is typical for these pipe materials in EPANET (Rossman 2000, 31).

Water Demands

Water demands were allocated in the model based on billing data and billing address. The average yearly demand was determined for each billing address, and then the billing addresses were geocoded in order to link the demands to a physical location. The geocoded demands were then assigned to the closest model node. This represented average daily demands, which were then scaled to reach the peak day demand determined in Chapter 3. Future demand was assigned to nodes in the future model which best represented the location of anticipated development.

The pattern of water demand over a 24 hour period is called the diurnal curve or daily demand curve. HAL developed a diurnal curve for peak day conditions using SCADA data and a peak factor of 2.0 (the ratio of peak instantaneous demand to peak day average demand). The diurnal curve used in this study is presented in Figure 5-1. The diurnal curve was input into the model to simulate changes in the water system throughout the day.

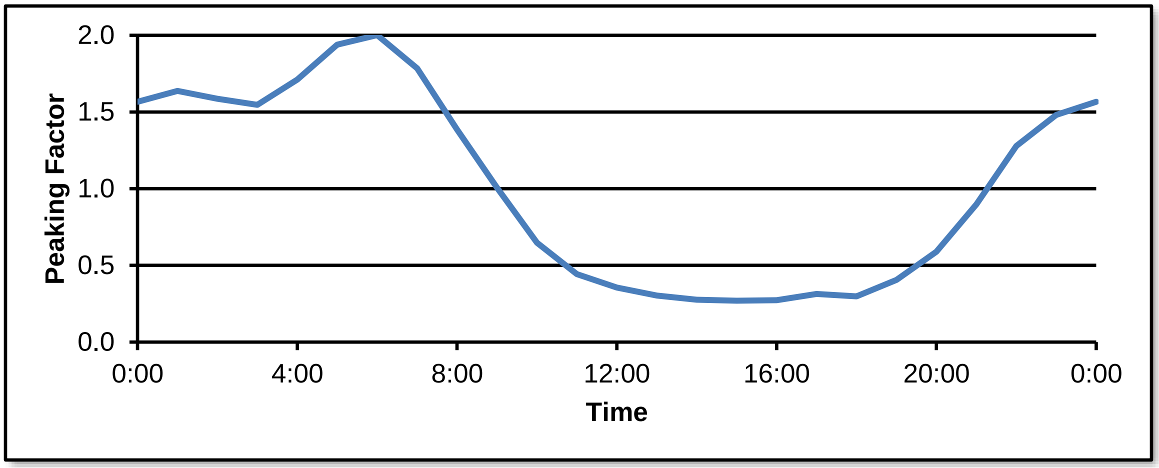

Figure 5-1: Springville Diurnal Curve

In summary, the spatial distribution of demands followed geocoded water use data; the flow and volume of demands followed the level of service described in Chapter 3; and the temporal pattern of demand followed a diurnal curve developed from SCADA data.

Water Sources and Storage Pond

The existing sources include water provided by Springville's existing shares in Springville Irrigation Company. The main two diversion locations include the "City Diversion" which is located on Hobble Creek a short distance above the existing debris basin and the Mapleton/Springville Lateral which connects to the 36" main pipeline out of the pond. The pond location, elevation, and volume are represented in the model. The extended-period model predicts water levels in the pond as they fill from sources and as they empty to meet demand in the system.

ANALYSIS METHODOLOGY

HAL used the extended-period model to analyze the performance of the water system with current and projected future demands. An extended-period model represents system behavior over a period of time: pond filling and draining, pressures fluctuating, and flows shifting in response to demands. The model was used to analyze flow conditions, controls, operation, and performance. Recommendations for existing and future conditions were checked with the extended-period model to confirm adequacy.

Two extreme operating conditions analyzed with the model were static conditions and peak instantaneous conditions. Peak day plus fire flow conditions was not analyzed as water for fire flow will come from the drinking water system. Each of these conditions is a worst-case situation so the performance of the distribution system may be analyzed for compliance with City requirements. Each operating condition is discussed in more detail below.

Static Conditions

Low-flow or static conditions are usually the worst case for high pressures in a PI water distribution system. Before the evening irrigation begins, storage is typically nearly full, and movement of water through the system is minimal. Under these conditions, the system approaches a static condition where water pressures are dictated only by elevation differences and pressure-regulating devices. This high-pressure condition was simulated with the model to analyze the system's existing and future conformance to pressure requirements.

Peak Instantaneous Demand Conditions

Peak instantaneous demand conditions are the worst-case for low pressures in a PI water distribution system. The PI water system reaches peak instantaneous demand conditions when irrigation is the highest, such as hot summer days or holidays. The high demand causes high velocities and increased losses in the distribution pipes, resulting in reduced pressure.

WATER DISTRIBUTION RECOMMENDATIONS

All existing distribution pipelines are sufficient to meet the existing level of service. It is recommended that sufficiently sized pipelines continue to be installed as development continues. It is also recommended that areas with PI pipelines that are not connected to the PI source and storage be provided water with crossovers approved by the Utah Division of Drinking Water.

The model was used to determine the most efficient way to keep waterline velocities, pressures, and pressure swings within the level of service criteria limits with added future demands. The level of service selected for pipelines was a peak instantaneous demand of 17.0 gpm per irrigated acre. Pipelines are considered at capacity when velocities at peak instantaneous demand using the extended period hydraulic model representing the system as a whole under typical peak demand conditions produce pressure swings of 25 psi. Most nodes will have less than a 20 psi swing.

Specific recommended pipeline projects anticipated in the next 20 years are detailed in the capital facility plan in Chapter 7. Pipelines projects anticipated beyond 20 years are displayed in Figure 3-1. Recommended pipes are intended to accomplish the following objectives:

- Provide transmission capacity to developing areas west of I-15
- Connect areas to the system which currently rely on drinking water to meet irrigation demands
- Provide acceptable service pressures and pressure swings
- Reserve sufficient capacity for future demands

CHAPTER 6 WATER RIGHTS

EXISTING WATER RIGHTS

Springville City currently owns water rights for use in the PI system. Some water rights are owned directly by the City and the remaining water rights are Springville Irrigation Company Shares owned by the City. Table 6-1 is a summary of the water rights used in the PI system delivered to Bartholomew Pond by the PI system sources list in Table 3-1.

Table 6-1: Existing Water Rights Used in the PI System

Water Right	Flow (gpm)	Volume (ac-ft)	PI Source
Strawberry Water Shares (Springville Irrigation Company)	3,000	1,970	Springville/Mapleton Strawberry Pipeline
Springville Irrigation Company Shares (Non-Strawberry Water)	645	513	Springville Irrigation Ditch #1
51-6025	627	499	Hobble Creek/ Highline Ditch
51-6219	145	115	Hobble Creek/ Highline Ditch
TOTAL	**4,417**	**3,097**	

* Flow and volume for each water right is estimated based on the State of Utah water right database and City records.

Springville City has a total of 3,097 ac-ft of water rights available for use in PI water system. Compared to the existing level of service water requirement of 1,736 ac-ft, the City currently owns a surplus of 1,361 ac-ft of water rights currently available for use in the PI water system (see Table 6-2).

Table 6-2
Existing PI Average Yearly Water Demand and Water Right Capacity

Parameter	Average Yearly (ac-ft)
Demand	1,736
Capacity	3,097
Surplus	1,361

FUTURE WATER RIGHTS

By 2060, the City will require a minimum of 3,964 ac-ft of water rights to meet requirements for the PI water system. Compared to the existing water rights available in the PI system, the City currently is short 867 ac-ft (see Table 6-3). Buildout requirements for the City will likely be higher than the predicted 2060 requirements. Similar to other components of the PI water system, water rights should have redundancy. Typically, some water rights cannot be used as planned or do not yield the allowed flow, and the City will need to acquire more than the minimum rights calculated in order to have the usable flow and volume required.

Table 6-3
Future PI Average Yearly Water Demand and Water Right Capacity

Time	Irrigated Acreage	Average Yearly Demand (ac-ft)	Average Yearly Capacity (ac-ft)	Surplus (ac-ft)
10-years	642	2,568	3,097	529
20-years	835	3,340	3,097	-243
2060	991	3,964	3,097	-867

Water rights are independent of physical source capacity in this study. For example, the Mapleton-Springville Strawberry Pipeline has a physical capacity of nearly 6,000 gpm, but the City currently does not own enough water rights to supply the PI system at this rate throughout irrigation season. Other water rights and Springville Irrigation Company shares the City owns are used for irrigation in small independent City-owned irrigation systems not connected to the PI system or are not currently used by the City. These water rights are summarized in Table 6-4. It is recommended that the City file change applications to change the use of these water rights to municipal use for better protection and ease of management of the water rights. It is recommended that the City file a change application to add a point of diversion on the Plat A water right (51-5224) at the City Dam to use the water in the PI system.

Table 6-4: Potential Water Rights for Use in the PI System

Water Right	Flow (gpm)	Volume (ac-ft)	Current Use	Water Source
Springville Irrigation Shares	45	36	Art Park	Hobble Creek
Springville Irrigation Shares	35	28	Bird Park	Hobble Creek
51-5328	450	724	Hobble Creek Golf Course	Jurg Springs
Springville Irrigation Shares	245	195	Jolly's Park, Kelly Park, and Hobble Creek Golf Course	Hobble Creek
51-5224	1,571	2,000	Plat A Irrigation System	Hobble Creek
51-5230	25	20	Irrigation at Westroc	Roundy Springs
51-7463 (a24494)	50	37	Industrial Park	Little Spring Creek
Total	**2,421**	**3,040**		

* Flow and volume for each water right is estimated based on the State of Utah water right database and City records.

ULS AND SUVMWA WATER

Springville City is obligated to purchase 4,945 ac-ft of Utah Lake Drainage Basin Water Delivery System of the Bonneville Unit of the Central Utah Project (ULS) water through a petition agreement between Central Utah Water Conservancy District (CUWCD) and South Utah Valley Municipal Water Association (SUVMWA). The pipeline to Springville is complete and the pipeline to the remaining SUVMWA cities could be completed as soon as 2025 at which time the City would be obligated to start paying for the pipeline for 50 years or delay start up to 10 years. It is recommended that the City start planning for how this obligation will be met.

There is important information in the contract between SUVMWA and CUWCD for delivery of ULS water that the City should consider about the proper timing, cost, payment, and potential options to avoid the purchase of the ULS water. It is recommended that the City start discussions with the Department of Interior, CUWCD and SUVMWA immediately to fully understand the contract and negotiate potential options so the City can make informed and timely decisions for the ULS water. The City could consider discussing the possibility of purchasing a portion of the water, purchasing an increasing portion of the water over time, leasing the water to SUVMWA or other water systems, trading or selling the water purchase obligation, or getting out of the obligation altogether.

The ULS water would be the most expensive water in the City's entire portfolio currently estimated at around $350 per acre-foot per year for 50 years. This would be a yearly cost of $1.7 Million and a total cost of $86.5 Million. After 50 years the City would pay operation and maintenance costs for the water currently estimated at about $40 an acre-foot in today's dollars. Delaying the starting time of petitioning for an allotment of the ULS water until the completion of the pipelines (approximately 6 years) comes with no penalty and could potentially make the annual payments less even though the total cost would remain the same. If the full cost of the ULS water is delayed for up to 10 years after the SFS pipeline is complete, the annual payment will be higher at the end of the deferral because the amortization period will be shorter. For example, if the annual cost for the 4,945 ac-ft allotment without deferment is $1.7 Million based on a 50-year period, it will be near $2.2 Million for a 10-year deferment based on a 40-year period. However, there is no interest assessed for delaying and the total cost remains the same.

It is important to note that there are conservation requirements in the contract that the City will be immediately subject to when the City starts to take ULS water. If the conservation requirements are not met, the City will be surcharged 5%. The City should confirm conservation documentation to be ready to prove the required reductions of 12.5% by 2020 and 25% by 2050. It is also important to note that no debt can be used to pay for the ULS water and none of the return flows of the ULS water may be claimed or used.

The connection to the ULS Pipeline is not complete. Although a turnout exists for the City, a connection to the City's pipeline would have to be constructed at the City's cost.

The feasibility of a drinking water treatment plant in Salem supplied by ULS water is being studied by CUWCD. It is recommended that the City participate and provide input in the study.

Springville also owns 95 ac-ft of East Jordan Canal water through the City's approximate 23.7 percentage of SUVMWA. It is recommended that the City sell the SUVMWA East Jordan Canal water right.

WATER RIGHT RECOMMENDATIONS

In summary, although the City has sufficient water rights to meet existing demands in the PI system, several actions with regards to PI water rights are recommended to ensure future demands have sufficient water rights. They include:

- Work with the Utah Division of Water Rights to aid in a decision being finalized in the water right adjudication.
- File change applications for all water rights based on shares to municipal use.
- File a change application to add a point of diversion on the Plat A water right (51-5224) at the City Dam to use the water in the PI system.
- Sell the City's SUVMWA portion of an East Jordan Canal water right.
- Start discussions with the Department of Interior, CUWCD, and SUVMUA to understand the contract between the SUVMWA and CUWCD for delivery of ULS water. The City should plan for the best options for meeting the obligation and using the water.

CHAPTER 7 CAPITAL FACILITY PLAN

GENERAL

The purpose of this section is to identify the PI facilities that are required to meet the demands placed on the system by future development for the IFFP 10-year planning period and the CFP 20-year planning period. Proposed facility capacities were sized to adequately meet the 20-year growth projections and were compared to current master planned facilities. A detailed design analysis will be required before construction of the facilities to ensure that the location and sizing is appropriate for the actual growth that has taken place since this CFP was developed.

METHODOLOGY

Future water demands were based on the growth projections converted into irrigated acreage projections. The demands were added incrementally by year to the facility analysis. A 20-year solution was identified for the year a facility reaches capacity. A hydraulic model was developed for the purpose of assessing the system operation and capacity with future demands added to the system. The model was used to identify problem areas in the system and to identify the most efficient way to make improvements.

The future system was evaluated in the same manner as the existing system, by modeling future Demands.

MASTER PLANNING

Throughout the master planning process, the three main components of the City's water system (source, storage, and distribution) were analyzed to determine the system's ability to meet existing demands and also the anticipated future demands at buildout. Each of the system deficiencies identified in the master planning process and described previously in this report were presented in an alternatives workshop with City staff. Possible solutions were discussed for each of the identified system deficiencies as well as possible solutions for maintenance and other system needs not identified in the system analysis. After the workshop, HAL studied the feasibility of the solution alternatives and developed conceptual costs.

One important method of paying for system improvements is through impact fees. Impact fees are collected from new development and should only be used to pay for system improvements related to new development. For this reason, it is important to identify which projects are related to resolving existing deficiencies, and which projects are related to providing anticipated future capacity for new development.

PRECISION OF COST ESTIMATES

When considering cost estimates, there are several levels or degrees of precision, depending on the purpose of the estimate and the percentage of detailed design that has been completed. The following levels of precision are typical:

Type of Estimate	Precision
Master Planning	±50%
Preliminary Design	±30%
Final Design or Bid	±10%

For example, at the master planning level (or conceptual or feasibility design level), if a project is estimated to cost $1,000,000, then the precision or reliability of the cost estimate would typically be expected to range between approximately $500,000 and $1,500,000. While this may seem very imprecise, the purpose of master planning is to develop general sizing, location, cost, and scheduling information on a number of individual projects that may be designed and constructed over a period of many years. Master planning also typically includes the selection of common design criteria to help ensure uniformity and compatibility among future individual projects. Details such as the exact capacity of individual projects, the level of redundancy, the location of facilities, the alignment and depth of pipelines, the extent of utility conflicts, the cost of land and easements, the construction methodology, the types of equipment and material to be used, the time of construction, interest and inflation rates, permitting requirements, etc., are typically developed during the more detailed levels of design.

At the preliminary design level, some of the aforementioned information will have been developed. Major design decisions such as the size of facilities, selection of facility sites, pipeline alignments and depths, and the selection of the types of equipment and material to be used during construction will typically have been made. At this level of design, the precision of the cost estimate for a $1,000,000 project would typically be expected to range between approximately $700,000 and $1,300,000.

After the project has been completely designed and is ready to bid, all design plans and technical specifications will have been completed and nearly all of the significant details about the project should be known. At this level of design, the precision of the cost estimate for the same $1,000,000 project would typically be expected to range between approximately $900,000 and $1,100,000.

SYSTEM IMPROVEMENT PROJECTS

As discussed in previous chapters, source, storage and distribution system capacity expansion will be needed to meet the demands of future growth. Project descriptions for water system improvements are presented in Chapters 3, 4 and 5 with the location of each project shown in the Master Plan Map. Each recommendation includes a conceptual cost estimate for construction and year needed.

Unit costs for the construction cost estimates are based on conceptual level engineering. Sources used to estimate construction costs include:

1. "Means Heavy Construction Cost Data, 2018"
2. Price quotes from equipment suppliers
3. Recent construction bids for similar work

All costs are presented in 2019 dollars. Recent price and economic trends indicate that future costs are difficult to predict with certainty. Engineering cost estimates provided in this study should be regarded as conceptual level for use as a planning guide. Only during final design can a definitive and more accurate estimate be provided for each project.

The recommended system improvement projects for the next 20 years through 2038 are summarized in Tables 7-1 and 7-2 and shown on Figure 7-1. A cost estimate calculation for each recommended project is provided in Appendix C. The estimated cost for the recommended system capital improvement projects for the next 10 years is **$4,225,000** with approximately **$884,000** of that being City upsizing. In the 10-20 year planning window, there is another **$1,237,000** in estimated cost for capital improvement projects, including **$560,000** for City upsizing.

Table 7-1
Recommended 0-10 Year Transmission Projects

MAP ID*	RECOMMENDED PROJECT	DEVELOPER COST	CITY COST	TOTAL ESTIMATED COST
1	20-inch pipeline in 700 S – from 950 W to 1500 W and in 1500 W – from 700 S to Center St	$81,000	$732,000	$813,000
2	16-inch pipeline in Center St- from 1500 W to W Frontage Rd, includes boring under railroad	$0	$834,000	$834,000
3	12-inch pipeline in Center St – from W Frontage Rd through 2600 W	$286,000	$132,000	$418,000
4	10-inch pipeline in 1750 W – from 400 S to Center St and in 1750 W/1950 W – from Center St to 1000 N	$466,000	$326,000	$792,000
5	10-inch pipeline in 1000 N – from W Frontage Rd to 1500 W, Includes boring under I-15	$0	$541,000	$541,000
6	8-inch pipeline in W frontage Rd – from 800 N to 1000 N	$0	$127,000	$127,000
7	8-inch pipeline in 800 N – from 2250 W to 2400 W	$51,000	$24,000	$75,000
8	8-inch pipeline in W Frontage Rd – from Center to 800 N	$0	$234,000	$234,000
14	8-inch pipeline in 900 S – from 2000 W to 1850 W	$0	$188,000	$188,000
15	Set up drinking water crossovers for existing disconnected PI pipelines (5 crossovers)	$0	$203,000	$203,000
	TOTAL	**$884,000**	**$3,341,000**	**$4,225,000**

* See Fig 7-1

Table 7-2
Recommended 10-20 Year Transmission Projects

MAP ID*	RECOMMENDED PROJECT	DEVELOPER COST	CITY COST	TOTAL ESTIMATED COST
9	10-inch pipeline in 1500 W – from 700 S to 900 S	$76,000	$54,000	$130,000
10	12-inch pipelines in 1200 W – from 1000 S to 1300 S and in 1250 W – from 900 S to 700 S	$155,000	$136,000	$291,000
11	16-inch pipelines in 800 S – from 100 E to State St and in State St from 800 S to a future road at approximately 1050 S	$161,000	$164,000	$325,000
12	12-inch pipelines in a future road at approximately 1050 S – from State St to 400 W and in 400 W – from the future road at approximately 1050 S to 700 S	$221,000	$176,000	$397,000
13	8-inch pipeline in the future road at approximately 1050 S – from 400 W to the railroad	$64,000	$30,000	$94,000
	TOTALS	**$677,000**	**$560,000**	**$1,237,000**

* See Fig 7-1

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APPENDIX A

Water System Data and Calculations

APPENDIX B

Computer Model Output
(see disk)

APPENDIX C

Cost Estimate Calculations

APPENDIX D

Water Right Summary Data