WATER SYSTEM MASTER PLAN UPDATE

FOR

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Prepared for:

CITY OF KINGMAN
310 NORTH 4TH STREET
KINGMAN, ARIZONA 86401
928.753.8329
ATTN. GREGORY T. HENRY, P.E.

Prepared by:

SUNRISE ENGINEERING, INC.
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
480.768.8600

Project Team Leads:

GREGORY D. POTTER, P.E.
Project Principal

CHRISTINA CHRISTIAN, P.E.
Engineer/Project Manager

JENA BECKER, E.I.T.
Water System Modeler

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63705
CHRISTINA RENEE
CHRISTIAN
Date Signed 01/05/18
ARIZONA, U.S.A.
Expires 3/31/2020

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EXECUTIVE SUMMARY

The City of Kingman contracted with Sunrise Engineering, Inc. to analyze and model the existing water system and create an updated Water System Master Plan from the results. This report summarizes the development of the existing (2017), 10-year, and 30-year water model scenarios as well as the proposed improvements recommended for each scenario.

The Water System Master Plan was developed through the completion of five tasks:

1. Data Collection & Evaluation
2. Design Criteria Development
3. Existing (2017) Water System Analysis
4. 10-Year (2027) Water System Analysis
5. 30-Year (2047) Water System Analysis

The Water System Master Plan was created as a follow-up to the *Water System Master Plan* completed by C5 Engineering, Inc. in May of 2005. An inventory of the existing water system was performed to determine its capacity of wells, storage tanks, and booster pumps. The City provided data for the existing water system and maps of the distribution system for the basis of the existing model. The City also provided historical usage data for water system demand calculations.

Design criteria was developed based on Arizona Administrative Code (AAC), American Water Works Association (AWWA) standards and guidance, the City of Kingman Utility Regulations, engineering judgment, and the City's past experience with operating the water system. Standards for population growth, as well as source, storage, and booster pump demands were established in which to analyze the existing water system and projected future system.

Projections for population, source, storage, and booster pump demands were calculated for each scenario and compared to capacities based on recommended improvements to the water system. The future demand projections are estimated based on a 2.5% annual growth factor applied to the existing number of connections in the system for each of the scenarios described above.

Four water models were created as part of the analysis of the City of Kingman water system; the existing model (without improvements), the existing model (with improvements), the 10-year, and the 30-year model. Steady state and fire flow simulations were conducted on the water system for each scenario. Steady state flow simulations were conducted on the system using average day, peak day, and peak hour demands. Fire flow simulations were conducted on the system at peak day demand on nodes throughout the system (one at a time) to simulate the available fire flow at peak day demand.

Redefinition of the City's existing pressure zones was completed to aide in maximizing the efficiency of the system. With both of the existing improvements model and 10-year model, the recommended improvements re-aligned pressure zone lines to more closely resemble the proposed pressure zones so that required pressures could be achieved in areas where they were previously deficient. The 30-year recommended improvements continued along realigned pressure zone boundaries.

The recommended improvements for the existing and 10-Year scenarios have been prioritized and evaluated with cost estimates that can be added to the City's CIP program to allow adequate time to fund, design, and construct the improvements. Projects can be added or removed from the Capital Improvement Program (CIP) list annually based on the number of connections expected to be added in the coming years and the location of the expected connections. It is encouraged that this Water System Master Plan should continue to be updated periodically to calibrate the plan for changes in projections, system demands, and new service area additions.

Existing (2017) Water System Analysis

The existing system was evaluated and existing infrastructure capacity was compared to source, storage and booster pump demands. Existing water system demand was determined by analyzing historical water usage data to determine average usage per connection in the system. It was determined that the existing system has sufficient capacity in source, storage, and booster pumps. However, the location of some of the existing infrastructure is not optimum, such that the capacity of source, storage, and booster pumps are unevenly distributed between pressure zones. For example, some zones have an abundant supply of storage while others have no storage at all. Moreover, some of the booster pumps are not utilized in the most efficient or cost effective manners. For example, the Castlerock Booster Station serves many zones within the system including the Main Tank, College Tank, Shangri La (within the Camelback Tank Zone), and Rattlesnake Tank Zones. However, these zones are located within different areas of the water system, have different elevations in which to serve, and therefore require different Hydraulic Grade Lines (HGL) to feed the areas within each zone. In the existing condition, the Castlerock Booster Station has one outlet pressure, which matches the Main Tank Zone. Consequently, the HGL of the water must be reduced in order for the Castlerock Booster Station to serve the College Tank, Shangri La, and Rattlesnake Tank Zones.

A water model was constructed using the Innovyze software H_2ONET Analyzer to simulate and analyze the existing water system. The existing model was based on the C5 model and expanded upon to more completely represent the existing water system. The existing model was loaded with the system demands based on existing connections per existing pressure zone and divided by the number of junctions in the model. Need for improvement within the existing water system was based on the analysis of source, storage, and booster pumps within the system as well as the results of the existing model.

The model of the existing system with recommended improvements was created using the existing model as a base. This model showed that although the City's distribution system is able to supply water during average, peak day and peak hour scenarios throughout most of the system, the system has significant areas where it cannot supply fire flow in accordance with the City's requirements. A prioritized list of proposed improvement recommendations, coupled with cost estimates for each, were developed to address these deficiencies, lack of redundancy, as well as expected growth within the existing water system boundary. A summary of the existing system improvement projects is shown below:

Existing Improvement Project Summary

Project #	Purpose	Estimated Total Project Cost
1	Redundant Supply	$664,400
2	Alleviate Fire Flow Deficiency	$2,423,500
3	Alleviate Fire Flow Deficiency & Pressure Zone Reconfiguration	$1,603,400
4	Alleviate Fire Flow Deficiency	$421,400
5	Alleviate Fire Flow Deficiency	$1,013,500
6	Alleviate Fire Flow Deficiency	$1,635,500
7	Alleviate Fire Flow Deficiency	$972,700
8	Alleviate Fire Flow Deficiency & Pressure Zone Reconfiguration	$1,327,100
9	Alleviate Fire Flow Deficiency & Pressure Zone Reconfiguration	$23,868,900
10	Alleviate Fire Flow Deficiency	$7,738,800
11	Alleviate Fire Flow Deficiency	$7,570,200
12	Alleviate Fire Flow Deficiency & Pressure Zone Reconfiguration	$3,205,400
13	Alleviate Fire Flow Deficiency	$1,226,200
14	Alleviate Fire Flow Deficiency	$284,300
15	Alleviate Fire Flow Deficiency	$773,600
16	Alleviate Fire Flow Deficiency	$57,900
17	Alleviate Fire Flow Deficiency	$159,900
18	Alleviate Fire Flow Deficiency	$2,189,800
	Total Cost	**$58,645,000**

There were no new wells, tanks, or booster pumps proposed as part of the existing improvements. The majority of the recommended improvements for the existing system are on the distribution system, including pipe upsizing and waterline looping, which address existing fire flow deficiencies. Existing City Well #10 has already been drilled, and is proposed to be equipped as part of the existing improvements to be a redundant supply in the southeast quadrant of the City. Both the Riata Valley and the Foothills pneumatic tanks are proposed to be adjusted or upgraded to increase the head output as part of the existing improvements. The adjustments of the Riata Valley and Foothills pneumatic tanks address fire flow deficiencies within the proposed White Cliffs and Foothills Zones, respectively.

10-Year (2027) Water System Analysis

The proposed 10-year system was analyzed and compared to the design criteria in regards to available water system source, storage, and booster pump demands. Zonal distribution of source, storage and booster pump capacity was evaluated as to determine need and safety, in the form of redundancy, within the system and projected 10-year demands. Projected demand for source, storage, and booster pump capacity was based on projected connections throughout the system. It was determined that the 10-year system has sufficient capacity in source, storage, and booster pumps. However, as within the existing improvements, the location of the infrastructure is, in some cases, not optimal, creating a condition where the capacity of source, storage, and booster pumps are unevenly distributed between pressure zones.

A water model of the 10-year system was created using the existing improvements model as a base. The 10-year model was loaded with the system demands based on projected connections per proposed pressure zone and divided by the number of junctions in the model. Need for improvement within the 10-year water system was based on the analysis of source, storage, and booster pumps within the existing system (with recommended improvements) as well as the results of the 10-year model. A list of proposed improvement recommendations, coupled with cost estimates for each, were developed to address deficiencies, lack of redundancy, as well as expected development within the proposed growth areas of the 10-year system. A summary of the 10-year system improvement projects is shown below:

10-Year Improvement Project Summary

Project #	Purpose	Estimated Total Project Cost
1	Dedicated Supply to Main Tanks	$6,766,900
2	Main Tank Zone Feed to East of Route 66	$3,704,200
3	Provide Storage for Foothills Zone	$3,690,900
4	Zone-Specific Infrastructure Improvements for Imminent Growth	$4,279,900
5	Provide Source for the Proposed White Cliff Zone	$4,173,600
6	Replace the Castlerock Booster Pump Station	$9,851,700
7	Provide Source for the Proposed Bull Mountain Zone	$4,928,100
8	Tank Level Stabilization	$2,299,900
9	Zone-Specific Infrastructure Improvements for Imminent Growth	$6,637,800
10	Zone-Specific Infrastructure Improvements for Imminent Growth	$4,986,900
11	Zone-Specific Infrastructure Improvements for Imminent Growth	$3,302,900
12	Zone-Specific Infrastructure Improvements for Imminent Growth	$1,267,400
13	Zone-Specific Infrastructure Improvements for Imminent Growth	$3,438,000
14	Zone-Specific Infrastructure Improvements for Imminent Growth	$1,372,100
15	Zone-Specific Infrastructure Improvements for Imminent Growth	$1,170,000
	Total Cost	**$61,378,900**

The recommended improvements for the 10-year system include well re-equipping, storage tanks, booster pump stations, main water lines, and pressure reducing valve stations. Long Mountain Well 1 is an existing inactive well, and is proposed to be re-equipped as part of the 10-year recommended improvements to address deficient source within the proposed White Cliff Pressure Zone. Three new booster pump stations and three new tanks are proposed as part of the 10-year recommended improvements to address deficient storage within the proposed Foothills, White Cliffs, and Bull Mountain Pressure Zones. Most importantly, the reconstruction/rehabilitation of the Castlerock Booster Station is proposed as part of the 10-year recommended improvements. The existing booster station is nearly at the end of its design life and is running in an inefficient manner. The recommended improvement project will improve the booster station's production capacity and cost effectiveness considerably.

30-Year (2047) Water System Analysis

The proposed 30-year system was analyzed and compared to the design criteria in regards to available water system source, storage, and booster pump demands. Zonal distribution of source, storage and booster pump capacity was evaluated as to determine need and safety, in the form of redundancy, within the system and projected 30-year demands. Projected demand for source, storage, and booster pump capacity was based on projected connections throughout the system. It was determined that the 30-year system has sufficient capacity in source, storage, and booster pumps. However, additional infrastructure will be needed for long-term sustained growth within the water system.

A water model of the 30-year system was created using the 10-year water system model as a base. The 30-year model was loaded with the system demands based on the 10-year model and with projected connections in new growth areas and divided by the number of junctions in the zone. Need for improvement within the 30-year water system was based on the analysis of source, storage, and booster pumps within the 10-year water system (with recommended improvements) as well as the results of the 30-year model. Proposed improvement recommendations, as well as a total cost estimate, was developed to address system deficiencies, lack of redundancy, as well as expected development within the proposed growth areas of the 30-year system. Proposed recommendations for the 30-year system are solely based on need as dictated by growth within the City and are therefore not in a prioritized list. The total estimates cost for the 30-year recommended improvements is $58,745,800. It is important to note that these costs are very rough estimates and have been based on current (2017) unit prices, which should be adjusted on an annual basis.

1.0 INTRODUCTION

The City of Kingman, located in northwestern Arizona, was founded by explorer Lewis Kingman in 1882. Settlement boomed with the Atlantic and Pacific Railroad's construction along the 35th parallel, with the first train rolling into Kingman in 1883. Kingman became the principal supply center for all of the neighboring mining communities. Route 66 was built in the 1920's and 30's and carried thousands of people to California in search of prosperity throughout the Great Depression. During World War II, the Kingman Army Air Field was the home of one of the Army Air Corps' largest aerial gunnery training facilities. After the war, the air field was established as a depot for storage and sale of surplus aircraft, with an estimate of around 5,500 airplanes being flown into Kingman for sale or disposal. Thousands of military who came through the area, returned after the war to make Kingman their home. Today, Kingman attracts both tourists and retirees with ideal weather, historic Route 66 and ample recreation opportunities nearby. From a business standpoint, Kingman is a prime location with I-40 and rail access to the community. With proximity to Los Angeles, Las Vegas and Phoenix the City expects to grow employment in both industrial and commercial business in the coming years.

The City of Kingman water system serves a total estimated population of nearly 48,000 as of 2017. An estimated 29,000 of the total population is located within City limits and the remaining 19,000 is located in the unincorporated areas surrounding the City. With renewed growth, master planning is crucial to both foster future growth and meet associated future demands. The purpose of this Water Master Plan Update is two-fold. The first purpose of this report is to provide the City of Kingman (City) with an evaluation and representative model of the existing water system. The second purpose of this report is to establish a functional frame work of water infrastructure improvements that, upon construction, will satisfy the City of Kingman's water needs through the 30-year development of the service area. The Water Master Plan accomplishes this purpose through documenting and modeling the existing water system, by establishing growth projections and land use densities, and through modeling of 10-year and 30-year system infrastructure.

The most recent water master plan and water model for the City was developed in 2005; however, the report does not sufficiently meet the current planning needs. The City's General Plan has been updated, as such, land usage has changed, and there have been changes and expansions to the City's water system.

The modeling and analysis performed under this project reflects the water system as constructed as of 2017 and includes the impact of land use updates. It is intended that this report will function as a planning tool to determine deficiencies with existing facilities, as well as sizing of future facilities and provide a comprehensive analysis of the City's entire network.

1.1 SCOPE OF WORK

The scope of work for the project consists of five (5) major tasks as follows.

Task 1 – Data Collection & Evaluation

Task 1 involves an inventory of the City's existing water infrastructure consisting of water lines, storage tanks, wells, booster pumps, and valves. Task 1 also includes the conversion of the existing water system model from WaterGems modeling software to H_2ONET modeling software. The existing WaterGems model only included pipes eight (8) inches and larger, so the addition of six (6) inch and smaller lines into the new H_2ONet model is also included in Task 1. The evaluation and analysis of the existing demand as it relates to pressure zones throughout the City is contained within Task 1 as well.

Task 2 – Design Criteria Development

Task 2 consists of the development of the design criteria that will be used as the governing analysis criteria for the water system. Task 2 also includes collaborative efforts with the City to determine infrastructure analysis/sizing criteria, anticipated growth rates, peaking factors and new development population/connection densities.

Task 3 – Existing (2017) Water System Analysis

Task 3 evaluates the existing conditions with the water system in regards to demand, source, and storage. Task 3 includes the refinement of the converted water model using the information gathered in Task 1. The scenarios to be analyzed include a steady state flow simulation at the average day, peak day, and peak hour demands, as well as a fire flow simulation and pressure zone analysis. Task 3 also provides a prioritized list of improvement recommendations and cost estimates based on the analysis performed to address any shortfalls or optimization opportunities within the water system.

Task 4 – 10-Year (2027) Water System Analysis

Task 4 examines 10-year projected growth of the water system in regards to demand, source, and storage. Task 4 includes water model simulations by adding to the City's existing model to determine how the system responds to these estimated demands and what facilities should be added to meet the demand. The scenarios to be analyzed include a steady state flow simulation at the average day, peak day, and peak hour demands, as well as a fire flow simulation. Task 4 also provides a prioritized list of improvement recommendations and cost estimates based on the analysis performed.

Task 5 – 30-Year (2047) Water System Analysis

Task 5 examines 30-year projected growth of the water system in regards to demand, source, and storage. Task 5 includes water model simulations by adding to the City's existing model to determine how the system responds to these projected demands and what facilities should be added to meet the demand. The scenarios to be analyzed include a steady state flow simulation at the average day, peak day, and peak hour demands, as well as a fire flow simulation. Task 5 also provides a prioritized list of improvement recommendations and cost estimates based on the analysis performed.

1.2 PROJECT STUDY AREA

The City of Kingman is located in Mohave County in Northwestern Arizona along historic Route 66. The City is approximately 150 miles west of Flagstaff and 100 miles southeast of Las Vegas. Nearby communities include Bullhead City and Laughlin 35 miles to the west and Lake Havasu City 60 miles to the southwest. The existing project study boundary matches the existing water service boundary as set forth in the City of Kingman Utility Regulations in 2011. The City of Kingman city limits as well as the existing project study boundary is within a portion of the City of Kingman 2030 planning boundary and is shown on the map in **Figure 1.1 – Project Study Boundary**. The City of Kingman 2030 planning boundary was established by the City to accommodate projected short and long term planning needs. The planning boundary is used as the study limits in the future scenarios for projected growth areas. Further analysis and master-planning will be required for those areas outside of the study boundary.

About 60 percent of the City's water system connections are located within the City limits. The other 40 percent of the water system connections are located in the unincorporated areas surrounding the City. The majority of the water system outside the City were part of private water companies and districts that were acquired by the City in past years. In addition, the Kingman Airport and industrial park is owned by the City of Kingman, but is leased to the Kingman Airport Authority, Inc. for management purposes.

1.3 BACKGROUND INFORMATION

The City of Kingman's water system serves approximately 30 square miles and contains over 2.2 million linear feet (lf) of distribution piping. Infrastructure within the City's water system includes 17 wells, 13 storage tanks, 2 pneumatic tanks, and 21 total booster pumps within 8 booster pump stations. The City's overall system water usage per day is nearly 6 million gallons per day (MGD).

In general, the water system functions by the wells feeding source water to storage tanks and booster pump stations via forebay tanks. Storage tanks within the system either gravity feed to the distribution system and/or feed to booster pump stations. Booster pumps within the system either feed directly to the distribution system, feed to the distribution system via PRV's, or boost to storage tanks within the system. The main motivations for this master plan update is to address existing deficiencies within the system, examine possibilities for increased efficiency in operation of the system, anticipate and project growth within the water system, govern development within the projected growth, and help in the development of a comprehensive list of CIP projects accordingly.

Analysis and refinement of the City's water system is essential to address key concerns, plan for growth, and govern development in Kingman. The City had a *Water System Master Plan* completed by C5 Engineering, Inc. in May of 2005. Since the Master Plan's creation, the city has grown by approximately 10,000 people and significant changes have been made within the water system infrastructure.

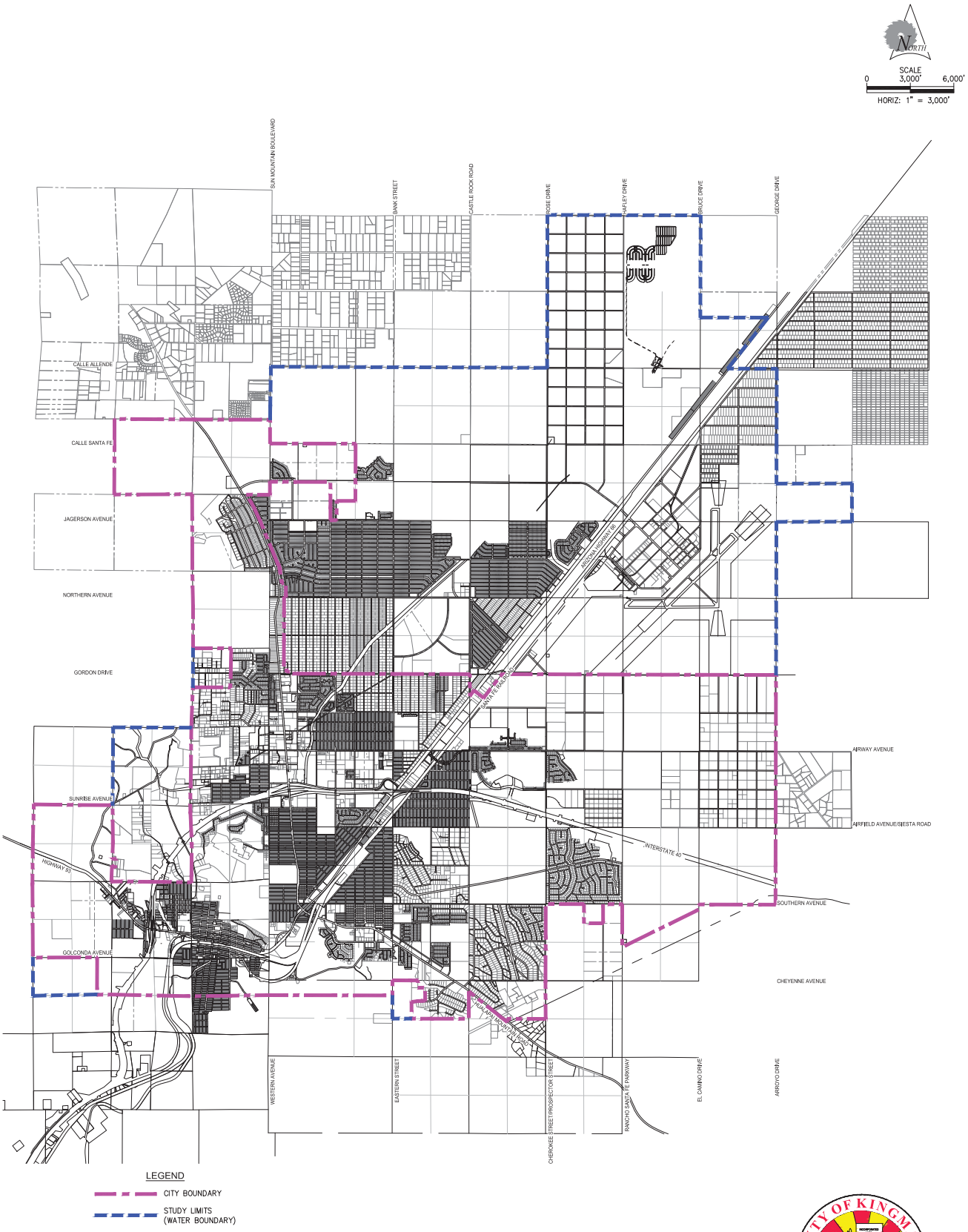
1.4 PREVIOUS STUDIES

Water System Master Plan 2005

The City of Kingman contracted with C5 Engineering to create a water master plan for their water system in 2005. The 2005 Water Master Plan modeled the existing system and planned for growth by proposed development projects that were working towards connecting to the water system. This plan was based on the City's local horizontal (NAD27) and vertical (NAVD29) datum's. For the water master plan, C5 used population data from 2003 and a growth rate of 4.5% to determine the population projections for the future demand of the study. The water master plan modeling was completed using Haestad Method's WaterGems for GIS. The modeling was generally limited to piping 8 inches and larger, with the exception of piping that was considered critical to the model. However, nearly half of the existing water system distribution lines (over one million linear feet of pipe) are smaller than 8 inches.

SECTION 1 FIGURES

Figure 1.1 – Project Study Boundary



CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 1.1
PROJECT STUDY BOUNDARY

SUNRISE ENGINEERING

2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

P:\Kingman\05387 Water Master Plan\Dwg\Exhibits\Project Study Boundary.dwg Aug 31, 2017 1:41pm tmoore

2.0 DATA COLLECTION

The City of Kingman provided data for the existing water system inventory, maps of the distribution system, and historical usage data for the basis of the existing water system analysis. As-built plans were provided by decade from as old as the 1940's to 2017. The City provided the City Master CAD file as reference of water infrastructure within the system as well as as-built numbers for projects. The City of Kingman Master CAD file is a drawing, in which, all of the existing water, sewer, and some storm drain infrastructure has been documented and tracked. This file was continuously managed and updated and documented the pipe size, material, and as-built reference number, as well as whether the pipe line is active or abandoned. In June of 2017, the City implemented a Geographic Information System (GIS) to track all of the water, sewer, and storm drain utilities within their system, and therefore the Master CAD file is no longer being updated. The Master CAD file, in conjunction with as-builts, was used in this Water Master Plan Update as the main source for pipe location, size, and material. A depiction of the pressure zones and infrastructure within the water system was provided by the City on the *City of Kingman Water Pressure Zone and Water Supply Map*. See **Appendix A – City Water Use, Connection, & Population Data** for this map.

The City also provided inventory lists for wells, tanks, and booster pumps within the system. The inventory lists provided active/inactive status for wells, storage tank capacity, and booster pump capacity and horsepower. The City provided what information they had on file for the infrastructure within the system. As-builts, pumps curves, historical production data, as well as historical well testing information was provided for the wells within the system. The operating pressures were tested and reported by the City staff as a double-check for about half of the wells within the system. As-builts were provided for all of the tanks within the system. As-builts and pumps curves were provided for almost all of the booster pumps within the system. A list of PRV's and check valves was provided by the City; the pressures in and out of each PRV were measured and reported by the City staff as a double check to existing data. All existing inventory information provided from the City is based on the City's local horizontal (NAD27) datum. Existing inventory information was based on a combination of the City's local vertical (NAGVD29) datum and the current vertical (NAVD88) datum. The difference between the two vertical datum's (NAGVD29 and NAVD88) is approximately 2.6 feet (or 1.1 psi). This difference does not appreciably change the modeling results and is therefore deemed acceptable.

Total water system connection counts, billing, and consumption data was provided from the City for fiscal years 1996 to 2015, broken down by month. In addition, a monthly breakdown of customer accounts and water usage by type was provided for fiscal years 2015 and half of fiscal years 2014 and 2016.

2.1 WATER SYSTEM INVENTORY

An inventory of the existing water system was performed to determine its capacity of wells, storage tanks, and booster pumps. The existing water system capacity was compared to the Existing (2017) water demands to determine if system improvements are necessary. An overview of the City's existing water system is shown in **Figure 2.1 – Existing System**. A brief summary description of the major components of the existing water system is located in the following sections:

2.1.1 Water Sources

Groundwater is currently the only source of drinking water for the system. As of 2017, the City operates 14 wells to meet existing (2017) system demand. See **Table 2.1 – Existing Water Sources** for a list of the existing wells and capacities in the system. The wells vary in their pumping capacity and configuration. Water produced by the City's existing wells requires no treatment other than chlorination except for City Well #6, which requires blending for Chromium. There are four (4) existing wells within the system that are currently not used because they are either currently require repairs or they aren't needed at this time to meet demand and are used as back-up sources.

Table 2.1 – Existing Water Sources

Name/Facility	Capacity (gpm)	Capacity (MGD)	Supply
City Well 1 (backup)	700	1.01	Airport in College Zone
City Well 2	900	1.30	Castlerock Booster Station
City Well 3	1,300	1.87	Castlerock Booster Station
City Well 4	1,000	1.44	Castlerock Booster Station
City Well 5	2,300	3.31	Castlerock Booster Station
City Well 6	1,450	2.09	College Tank Zone
City Well 7	2,300	3.31	College Tank
Bank Street Well (inactive)	-	-	Intended to feed College Tank Zone
Castlerock Well	1,600	2.30	Castlerock Booster Station
City Well 10 (future)	2,980	4.29	City Well 11 Booster Station
City Well 11	2,200	3.17	Rattlesnake Tank Zone
Long Mountain 1 (inactive)	130	0.19	Intended to feed Main Tank Zone
Long Mountain 4	800	1.15	Camelback Tank Zone
Long Mountain 6 (backup)	1,500	2.16	College Tank
Hubbs Well	200	0.29	Downtown Zone 2
Pomona Well	230	0.33	Downtown Zone 2
Santa Fe Well	120	0.17	Downtown Zone 2
Byron Jackson Well	100	0.14	Downtown Zone 2
Total Source	14,500	23.04	

City Well 1 and Long Mountain Well 6 are currently designated as backup, Bank Street Well and Long Mountain Well 1 are currently inactive. All four (4) of the aforementioned wells are not included in the total source calculation. City Well 10 has been drilled and tested, but is not yet an active well site, and therefore is also not included in the total source calculation.

2.1.2 Water Storage

The existing water storage within the system includes 13 separate storage tanks. These tanks are all welded steel and are a wide variety of sizes that range from 126,000 gallons to 1.50 million gallons. The storage tanks deliver water to the system either via gravity or booster pumps. Storage tanks fill either directly from well pumps or from booster pumps on a different site. Most of the storage tanks have an alternative fill option in which they can fill directly from a well and/or fill directly from the water system. See **Table 2.2 – Existing Water Storage Tanks** for a list of the existing storage tanks and storage volumes in the existing water system.

Table 2.2 – Existing Water Storage Tanks

Name/Facility	Capacity (gallons)	Capacity (MG)	Supply	Diameter (feet)	Height (feet)	Tank Elevation (feet)	Tank Design (gallons)
Main Tanks 1	1,000,000	0.90	Main Tank Zone	77	30.00	3677.00	1,044,490
Main Tanks 2	1,500,000	1.50	Main Tank Zone	90	30.00	3677.00	1,426,947
Main Tanks 3	1,500,000	1.50	Main Tank Zone	97	28.00	3677.00	1,547,045
Beale Springs	1,000,000	1.00	Downtown Zone 2	74	30.00	3535.25	964,686
Camelback	1,000,000	1.00	Camelback Tank Zone	75	30.00	3600.00	990,935
College	1,500,000	1.50	College Tank Zone	90	32.00	3498.00	1,522,076
Rattlesnake	1,500,000	1.50	Rattlesnake Tank Zone	97	27.00	3606.00	1,491,793
Hualapai	1,500,000	1.50	Hualapai Shadows Zone	93	29.00	3679.00	1,472,873
Rancho Santa Fe	1,500,000	1.50	Foothills Pneumatic Zone	90	32.00	3886.47	1,522,076
Foothills (Hualapai 2)	500,000	0.50	Foothills Pneumatic Zone	54	29.80	3888.50	510,276
Well 11 Forebay	500,000	0.50	College Tank Zone	56	30.00	3439.00	552,457
Castlerock Forebay 1	126,000	0.13	Main Tank Zone	30	24.00	3381.00	126,840
Castlerock Forebay 2	150,000	0.15	College Tank Zone	33	24.00	3381.00	153,476
Total Available Storage	13,276,000	13.28					

2.1.3 Booster Pump Capacity

There are eight (8) booster pump stations within the water system. Booster pumps within the system either feed directly to the distribution system, feed to the distribution system via PRV's, or boost to storage tanks within the system. Some booster pump stations have a combination of uses, such as the Rattlesnake Booster Station, in which two (2) of the booster pumps are dedicated to filling the Rancho Santa Fe Tank and two (2) of the booster pumps are dedicated to feeding the Rattlesnake Tank Zone.

The largest booster station in the system is Castlerock. This station is a focal point of the water system where water from the City's well field, located to the north, is pumped to a forebay at Castlerock and then boosted to the system. This booster pump station feeds a vast majority of the pressure zones and connections within the City.

Some of the City's water campuses contain an array of booster pumps that pump demand flow and fire flow directly into the system. See **Table 2.3 – Existing Booster Pump Capacity** for a list of booster pumps and capacities in the existing water system. This table includes the pumping capacity per horse power for each of the booster pumps. This factor is determined from dividing the booster pump capacity by its horse power. The pumping capacity per horse power is a good indicator of efficiency, in that, the higher the number is, the more efficient the booster pump operates.

Some of the existing booster pumps stations have the booster pump(s) equipped with variable frequency drives (VFD's). A VFD turns a single speed alternating current pump motor into a variable speed motor. Variable speed functionality allows operators and SCADA to set pump output to match system demand. This functionality to adjust pump outputs allows the City to save money through lower electrical and maintenance costs. VFD's are also efficient in conserving power, as the pump uses only the power required to meet demand.

The remainder of the booster pumps stations are run without VFD's. These booster pumps are generally run as single-stage with a lead-lag start. A single-stage booster pump runs simply like an on-off switch. Usually booster pumps run in series have the same capacity. The first (lead) pump will run alone until demands above its capacity are called for. When additional demands are called for, supplementary (lag) pumps will turn on until the demands are met. The lead and lag pumps switch every so often, based on the SCADA design, to equalize the pump run times.

Table 2.3 – Existing Booster Pump Capacity

Name/Facility	Capacity (gpm)	Supply	Horse Power	Pumping Capacity per Horse Power
Castlerock				
Castlerock-1	1,400	Feeds the Main Tanks and Hualapai Tank and Camelback Tank Zone as Backup	150	9
Castlerock-2	2,500		276	9
Castlerock-3	2,300		250	9
Castlerock-4	3,000		525	6
Castlerock-5	2,700		400	7
Long Mountain 4				
Long Mountain 4-1	500	Feeds the Camelback Tank Zone	150	3
Long Mountain 4-2	500		150	3
Well 11				
Well 11-1	2,500	Feeds the Rattlesnake Tank	150	17
Well 11-2	2,500		150	17
Riata Valley Pneumatic				
Riata Valley Pneumatic	100	Feeds the Main Tank Zone	3	33
Rattlesnake				
Rattlesnake-1	2,455	Feeds the Rattlesnake Tank Zone	150	16
Rattlesnake-2	2,455		150	16
Rattlesnake-3	2,250	Feeds the Rancho Santa Fe Tank	250	9
Rattlesnake-4	2,250		250	9
Hualapai				
Hualapai-1	550	Feeds the Main Tank Zone	50	11
Hualapai-2	650		50	13
Hualapai-3	1,200		125	10
Foothills Pneumatic				
Foothills Pneumatic-1	550	Feeds the Main Tank Zone	20	28
Foothills Pneumatic-2	650		20	33
Vista Bella				
Vista Bella-1	200	Feeds the Rattlesnake Tank Zone	10	20
Vista Bella-2	200		10	20
Total Available Booster Capacity (GPM)	31,410			

2.2 DISTRIBUTION SYSTEM

The City's distribution network contains pipe sizes from 2-inch to 24-inch in diameter. Just over one-half of the piping within the system is 8-inch and larger. The existing system's infrastructure can currently provide water to elevations of approximately 3300 to 3900. The existing system has been divided into four (4) main pressure zones by PRV's and zone valves. The main source, storage, and booster pumps of each zone is discussed in **Section 2.2.1 - Existing Pressure Zones** and is depicted in **Figure 2.2 – Existing System Schematic**.

2.2.1 Existing Pressure Zones

As mentioned in the previous section, the system currently contains four (4) main pressure zones and twelve (12) sub pressure zones that are described as follows (See **Figure 2.3 – Existing Pressure Zones** for more detail):

- College Tank Zone: Largest zone, by area, in the system with boundaries generally from Calle Alamo Road to the north, Gordon Drive to the south, Sun Mountain Boulevard to the west, and Charles Drive to the east. The College Tank Zone is adjacent to the Camelback Tank Zone to the west and the Rattlesnake Zone to the south. The College Tank Zone is the lowest existing zone in the water system and also has the most source within the zone than any other in the system. Many of the wells within the College Tank Zone, including City Wells 2, 3, 4, and 5, are wells dedicated to providing source to the Castlerock Forebay Tanks. In any case where the College Tank Zone may need more source, a flow control valve is strategically located to allow flow from these wells into the College Tank Zone. The main source of the College Tank Zone is City Wells 6 and 7 as well as Long Mountain Well 4. The main storage for the College Tank Zone is the College Tank. There are no booster pumps within the existing system that feed the College Tank Zone.

- Camelback Tank Zone: Northwest zone in the system with boundaries generally from Fountain Hills Road to the north, Morrow Avenue to the south, Bull Mountain Drive to the west, and Illinois to the east. This zone includes two (2) sub pressure zones to the south called the Walleck Ranch Zone and the Shangri La Improvement District Zone. The Camelback Tank Zone is adjacent to the College Tank Zone to the east and the Main Tank Zone to the west and south. The Camelback Tank Zone does not have any direct-feed source within the system; however, the Long Mountain 4 Well provides source for the zone through the Long Mountain 4 Booster Pumps. If necessary, the Long Mountain 4 Booster Pumps can be fed through the College Tank gravity line as well. The main storage for the Camelback Tank Zone is the Camelback Tank. The only booster pumps within the existing system that feed the Camelback Tank Zone are the Long Mountain 4 Booster Pumps.

- Rattlesnake Zone: Middle east zone in the system with boundaries generally from Gordon Drive to the north, Interstate 40 to the south, Rutherford Street to the west, and Rancho Santa Fe Parkway to the east. The Rattlesnake Zone is adjacent to the College Tank Zone to the north, the Camelback Tank Zone to the west, and the Main Tank Zone to the south. The main source for the Rattlesnake Zone is City Well #11. The main storage for the Rattlesnake Zone is the Rattle Snake Tank. The Rattlesnake Zone can also be fed by the Castlerock Booster Station if required. The Rattlesnake Zone is also fed by the Rattlesnake (only when necessary) and Vista Bella booster pumps.

- Main Tank Zone: Second largest zone, by area, in the system, but largest by number of connections served. Boundaries of this zone are generally from Gordon Drive to the north, Queens Avenue to the south, Fort Beale Drive to the west, and Rancho Santa Fe Parkway to the east. This zone has eight (8) sub pressure zones including, Downtown Zone 1 and Downtown Zone 2 to the southwest, Ricca Dr/Hospital Zone to the north, and Fripps Ranch Zone, Hualapai Shadow Zone, Foothills Regulated Zone, Foothills Pneumatic Zone, and Rancho Santa Fe Regulated Zone to the southeast. The Main Tank Zone is adjacent to the Camelback Tank Zone and the Rattlesnake Zone to the north. The main source for the Main Tank Zone is the well field within the northern part of the system, which includes City Wells 2, 3, 4, and 5, that feed the Castlerock Booster Station. City Well 7 can also feed the Castlerock Booster Station, but normally pumps directly to the College Tank Zone. Four additional wells which provide source to the Main Tank Zone are located in the downtown area; Hubbs Well, Pamona Well, Santa Fe Well, and Byron Jackson Well. The main storage for the Main Tank Zone are the three (3) Main Tanks. The Beale Springs Tank also provides storage for the Main Tank Zone. The Main Tank Zone is also fed by the Castlerock and Hualapai booster pumps as well as the Riata Valley and Foothills Pneumatic Tanks.

The hydraulic grade line (HGL) for most pressure zones were calculated based on the elevation of each tank. The tank HGL is calculated by its ground elevation plus 75% of the height of the tank. The well(s), booster pump(s) and PRV HGLs were calculated based on the ground elevation plus the pressure they contribute to the zone(s). See **Table 2.4 – Existing System Pressure Zones** for the current limits if the existing pressure zones.

Table 2.4 – Existing System Pressure Zones

Pressure Zone	Hydraulic Grade Line	Upper Elevation	Lower Elevation	Low Pressure (psi)	High Pressure (psi)
College Tank Zone	3700	3426	3269	42	110
Rattlesnake Zone	3627	3526	3399	44	99
Vista Bella Zone	3627	3548	3483	95	123
Camelback Tank Zone	3623	3550	3395	32	99
Walleck Ranch Zone	3550	3402	3377	64	75
Shangri La Improvement District Zone	3563	3427	3360	59	88
Main Tank Zone	3700	3600	3397	43	131
Downtown Zone 1	3460	3377	3304	36	68
Downtown Zone 2	3540	3447	3330	48	99
Ricca Dr./Hospital Zone	3623	3503	3402	52	96
Fripps Ranch Zone	3780	3669	3586	48	84
Hualapai Shadows Zone	3773	3721	3667	23	46
Foothills Regulated Zone	3777	3679	3569	42	90
Foothills Pneumatic Zone	3992	3906	3772	37	95
Foothills (Hualapai 2) Zone	3911	3830	3673	35	103
Rancho Santa Fe Regulated Zone	3789	3678	3607	48	79

2.2.2 Existing PRV's, Check Valves & Zone Valves

Interconnections between the zones are functional through the use of PRV's, check valves, and zone valves. PRV stations automatically regulate water flow and pressure across zone boundaries. Check valves allow flow from one direction, but block it from another. Zone valves block flow from either direction on a water line, essentially acting like two (2) dead end lines butted up to one another. **Table 2.5 - Existing PRV's and Check Valves** lists the existing PRV's and check valves within the water system, their size, as well as the pressure and line size on the upstream and downstream side of the valve. A significant amount of zone valves (quantitatively more than PRV's and check valves) exist in the water system, typically separating zones.

Table 2.5 - Existing PRV's and Check Valves

PRV #	Location	Status	Valve Size (in)	Pressure IN (psi)	Pressure OUT (psi)	Size IN (in.)	Size OUT (in.)
Main Tank Zone							
1	Southern Ave. / Seneca St.	Active	8	112	47	8	8
2	Louise Ave. / Mountain Trails Rd.	Active	8	110	55	8	8
3	Louise Ave. / Diamond Spur	Active	8	90	45	8	8
4	Hoover St. / Ashfork Ave.	Active	12	120	62	12	8
5	Detroit Ave. / McDonald Ave.	Active	8	115	72	8	8
6	McDonald Ave. / Michael St.	Active	8	115	75	8	8
7	Western Ave. / Airfield Ave.	Inactive	8	105	0	8	6
8	Western Ave. / Detroit Ave.	Active	8	110	60	8	6
9	Western Ave. / Beverly Ave.	Active	8	117	82	8	8
10	Western Ave. / Sycamore Ave.	Active	8	120	92	8	8
11	Northwest Corner of Stockton Hill Rd. / Airway Ave.	Active	8	134	92	8	8
12	Airfield Ave. / MacDonald Ave.	Active	12	105	52	16	16
13	Hualapai Mtn. Rd. / Central St.	Active	8	95	48	8	8
14	Wallapai Ln. / Slaughterhouse Canyon Rd.	Active	12	99	72	14	14
15	Topeka St. / Fifth St.	Active	8	94	53	12	12
16	Topeka St. / Sixth St.	Active	6	94	55	6	6
17	Darby Ln. / Elm St.	Active	8	110	40	8	8
18	Near Hualapai Mtn. Rd. / at Hualapai Tank	Active	12	100	45	12	12
19	N. Burbank St. / Airway Ave. North	Active	8	135	62	8	8
20	N. Willow Rd. / Airway Ave. North	Active	8	136	60	8	8
21	Horizon Blvd. / E. Hwy 66	Active	8	124	75	8	8
22	Sunshine Dr. / Castle Rock Rd.	Active	8	140	87	8	8
23	McDonald / Bruce	Active	6	115	82	6	6
24	Eastern / Detroit (Electric PRV)	Active	8	101	60	8	8
25	Wallapai Ln.	Inactive	12				
26	Florence Ave. / Western Ave.	Active	8	90	55	8	4
27	Kingman Ave. / Fairgrounds Blvd.	Inactive					
28	Sycamore Ave. / Fairfax St.	Active	8	110	51	8	8
29	SHR/ Smith's Market	Inactive					
30	Fairfax St. / Calumet Ave.	Active	8	115	45	8	8
31	Old Trails Rd. (Section 35)	Active	4	145	43	6	6

Table 2.5 - Existing PRV's and Check Valves (continued)

PRV #	Location	Status	Valve Size (in)	Pressure IN (psi)	Pressure OUT (psi)	Size IN (in.)	Size OUT (in.)
Camelback Zone							
32	N. Bank St. / Gordon Dr. (Electric PRV)	Active	10	150	114	12	12
33	N. Glen Rd. / Kino Ave.	Active	8	99	66	8	8
34	Townsend / Airway Ave.	Inactive					
College Tank Zone							
35	Gordon Dr. / Castle Rock Rd.	Active	10	150	60	12	12
36	Gordon Dr. / Bank St.	Active	10	150	68	12	12
37	Thompson Ave. / Monroe Dr.	Inactive	8	0	0	8	8
38	Roosevelt St. – Between Carver Ave. and Jagerson Ave.	Active	6	80	48	6	6
39	Hwy. 66 / Lot 239 of Hwy 66 Business Frontage	Active	4	105	70	4	4
Rattlesnake Tank Zone							
40	Airway Ave. / Hwy 66	Inactive	10	0	0	12	12
41	Beverly Ave. / Bank St.	Inactive	6	0	0	8	8

Check Valve #	Location	Status	Valve Size (in)	Description
Main Tank Zone				
1	Packsaddle Rd. / Cheyenne Ave.	Active	6 or 8?	Allows flow from the Foothills (Hualapai 2) Zone to the Foothills Pneumatic Zone
2	Eastern St. / Karen Ave.	Active	8	Allows flow from the Main Tank Zone to the Fripps Ranch Zone
3	Pasadena Ave. / Central St.	Active	8	Allows flow from the Main Tank Zone to the Foothills Regulated Zone
4	Airfield Ave. – Between N. Prescott St. and N. Central St.	Active	8	Allows flow from Kingman Airrail Manor to Kingman Park Estates within the Main Tank Zone
5	Canyon Hills / Orr Ave.	Active	8	Allows flow from the Camelback Tank Zone to the Main Tank Zone
Rattlesnake Tank Zone				
6	Santa Rosa Dr. / Rosewood St.	Active	8	Allows flow from the Vista Bella Zone to the Rattlesnake Zone
College Tank Zone				
7	Well #1 / Windrose Lane	Active	8	Allows flows from City Well #1 and the Castlerock Booster Station to the Airport area of the College Tank Zone

2.2.3 Historic Connection Information

Historical number of connections (accounts) per month were provided from the City for fiscal years 1996 through 2015. The average number of customer accounts per year is summarized in **Table 2.6 - Historic Connections**. See **Appendix A – City Water Use, Connection, & Population Data** for the monthly data supplied from the City.

Table 2.6 - Historic Connections

Year	Average Number of Accounts
1997	13,088
1998	13,411
1999	13,831
2000	14,181
2001	14,458
2002	14,816
2003	15,284
2004	16,053
2005	17,218
2006	18,140
2007	18,465
2008	18,543
2009	18,439
2010	18,414
2011	18,433
2012	18,487
2013	18,597
2014	18,790
2015	19,047

2.2.4 Historic Water Usage

Historical water usage data was provided by the City for fiscal years 2015 and half of fiscal years 2014 and 2016, by month. Water usage data was separated by user type; irrigation, commercial, municipal, residential, and non-metered municipal. The non-metered municipal water usage is not included in the total consumption value. Water usage for the year of 2015; January to December, was used in this analysis, as it was the most complete data set provided. A summary of total consumption for January through December of 2015 is summarized in **Table 2.7 – 2015 Monthly Water Usage Summary**.

Table 2.7 – 2015 Monthly Water Usage Summary

Month	Days per Month	Number of Accounts	Water Usage (gal/month)	Water Usage (gal/day)	Water Usage (gal/min)	Water Usage (gal/conn/day)
January	31	18,902	124,717,550	4,023,147	2,794	213
February	28	18,850	112,287,160	4,010,256	2,785	213
March	31	18,947	120,308,770	3,880,928	2,695	205
April	30	19,016	164,623,470	5,487,449	3,811	289
May	31	19,021	192,950,710	6,224,216	4,322	327
June	30	19,052	222,854,410	7,428,480	5,159	390
July*	31	19,167	270,247,520	8,717,662	6,054	455
August	31	19,108	245,799,070	7,929,002	5,506	415
September	30	19,123	226,519,190	7,550,640	5,244	395
October	31	19,209	215,276,480	6,944,403	4,823	362
November	30	19,096	147,600,490	4,920,016	3,417	258
December	31	19,077	129,202,930	4,167,836	2,894	218
	Average	**19,047**	**181,032,313**			**312**

*Peak Month

Average Daily Use (ADU)	**5,940,336**	**gal/day**
Average Daily Use (ADU)	**4,125**	**gpm**
	Calculated Based on Usage	
****Maximum Day Demand Factor (x ADU)**	**1.47**	
Maximum Day (gal/day)	**8,717,662**	
Maximum Day (gpm)	**6,054**	

**Also known as "Peak Month" in City of Kingman Utility Regulations

2.3 CITY OF KINGMAN LAND USE

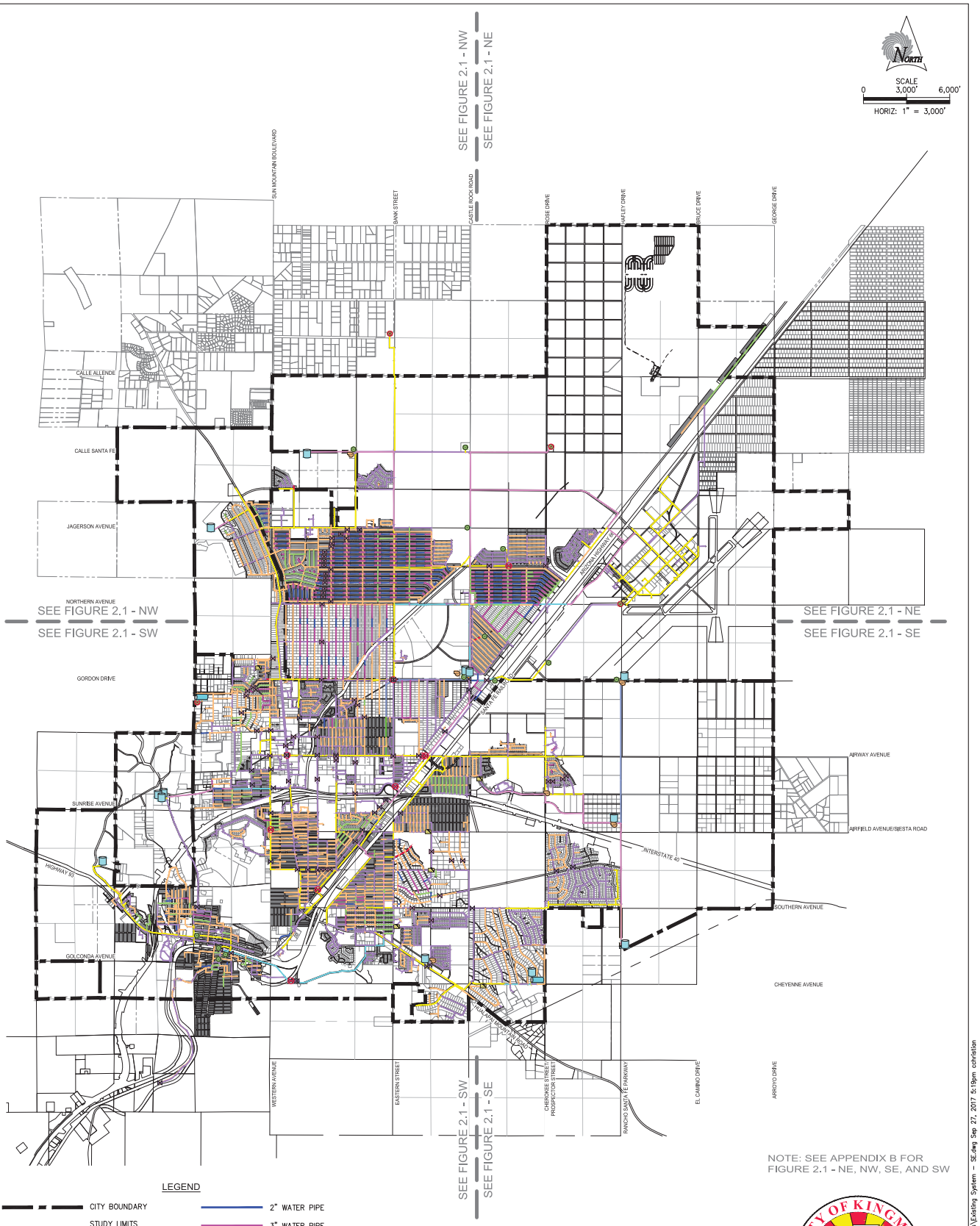
In March of 2014, the City of Kingman adopted an updated General Plan. A projected land use map was created in conjunction with the General Plan Update and details the projected land use designations for the City and surrounding areas based on the approved General Plan. The General Plan 2030 Projected Land Use Map was updated in October of 2016. See **Appendix A – City Water Use, Connection, & Population Data** for a copy of this map.

SECTION 2 FIGURES

Figure 2.1 – Existing System

Figure 2.2 – Existing System Schematic

Figure 2.3 – Existing Pressure Zones



NOTE: SEE APPENDIX B FOR FIGURE 2.1 - NE, NW, SE, AND SW

LEGEND

	CITY BOUNDARY
	STUDY LIMITS (WATER BOUNDARY)
EXISTING / PROPOSED	
	WELL
	INACTIVE WELL
	BACKUP WELL
	TANK
	PNEUMATIC TANK
	BOOSTER PUMP
	PRESSURE REDUCING VALVE (PRV)
	INACTIVE PRV
	ZONE VALVE
	CHECK VALVE
	2" WATER PIPE
	3" WATER PIPE
	4" WATER PIPE
	6" WATER PIPE
	8" WATER PIPE
	10" WATER PIPE
	12" WATER PIPE
	14" WATER PIPE
	16" WATER PIPE
	18" WATER PIPE
	20" WATER PIPE
	24" WATER PIPE

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 2.1
EXISTING SYSTEM

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CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 2.2
EXISTING SYSTEM SCHEMATIC

STORAGE TANKS
- 1 MAIN TANKS 1
- 2 MAIN TANKS 2
- 3 MAIN TANKS 3
- 4 BEALE SPRINGS
- 5 CAMELBACK
- 6 COLLEGE
- 7 RATTLESNAKE
- 8 HUALAPAI
- 9 RANCHO SANTA FE
- 10 FOOTHILLS (HUALAPAI 2)
- 11 WELL 11 FOREBAY
- 12 CASTLEROCK FOREBAY 1
- 13 CASTLEROCK FOREBAY 2
- 14 FOOTHILLS PNEUMATIC

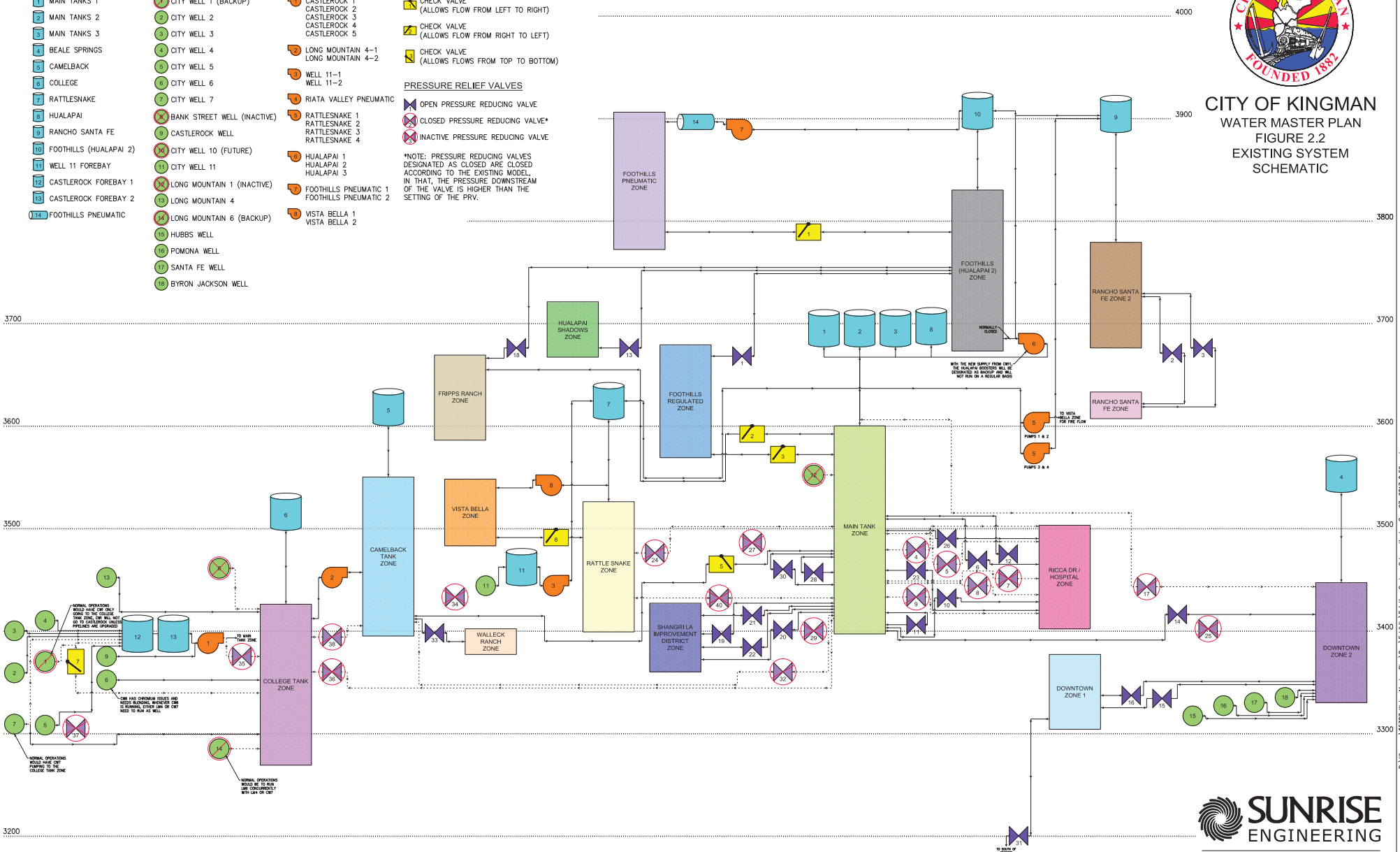
CITY WELLS
- 1 CITY WELL 1 (BACKUP)
- 2 CITY WELL 2
- 3 CITY WELL 3
- 4 CITY WELL 4
- 5 CITY WELL 5
- 6 CITY WELL 6
- 7 CITY WELL 7
- 8 BANK STREET WELL (INACTIVE)
- 9 CASTLEROCK WELL
- 10 CITY WELL 10 (FUTURE)
- 11 CITY WELL 11
- 12 LONG MOUNTAIN 1 (INACTIVE)
- 13 LONG MOUNTAIN 4
- 14 LONG MOUNTAIN 6 (BACKUP)
- 15 HUBBS WELL
- 16 POMONA WELL
- 17 SANTA FE WELL
- 18 BYRON JACKSON WELL

BOOSTER STATIONS
- 1 CASTLEROCK 1, CASTLEROCK 2, CASTLEROCK 3, CASTLEROCK 4, CASTLEROCK 5
- 2 LONG MOUNTAIN 4–1, LONG MOUNTAIN 4–2
- 3 WELL 11–1, WELL 11–2
- 4 RIATA VALLEY PNEUMATIC
- 5 RATTLESNAKE 1, RATTLESNAKE 2, RATTLESNAKE 3, RATTLESNAKE 4
- 6 HUALAPAI 1, HUALAPAI 2, HUALAPAI 3
- 7 FOOTHILLS PNEUMATIC 1, FOOTHILLS PNEUMATIC 2
- 8 VISTA BELLA 1, VISTA BELLA 2

CHECK VALVES
- CHECK VALVE (ALLOWS FLOW FROM LEFT TO RIGHT)
- CHECK VALVE (ALLOWS FLOW FROM RIGHT TO LEFT)
- CHECK VALVE (ALLOWS FLOWS FROM TOP TO BOTTOM)

PRESSURE RELIEF VALVES
- OPEN PRESSURE REDUCING VALVE
- CLOSED PRESSURE REDUCING VALVE*
- INACTIVE PRESSURE REDUCING VALVE

*NOTE: PRESSURE REDUCING VALVES DESIGNATED AS CLOSED ARE CLOSED ACCORDING TO THE EXISTING MODEL, IN THAT, THE PRESSURE DOWNSTREAM OF THE VALVE IS HIGHER THAN THE SETTING OF THE PRV.



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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
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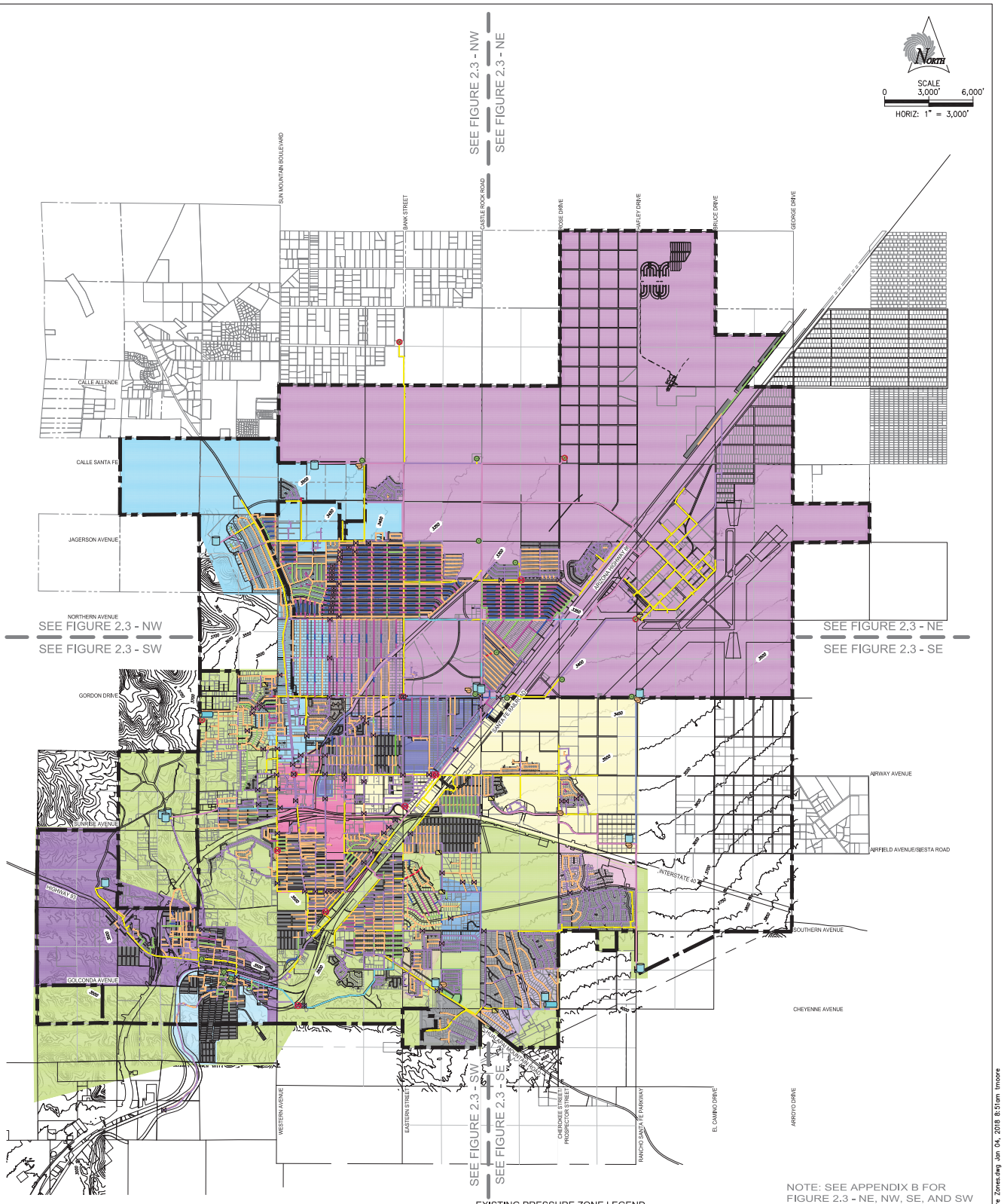

NOTE: SEE APPENDIX B FOR FIGURE 2.3 - NE, NW, SE, AND SW

LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE

- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE

EXISTING PRESSURE ZONE LEGEND

- MAIN TANK ZONE
  - DOWNTOWN ZONE 1
  - DOWNTOWN ZONE 2
  - RICCA DR / HOSPITAL ZONE
  - FRIPPS RANCH ZONE
  - HUALAPAI SHADOW ZONE
  - FOOTHILLS REGULATED ZONE
  - FOOTHILLS PNEUMATIC ZONE
  - FOOTHILLS (HUALAPAI 2) ZONE
  - RANCHO SANTA FE REGULATED ZONE
- CAMELBACK TANK ZONE
  - WALLECK RANCH ZONE
  - SHANGRI LA IMPROVEMENT DISTRICT ZONE
- COLLEGE TANK ZONE
- RATTLESNAKE ZONE

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 2.3
EXISTING PRESSURE ZONES

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3.0 DESIGN CRITERIA

The design criteria are the standards for which the system is analyzed and the basis of design for new facilities. Design criteria is based on Arizona Administrative Code (AAC), American Water Works Association (AWWA) standards and guidance, the City of Kingman Utility Regulations, engineering judgment, and the City's past experience with operating the water system. A summary of the design criteria chosen for this Water System Master Plan report is as follows:

3.1 AAC & ADEQ REQUIREMENTS

Arizona Administrative Code (AAC) requirements (R18-5-502 Minimum Design Criteria & R18-5-503 Storage Requirements) were considered when analyzing the water system. Moreover; per AAC requirements (R18-5-502A), all public water systems shall be designed using good engineering practices per ADEQ Engineering Bulletin No. 10, *Guidelines for the Construction of Water Systems*, issued by the Arizona Department of Health Services, May 1978 (and no future editions). City of Kingman utility regulations meet or exceed AAC & ADEQ requirements.

3.2 AWWA REQUIREMENTS

American Water Works Association (AWWA) M32 required minimum peaking factors were considered when recommending adjustments to existing City peaking factors. AWWA M32 storage requirements were also considered as part of the design criteria. In addition, AWWA M32 recommendations are the basis for the system booster pump design criteria. Recommended peaking factors as well as City of Kingman standard peaking factors meet or exceed AWWA minimum standards.

3.3 CITY OF KINGMAN REQUIREMENTS

City of Kingman Requirements were used for the majority of the water system design criteria. City standards were used for the basis of peaking factors, pipe sizing, fire flow demand and fire hydrant spacing. An overall summary of the design criteria used for the analysis for the existing water system and projected 10-year and 30-year water systems is summarized in **Table 3.1 - Design Criteria Summary** on the following pages.

Table 3.1 - Design Criteria Summary

	COMBINED SYSTEM		
	2017	**2027**	**2047**
Average Day (gal/day)	**5,942,664**	**7,607,112**	**12,465,139**
Average Day (gal/min)	**4,127**	**5,283**	**8,656**
Maximum Day (gal/day)[2]	**8,913,996**	**13,692,802**	**22,437,251**
Maximum Day (gal/min)	**6,190**	**9,509**	**15,581**
Peak Day (gal/day)	**11,885,328**	**19,017,781**	**31,162,848**
Peak Day (gal/min)	**8,254**	**13,207**	**21,641**
Peak Hour (gal/day)	**17,827,992**	**26,624,893**	**43,627,988**
Peak Hour (gal/min)	**12,381**	**18,490**	**30,297**

Maximum Day Factor[1]
1.5

Peak Day Factor[1]
2.0

Peak Hour Factor[1]
3.0

[1]Maximum Day ("Peak Month"), Peak Day, and Peak Hour Factors based on The City of Kingman Utility Regulations, Section 7.5 are 1.8, 2.5, and 3.5, respectively. The peaking factors shown are recommended based on local standards and comparable municipalities. These factors are multiplied by Average Day flows to get peak flows.

[2]The calculated maximum day demand factor for the peak month is 1.47 based on actual water usage (see **Table 2.7 – 2015 Monthly Water Usage Summary***)*

	SOURCE		
Source Required (gpm)	**6,809**	**10,460**	**17,140**

<u>Source (Wells) Design Criteria</u>

Must meet Maximum Day Demand Plus 10% with the Largest Well Out of Service

Table 3.1 - Design Criteria Summary (continued)

	STORAGE		
	2017	**2027**	**2047**
Equalizing & Emergency Storage (gal)	5,348,398	8,558,001	14,023,282
Fire Storage (gal)	1,920,000	1,920,000	1,920,000
Total Storage Volume Required (gal)	**7,268,398**	**10,478,001**	**15,943,282**

Storage Design Criteria

Storage will be sized to Equalizing Storage + Emergency Storage + Fire Flow.

Equalizing Storage =	*25%*	*of Maximum Day*					
Emergency Storage =	*20%*	*of Maximum Day*					
Fire Flow =	*2*	*Commercial Fires*	*+*	*2*	*Residential Fires*		
Commercial Fire =	*3500*	*gallon per minute for*		*4*	*hours*	840,000	*gal*
		(This assumes a big box store with a sprinkler system)					
Residential Fire =	*1000*	*gallon per minute for*		*2*	*hours*	120,000	*gal*
		(This assumes houses smaller than 3,600 square feet)					

	BOOSTER PUMPS		
Pumps Required (gpm)	**12,381**	**18,490**	**30,297**

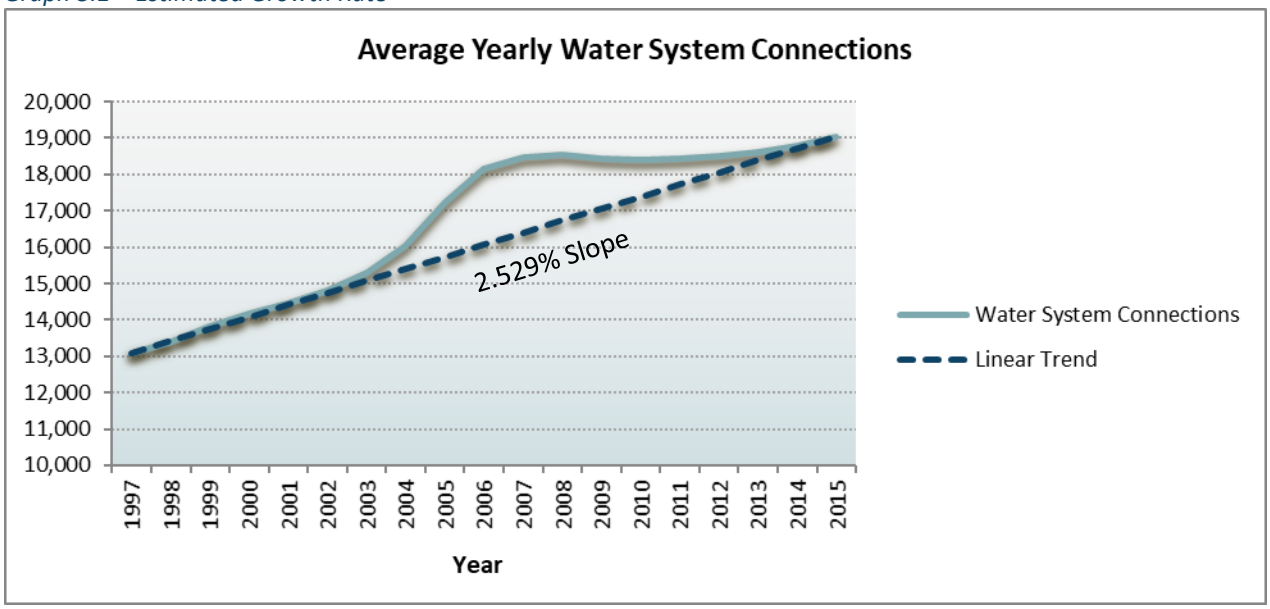
Booster Pump Design Criteria

'The combined booster pumps' capacities (with the largest pump out of service) of the system must be able to deliver Peak Hour flow.

3.4 CONNECTIONS & POPULATION GROWTH

Future demand projections are connection based. Population is calculated to compare with census population projections. The estimated growth rate was determined from historical number of accounts from the years 1997 to 2015 provided by the City. See **Appendix A – City Water Use, Connection, & Population Data** for the historic data supplied from the City. The average number of connections (accounts) were plotted by year and a linear trend of the data was extrapolated. The growth rate of number of connections in the system has a linear trend of approximately 2.5%. There is an extreme rise in connections within 2004 through 2006 and then nearly no rise in connections within 2006 through 2012. This jump and fall in connections is similar to the rise and fall of the population growth rate within the nation due to the economic boom in the 1990's and early 2000's followed by the Great Recession in the late 2000's and early 2010's. This jump and fall in connections is not included in the estimated growth rate because it does not follow the "normal" pattern of growth in the City. See **Graph 3.1 – Estimated Growth Rate** for a graph of number of connections in the system.

Graph 3.1 – Estimated Growth Rate



The conclusion of the analysis of this information is that a 2.5% growth rate is reasonable for future connection and populations projections.

According to City of Kingman Utility Regulations, Article VII: Water Distribution and Sewer Collection, population projections shall be based on the following minimum design standard:

- Single Family Residential Projections = 3.5 persons per lot minimum

However, with City staff input, it was decided because this water system analysis is based on the entirety of the City and therefore many different zoning types, population projections will be in accordance with the following recommended criteria:

- 2.5 people per connection

3.5 DEMAND FACTORS

The analysis and definitions for the system water use calculations will be in accordance with the following demand factors. Demand factors are used in determining source, storage, and booster pump minimum requirements. Demand factors are used to multiply the average daily use within the water system to determine required need. Average Daily Use (ADU) within the system is defined as a per day average of water usage (gal/day and gpm) within the water system over any year from January to December.

Maximum day demand factor is calculated by dividing the month with the highest water usage (gal/month) by the average monthly water usage (gal/month) throughout the year. The maximum day demand factor is applied to the ADU to estimate the water use (gal/day and gpm) during the highest water use month in the year, usually June, July, or August. The maximum day demand factor is also known as the "Peak Month" factor in the City of Kingman Utility Regulations. Maximum day demand factor is used to determine total source as well as equalizing and emergency storage requirements.

Peak day demand factor is applied to the ADU to estimate the water use (gal/min) during the highest day of demand in the system during the year. Peak day demand factor is used, in the model, in a steady state scenario as well as when running the fire flow scenario.

Peak hour demand factor is applied to the ADU to estimate the water use (gal/min) during the highest hour of demand in the system during the year. Peak hour demand is used to determine booster pump requirements within the system as well as in the model, as the worst-case scenario in the steady state analysis.

According to City of Kingman Utility Regulations, Article VII: Water Distribution and Sewer Collection, water use analysis calculations shall use the following peaking factors for design:

- Average Day Demand = Average of Actual Monthly Water Usage
- Maximum Day Demand = 1.8 x Average Day Demand
- Peak Day Demand = 2.5 x Average Day Demand
- Peak Hour Demand = 3.5 x Average Day Demand

However, recommendations were made to modify the City of Kingman demand factors. See **Table 3.2 – Peaking Factor Analysis** for a table of the peaking factors used for the selection of recommendations for demand factors used in the water system analysis.

Table 3.2 – Peaking Factor Analysis

	Town of Gilbert	Town of Queen Creek	City of Mesa	City of Phoenix	AWWA M32	Current City of Kingman Standard	Recommended City of Kingman Standard
Maximum Day Demand Factor (Avg. Daily Used Hottest Month)		1.65				1.80	1.50*
Peak Day Demand Factor	1.55	1.8	2.0	1.7		2.50	2.0
Peak Hour Demand Factor	1.8 to 2.4	3.0	3.0	n/a	2.15 to 3.30	3.50	3.0

* Maximum Day demand factor for the peak month is calculated as 1.47 based on actual water usage. See **Table 2.7 – 2015 Monthly Water Usage Summary** for calculation.

Through careful comparison of American Water Work Association (AWWA) requirements and current standards of similar local municipalities, the water use analysis and calculations will be in accordance with the following recommended criteria:

- Average Day Demand = Average of Actual Monthly Water Usage
- Maximum Day Demand = 1.5 x Average Day Demand
- Peak Day Demand = 2.0 x Average Day Demand
- Peak Hour Demand = 3.0 x Average Day Demand

Maximum day demand factor was calculated with 2015 water usage data as 1.47 based on dividing the month with the highest water usage (July) by the average monthly water usage throughout the year. The recommended maximum day demand factor is based on the calculation, rounded to the tenths place. The recommended peak day and peak hour factors are based on the need to align the City of Kingman standard peaking factors with AWWA requirements and those of similar local municipalities.

3.6 SOURCE

Source water is the supply of water to a water system, which can include surface waters such as rivers, lakes, or reservoirs, or, in the City's case, ground waters such as aquifers. Water wells, within the system, supply water from the aquifer to the surface to be used to distribute flow to the City. The analysis and definitions for the water source analysis and calculations will be in accordance with the following criteria:

- Total Source Requirement = Maximum Day Demand + 10%
- Largest Well Out of Service (for maintenance, repair, or other reasons)
- Estimated Flow Rate of City Well #10 = 2,900 gpm
- Estimate Flow Rate of New Wells = 2,000 gpm

The water source must be capable of delivering the flows required in a peak day scenario plus ten percent (10%) with the largest well out of service. Developing the system sources to meet design criteria allows the water system to meet demands on the highest usage day without using water that has been stored in tanks. Margins of safety are; an additional ten percent (10%) of peak day demand and the largest well out of service for maintenance, repair, or other reasons. Source water generated in excess of the system demands (at low demand periods) is used to fill storage tanks. Low demand periods are typically late at night to early morning.

3.7 STORAGE

Water system storage is the total capacity of reservoirs or tanks within the water system. The analysis and definitions for the water storage analysis and calculations will be in accordance with the following criteria:

- Storage Volume = Equalizing + Emergency + Fire Flow Storage
    - Equalizing Storage = 25% of Maximum Day Demand
    - Emergency Storage = 20% of Maximum Day Demand
    - Fire Flow Storage = 2 Commercial + 2 Residential Fires
        - Commercial Fire = 3,500 gpm for 4 hours
        - Residential Fire, Existing = 1,000 gpm for 2 hours

Water storage criteria are based on AAC and AWWA recommendations. AAC Title 18 Chapter 5 Article 5 Section 503.B Storage Requirements specifies the minimum storage capacity for a multiple-well system as the total daily production capacity minus the production from the largest producing well. If enough wells are in the system, the storage required can be reduced to zero. Zero storage is not feasible unless the system sources were able to meet peak hour demands. Source water that provides peak hour demand is usually not feasible as source water tends to be a steady flow rate while peak hour demands change quickly, often over short periods of time. AWWA M32, specifies that the water system shall have equalizing storage, emergency storage and fire flow storage.

3.7.1 Equalizing Storage

AWWA generally defines equalizing storage as one half of the total storage required, about 10 to 15 percent of the average day demand, and could exceed 30 percent in arid climates. Kingman is generally in an arid climate; thereby, equalizing storage should be closer to 30 percent of the average day demand. Equalizing storage is a balance of source water being pumped versus storage space. Equalizing storage supplies all systems demands above the average rate.

3.7.2 Emergency Storage

Emergency storage provides water during emergency situations, such as pipeline and equipment failures. Emergency storage is typically allocated by a risk assessment performed by the owner. AWWA does not provide guidance for allocating emergency storage. More storage has the effect of reducing risk and allows longer system down times in the event of a failure. Less storage could result in a system outage in which water would not be available to meet system demands. Emergency storage was designed as 20 percent of the maximum day storage demand because it is a factor of safety in the case where well(s) and/or tank(s) are out of service for maintenance, repair or other reasons.

3.7.3 Fire Flow Storage

Fire storage is the water stored for a flow and duration of a fire. Fire storage does not have to be allocated to one (1) tank and can be spread around different tanks in the system. For this Water System Master Plan, the City has chosen to provide fire storage for two (2) commercial building fires and two (2) residential fires at the same time.

3.8 BOOSTER PUMPS

Booster pumps are machines which increase the pressure of water within the system. Booster pumps are used to supply water from low elevations to high elevations with adequate pressure to provide water to the ends of the distribution system. The analysis and definitions for the booster pump design criteria will be in accordance with the following standards:

- Booster Pump Capacity = Peak Hour Demand
- Largest Pump Out of Service

The booster pump design criteria are primarily based on AWWA M32 recommendations. AWWA recommends that source pumps be sized for peak day demand plus fire flow with the largest pump out of service and that booster pumps that pump out of tanks be sized for the peak hour demand.

The highest demand in the system is peak hour demand. The design criteria requires that the booster pumps be sized to meet peak hour demand with the largest pump out of service. The largest pump out of service provides a factor of safety. Booster pumps are typically installed at storage tank sites in an array of two (2) to four (4) pumps. The booster pump capacity after the largest pump is taken out of service is called the firm capacity. The firm capacity is calculated for every pump site. The firm capacity of the total system is the sum of the firm capacity for each pump site.

AAC Title 18 Chapter 5 Article 5 Section 502.B Minimum Design Criteria states, the system shall maintain pressure of at least 20 pounds per square inch at ground level at all points in the distribution system under all conditions. The City's utility regulations, used in this Water Master Plan, require that the system be designed to maintain a minimum static pressure of 40 pounds per square inch and a minimum residual pressure of 20 pounds per square inch at ground level at all conditions of flow. This design criteria ensures that there is enough booster pump capacity working in conjunction with gravity tanks to deliver the required flows at greater than minimum pressures, and meet both AAC and City design criteria.

3.9 DISTRIBUTION SYSTEM REQUIREMENTS

The analysis for the water distribution system will be in accordance with the following criteria:

3.9.1 Flow Simulations

A steady state flow simulation was conducted on the system using average day, peak day, and peak hour demands. Steady state simulations are performed without time steps. The peak hour modeled demands are considered worse case and most taxing on the system. Average day demand is the historic 2015 average demand established in **Section 2.2.4 - Historic Water Usage**. Peak day demand is the highest day of demand in the system during the year. Peak day demand has a factor of 2.0 times average day per **Section 3.5 - Demand Factors**. Peak hour is the demand represented when the system experiences peak usage in short bursts, such as in the morning when water system customers are getting ready for the day. Peak hour demand has a factor of 3.0 times average day per **Section 3.5 - Demand Factors**.

These demands are intended to simulate how the water system operates at a wide range of flows throughout the entire year with all of the water system facilities performing and/or contributing to the system. The peak hour analysis results are provided in this report as the worst-case results for the steady state analysis. The peak hour analysis results provide the static pressure of the node at the assigned junction demand. The minimum allowable static pressure at any point in the system during these scenarios is 40 pounds per square inch per the City of Kingman Utility Regulations, section 7.5.

Fire flow simulations were conducted on the system at peak day demand on nodes throughout the system (one at a time) to simulate the available fire flow at peak day demand. The fire flow simulation shows the water system's ability to produce fire flow at each node in the system. The fire flow analysis results provide the residual pressure of the node at the assigned fire flow rate. The minimum allowable residual pressure at any point in the system during these scenarios is 20 pounds per square inch per the City of Kingman Utility Regulations, section 7.5.

Model nodes were assigned a fire flow of 1,000 gallons per minute for residential fire flow demand and 3,500 gallons per minute for commercial and industrial fire flow demand. Fire flow was assigned to nodes based on existing infrastructure and the City of Kingman General Plan 2030 Projected Land Use Map.

Nodes that could not supply the assigned fire flow are identified in red in the model output figures. Many nodes can supply far greater flows then the assigned minimum. The model output figures classify ranges of residual pressure available at each node for the assigned fire flow. The City adopted the International Fire Code (IFC) currently 2012. Typically, residential fire flow in the IFC is in the 1,000 to 1,500 gallons per minute range and varies by square footage and if fire sprinklers are installed.

According to the City of Kingman Utility Regulations Article III: Water System Section 3.7A-3 fire hydrant spacing shall be in accordance with the following minimum distance guidelines:

- Industrial/Commercial Zone = 300 feet
- Residential Zone = 600 feet
- Rural Zone = 800 feet

However, according to the City, ADEQ has been requiring the City to limit spacing in residential and rural areas to 500 feet between hydrants. Moreover, the City is proposing an amendment to their standards to reflect this change. Therefore, proposed design criteria for fire hydrant spacing within the water system will be in accordance with the following standards:

- Industrial/Commercial Zone = 300 feet
- Residential/Rural Zone = 500 feet

3.9.2 Pipes

Pipes in the distribution system were modeled and sized following the design criteria:

- Hazen Williams 'C' based on pipe age for Cast Iron Pipe – See **Table 3.3 – Pipe Roughness Coefficients by Age** for the values used for modeling the existing pipes within the system
- Maximum velocity of 5 feet per second for 12-inch diameter and less

Table 3.3 – Pipe Roughness Coefficients by Age

Pipe Built in Decade	Pipe Age (years)	Roughness Coefficient ('C-Value')
2010	Up to 7	140
2000	8-17	120
1990	18-27	100
1980	28-37	100
1970	38-47	100
1960	48-57	100
1950	58-67	100
1940	68-77	100

To apply pipe roughness by age, the pipe age will be assigned to the pipes within the model based on information provided by as-builts and City staff input. See **Figure 3.1 – Existing Pipe Ages** for the ages assigned to the pipes by decade.

New pipes added to the water system models are generally 8 inches and larger. Pipes are shown in locations that generally align with how collector and arterial streets in a subdivision development would be constructed.

Pipe head loss criteria are based on AWWA M32 recommendations. Generally, pipe diameters smaller than 12 inches are used for distribution and larger than 12 inches are used for transmission mains where less head loss is required because the total head loss over long runs of pipe can become significant. Ultimately, head loss and velocity criteria are flexible as long as minimum pressure criteria are being met at the most stringent demand.

3.9.3 Proposed Pressure Zones

Proposed pressure zones were designed to have an operating range in the distribution system of about 40 to 90 pounds per square inch. The design pressure zone will have an upper and lower contour elevation as identified in the distribution sections in which they are described. The upper elevation is where the pressure will generally be 40 pounds per square inch. Elevations higher than the upper elevation will result in pressures less than 40 pounds per square inch. The lower elevation is the elevation where the pressure will generally be 90 pounds per square inch. Elevations lower than this will result in pressures higher than 90 pounds per square inch. Connections on the low side, 40 pounds per square inch or less, of a zone break may have to be connected to the adjacent higher zone. At times, switching subdivisions from lower to higher zones may result in pressures that are higher than 90 pounds per square inch. Connections with water pressure higher than 90 pounds per square inch will require a pressure reducing valve be installed on the customer side of the connection.

3.9.3.1 Pressure Reducing Valves

Pressure reducing valves (PRV) reduce pressure in the flow direction of the valve, and act as a check valve by closing when flow is reversed. The PRV maintains a steady, predetermined pressure in the system downstream of its location regardless of upstream pressure or changing flow. If the downstream pressure is higher than the inlet pressure, the valve will close, preventing reverse flow.

PRV's are generally installed in water systems in series at pressure zone boundaries. At the zone boundaries, PRV's reduce pressure as water crosses from the higher pressure zone to a lower pressure zone.

The design criteria for PRV's is to have the set pressure more or less match the downstream hydraulic grade. The pressure may be adjusted as desired by the operator to vary flow through the valve. Typically, PRV's will be closed and only used to transfer water between pressure zones in extreme cases of low pressure. In these extreme cases, where lower zone system pressure cannot be sustained and pressure drops below the PRV set point, the PRV valve is allowed to open and pass flow through from a higher pressure zone to a lower pressure zone. Examples of extreme cases would be multiple fires or an electrical outage at a booster pump station in the lower zone.

At times PRV's can also be used to continuously supply source water from higher pressure zones to lower pressure zones. PRV's that convey water are proposed to be used in the City's system and will be identified and described in the sections of the report in which they are used.

3.9.3.2 Zone Valves

Zone valves (ZV) are used to segregate flow within the water system. Zone valves are used in the City of Kingman water system typically in between pressure zones. This is a less effective way to manage pressure between zones compared to parallel lines in combination with PRV's, and has created multiple "dead end" lines within the system and reduces looping.

3.10 WATER MODELING SOFTWARE

The water system steady state modeling and fire analysis was performed using the Innovyze software H_2ONET Analyzer. The software version used is H_2ONET Analyzer 12 for AutoCAD version 11.0, Service Pack 1, Update 2. H_2ONET Analyzer is a powerful and complete water distribution modeling, analysis, and design software. It performs fast, reliable, and comprehensive hydraulic modeling and fire flow analysis.

The C5 water model from 2005 was used as a base for the existing system Water Master Plan model. This model was converted the model from the Haestad Method's WaterGems for GIS software to H_2ONET Analyzer.

The scope of this Water System Master Plan limited the modeling to steady state analysis. In the future, a more comprehensive and detailed dynamic water modeling can be performed on the system which would provide reports such as tank fill times, tank levels throughout the day (including emptying during peak hour demands), fill times at night and pump flow at every time step modeled. The H_2ONET software is capable of dynamic water modeling, water quality modeling, energy management, real-time simulation, and control with automated on-line SCADA interface.

3.11 COST ESTIMATION

Unit costs used for project cost estimation include all labor and material cost. Unit costs are based on bid tabulations obtained from similar construction projects. Unit costs are as follows:

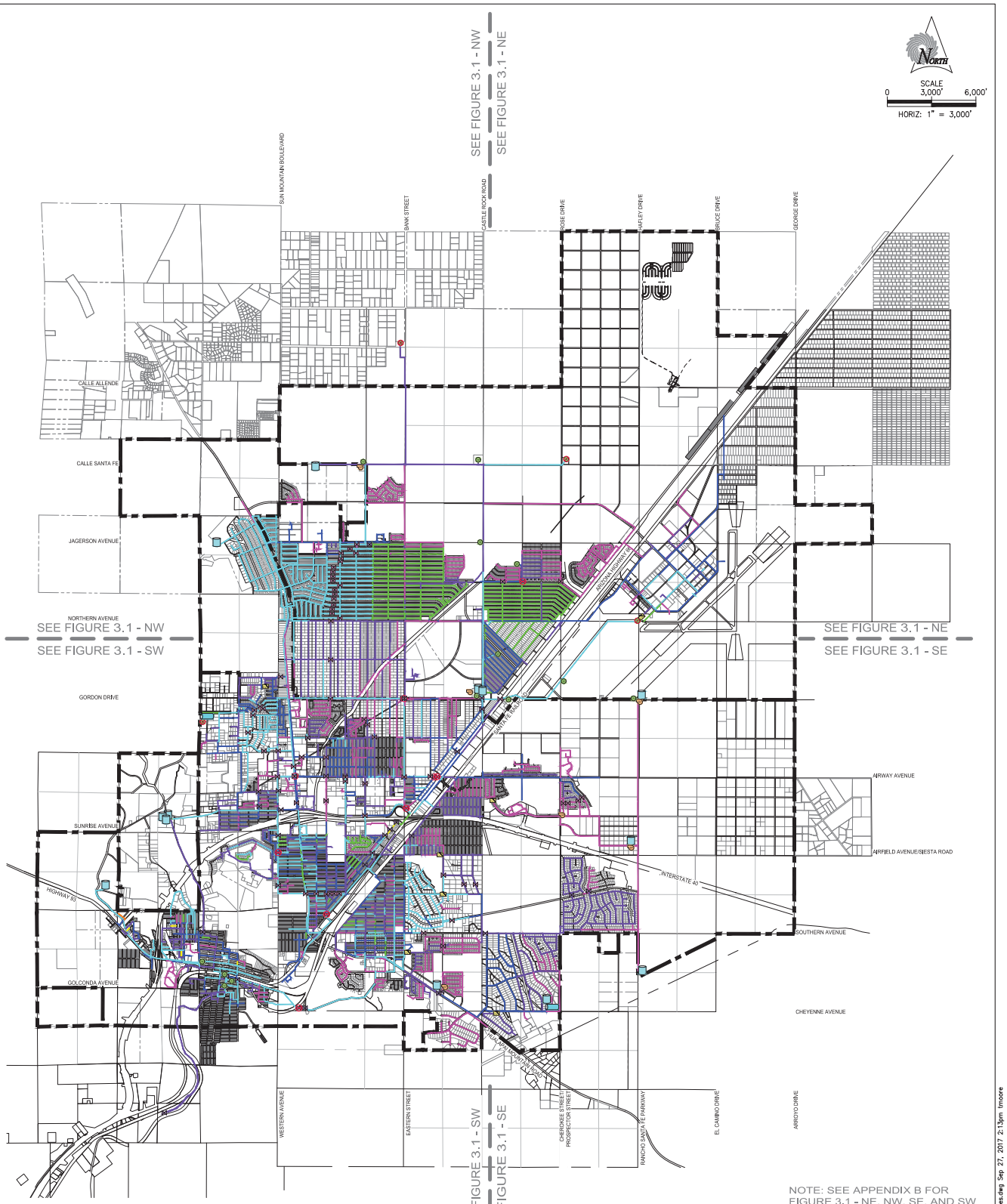
- Water Lines (6-inch) = $45 per linear foot
- Water Lines (8-inch) = $55 per linear foot
- Water Lines (12-inch) = $100 per linear foot
- Water Lines (16-inch) = $125 per linear foot
- Water Lines (24-inch) = $200 per linear foot
- Water Valve, Box, and Cover = $2,500 each (per 500 linear foot of water line) (6" to 12")
- Fire Hydrant Assembly with Gate Valve = $4,500 each
- 8" PRV Station = $75,000 each
- 12" PRV Station = $100,000 each
- 16" PRV Station = $125,000 each
- Well Drilling @ 2,000 gpm = $350,000 each
- Well Equipping = $750,000 each
- Storage Tanks = $1 per gallon of storage
- Booster Pump Station = $450,000 each

Some of the projects proposed have unique elements and conditions, in which these unit costs have been adjusted to accommodate such conditions. In addition, not all unit costs for each project are shown above.

Cost estimates will also include rough calculations for engineering, administration, right-of-way and land acquisition, and other costs associated with completing the project.

SECTION 3 FIGURES

Figure 3.1 – Existing Pipe Ages



NOTE: SEE APPENDIX B FOR FIGURE 3.1 - NE, NW, SE, AND SW

LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE

- 1940'S INFRASTRUCTURE
- 1950'S INFRASTRUCTURE
- 1960'S INFRASTRUCTURE
- 1970'S INFRASTRUCTURE
- 1980'S INFRASTRUCTURE
- 1990'S INFRASTRUCTURE
- 2000'S INFRASTRUCTURE
- 2010'S INFRASTRUCTURE

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 3.1
EXISTING PIPE AGES

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

P:\Kingman\05387 Water Master Plan\Dwg\Exhibits\Existing Pipe Ages.dwg Sep 27, 2017 2:13pm tmoore

4.0 EXISTING (2017) WATER SYSTEM ANALYSIS

The existing water system was analyzed and compared to the design criteria presented in **Section 3.0 - Design Criteria** in regards to available water system source, storage, and booster pump demands. Zonal distribution of source, storage and booster pump capacity was evaluated as to determine need and safety, in the form of redundancy, within the system. The existing water distribution system was examined to provide adequate pressures on an average day, month, year as well as in fire flow conditions. Two models were created for the existing (2017) system analysis. The existing model was generated from the WaterGems model from the C5 Water Master Plan completed in 2005, as explained in **Section 3.10 - Water Modeling Software**, and verified with the help of the City's data as described in **Section 2.1 - Water System Inventory**. The existing improvements model was produced as a copy of the existing model and modified per the recommended improvements proposed for the existing system.

4.1 WATER DEMAND ANALYSIS

Existing water demand was determined by analyzing historical water usage data to determine average usage per connection in the system. The City provided 2015 monthly consumption data for the water system broken down by user type. Generally, residential and non-residential accounts consisted of a 91 percent to 9 percent split respectively; however, residential and non-residential usages consisted of a 60 percent to 40 percent split respectively. See **Table 4.1 – 2015 Monthly Number of Water Accounts by User Type** and **Table 4.2 – 2015 Monthly Water Consumption by User Type** for the breakdown of water accounts and water consumption by user type. Non-residential usage is the total of irrigation, commercial, and municipal water. The City also provided a total of non-metered municipal water, which includes water line leakage, as well as water used for street maintenance, sewer cleaning, construction, and water used by the City Fire Department. The non-metered municipal water usage is not included in the total consumption value.

The City has elected to estimate demand in the model by dividing the total usage by the average number of total connections (residential and non-residential combined) rather than splitting the demand into individual residential and non-residential components. Analyzing the data in this manner creates a blended rate between residential and non-residential usage. This method assumes the ratios of residential and non-residential accounts and usage remain relatively similar to historical ratios. See **Table 4.3 – 2015 Monthly Total System Water Consumption Summary** for a table of the total system water usage and demand calculations. See **Appendix A – City Water Use, Connection, & Population Data** for archival system flow data supplied by the City. If, in the future, the City concludes that development has varied significantly from the residential versus non-residential ratios as determined in this Master Plan Update, additional examination may be required to project demand and infrastructure needs accordingly.

Table 4.1 – 2015 Monthly Number of Water Accounts by User Type

Month	Days per Month	Irrigation	Commercial	Municipal	Residential	Total
January	31	243	1,335	56	17,268	18,902
February	28	240	1,338	50	17,222	18,850
March	31	243	1,333	60	17,311	18,947
April	30	239	1,328	66	17,383	19,016
May	31	241	1,320	69	17,391	19,021
June	30	245	1,329	70	17,408	19,052
July	31	244	1,329	69	17,525	19,167
August	31	247	1,328	71	17,462	19,108
September	30	251	1,331	73	17,468	19,123
October	31	252	1,335	69	17,553	19,209
November	30	250	1,332	71	17,443	19,096
December	31	250	1,334	70	17,423	19,077
Average Connections		245	1,331	66	17,405	19,047
		Avg. Non-Residential Accounts	**1,643**	**Avg. Residential Accounts**		**17,405**
		% of Total Accounts	**9%**	**% of Total Accounts**		**91%**

Table 4.2 – 2015 Monthly Water Consumption by User Type

Month	Days per Month	Irrigation	Commercial	Municipal	Residential	Total	Non-Metered Municipal	Grand Total
January	31	4,728,020	30,434,530	3,310,550	86,244,450	124,717,550	111,540	124,829,090
February	28	6,248,460	26,326,000	3,943,550	75,769,150	112,287,160	157,440	112,444,600
March	31	12,510,020	21,288,780	9,560,630	76,949,340	120,308,770	245,557	120,554,327
April	30	22,938,270	20,820,380	17,635,400	103,229,420	164,623,470	118,625	164,742,095
May	31	38,771,680	5,849,830.00	35,131,280	113,197,920	192,950,710	538,330	193,489,040
June	30	46,025,290	9,850,850.00	34,703,390	132,274,880	222,854,410	231,244	223,085,654
July	31	62,336,590	7,711,610.00	45,417,440	154,781,880	270,247,520	181,850	270,429,370
August	31	56,999,450	8,192,100	40,838,300	139,769,220	245,799,070	428,050	246,227,120
September	30	52,625,490	9,169,750.00	35,701,850	129,022,100	226,519,190	1,179,410	227,698,600
October	31	44,452,610	14,820,420	30,813,590	125,189,860	215,276,480	285,245	215,561,725
November	30	24,416,300	17,786,510	16,713,680	88,684,000	147,600,490	494,485	148,094,975
December	31	12,293,040	24,557,190	8,876,340	83,476,360	129,202,930	4,093,226	133,296,156
Total Use (gallons/yr)		384,345,220	196,807,950	282,646,000	1,308,588,580	2,172,387,750	8,065,002	2,180,452,752
Total Use (Mgal/yr)		384	197	283	1,309	2,172	8	2,180
Total Use (ac-ft/yr)		1,179	604	867	4,016	6,666	25	6,691
Total Non-Residential (gal/yr)			**863,799,170**	**Total Residential (gal/yr)**		**1,308,588,580**		
% of Total Use			**40%**	**% of Total Use**		**60%**		

4.1.1 Total Water Usage

The total system; residential and non-residential, water accounts and usage rates are shown in **Table 4.3 – 2015 Monthly Total System Water Consumption Summary**. This table is used to calculated the average daily water use per connection within the water system. The average daily water use of 312 gallons per connection per day is used for future demand projections.

Table 4.3 – 2015 Monthly Total System Water Consumption Summary

Month	Days per Month	Number of Accounts	Water Usage (gal/month)	Water Usage (gal/day)	Water Usage (gal/min)	Water Usage (gal/conn/day)
January	31	18,902	124,717,550	4,023,147	2,794	213
February	28	18,850	112,287,160	4,010,256	2,785	213
March	31	18,947	120,308,770	3,880,928	2,695	205
April	30	19,016	164,623,470	5,487,449	3,811	289
May	31	19,021	192,950,710	6,224,216	4,322	327
June	30	19,052	222,854,410	7,428,480	5,159	390
July*	31	19,167	270,247,520	8,717,662	6,054	455
August	31	19,108	245,799,070	7,929,002	5,506	415
September	30	19,123	226,519,190	7,550,640	5,244	395
October	31	19,209	215,276,480	6,944,403	4,823	362
November	30	19,096	147,600,490	4,920,016	3,417	258
December	31	19,077	129,202,930	4,167,836	2,894	218
	Average	**19,047**	**181,032,313**			**312**

*Peak Month

Average Daily Use (ADU)	**5,940,336**	**gal/day**
Average Daily Use (ADU)	**4,125**	**gpm**

	Calculated Based on Usage	Current Kingman Utility Regulations	Recommended Design Criteria
****Maximum Day Demand Factor (x ADU)**	**1.47**	**1.80**	**1.50**
Maximum Day (gal/day)	**8,717,662**	**10,692,605**	**8,910,504**
Maximum Day (gpm)	**6,054**	**7,425**	**6,188**
Peak Day Demand Factor (x ADU)		**2.50**	**2.00**
Peak Day Demand (gal/day)		**14,850,840**	**11,880,672**
Peak Day Demand (gpm)		**10,313**	**8,250**
Peak Hour Demand Factor (x ADU)		**3.50**	**3.00**
Peak Hour Demand (gal/day)		**20,791,176**	**17,821,008**
Peak Hour Demand (gpm)		**14,438**	**12,375**

**Also known as "Peak Month" in City of Kingman Utility Regulations

4.2 WATER SOURCE ANALYSIS

A water source analysis was conducted for the Existing system in 2017. The minimum required water source for the system is maximum day demand plus 10 percent with the largest well out of service, as defined in **Section 3.0 - Design Criteria**. The maximum day factor is 1.5 times average day water demands. In 2015, the system had 19,047 total average connections. The required minimum source was calculated to be 9.81 million gallons per day of source water. Existing wells in the water system can deliver 20.88 million gallons per day of water. This total capacity does not include City Well 1 and Long Mountain Well 6, which are backup wells, as well as Bank Street Well and Long Mountain Well 1 which are inactive wells, and City Well 10, which is a drilled well that is not yet connected to the system. The largest wells in the system are City Well 5 and City Well 7, which each have a capacity of 3.31 million gallons per day. With either City Well 5 or City Well 7 out of service, the existing wells in the system can deliver 17.57 million gallons of water per day. The existing system delivers enough source water to meet minimum design criteria for existing demand. The activation of backup wells would increase the available source by another 3.17 million gallons. For minimum required source calculations, see **Table 4.4 – Existing Water Source Analysis**.

Table 4.4 – Existing Water Source Analysis

	Capacity (gpm)	Capacity (MGD)
Total Source	14,500	20.88
Total Available Source*	**12,200**	**17.57**
Minimum Required	6,809	9.81

**Largest Well out of Service*

All but four (4) of the wells within the water system are located north of the City boundary. Most of these wells feed the Castlerock booster station. This creates a challenge because some of the zones in the southeast quadrant of the City do not have a redundant source.

The four (4) wells within City limits are all located within the downtown area and supply the downtown zones.

4.3 WATER STORAGE ANALYSIS

Water storage for the Existing connections was checked against storage criteria as defined in **Section 3.0 - Design Criteria**. Required storage is the sum of the equalization storage, emergency storage, and fire storage. Equalization storage is 25 percent of maximum day demand, which is about 38 percent of average day demand. Emergency storage is 20 percent of the maximum day demand, which is about 30 percent of average day demand. Fire storage is calculated as the volume equal to two (2) commercial fires and two (2) residential fires. Commercial fire storage is defined as 3,500 gallons per minute over a four (4) hour period per fire. The total system wide commercial fire flow storage requirement is equal to 1.68 million gallons. Residential fire storage is defined as the volume equal to 1,000 gallons per minute over a two (2) hour period per fire. The total system wide residential fire flow storage requirement is equal to 240,000 gallons. Total system wide combined residential and commercial fire flow storage is 1.92 million gallons. Adding fire flow to emergency storage and equalization storage, in 2017, the existing condition storage requirement was approximately 5.93 million gallons. The storage tanks within the existing system in 2017 have a total capacity of 13.28 million gallons. Therefore, the system has over double the required storage capacity. For minimum required storage calculations see **Table 4.5 – Existing Water Storage Analysis**.

Table 4.5 – Existing Water Storage Analysis

	Capacity (gallons)	Capacity (MG)
Total Available Storage	**13,276,000**	**13.28**
Minimum Required	5,931,298	5.93

Even though the system as a whole has over double the required storage, some of the pressure zones have considerable excess storage while others are deficient, specifically the Foothills and Rancho Santa Fe Zones. Moreover, having storage redundancy either within specific zones or across zones is important in fire flow conditions. Redundancy is not available in some of the zones, specifically, the Foothills, Rancho Santa Fe, Rattlesnake Tank, or College Tank Zones.

4.4 BOOSTER PUMP ANALYSIS

Booster pumping capacity of the Existing system was checked against booster pump criteria as defined in **Section 3.0 - Design Criteria**. Booster pumps must be able to supply peak hour demand with the largest pump out of service. Peak hour demand is 3.0 times average day demand. The booster pump capacity after the largest pump is taken out of service is the firm capacity. The firm capacity is calculated for every pump site. The firm capacity of the total system is the sum of the firm capacity for each pump site. In 2017, the existing booster pump capacity required was 17.83 million gallons per day. The system has a firm booster pump capacity of 34.42 million gallons per day. The system currently provides enough booster pump capacity required to meet design criteria. For minimum required booster pump calculations see **Table 4.6 – Existing Booster Pump Analysis**.

Table 4.6 – Existing Booster Pump Analysis

	Capacity	Firm Capacity*
Total Available Booster Capacity (GPM)	31,410	23,905
Total Available Booster Capacity (MGD)	**45.23**	**34.42**
Minimum Required (MGD)	-	17.83

**Largest Pump out of Service*

Booster pumps within the water system serve a variety of uses. The booster pumps within the existing system either feed directly to the distribution system, feed to the distribution system via PRV's, or boost to storage tanks within the system. Some booster pump stations have a combination of uses, such as the Rattlesnake Booster Station, in which two (2) of the booster pumps are dedicated to filling the Rancho Santa Fe Tank and two (2) of the booster pumps are dedicated to feeding the Rattlesnake Tank Zone.

Some of the booster pumps are not utilized in the most efficient or cost effective manners. For example, the Castlerock Booster Station serves many zones within the system including the Main Tank, College Tank, Shangri La (within the Camelback Tank Zone), and Rattlesnake Tank Zones. However, these zones are located within different areas of the water system, have different elevations in which to serve, and therefore require different Hydraulic Grade Lines (HGL) to feed the areas within each zone. In the existing condition, the Castlerock Booster Station has one outlet pressure, which matches the Main Tank Zone. Consequently, the HGL of the water must be reduced in order for the Castlerock Booster Station to serve the College Tank, Shangri La, and Rattlesnake Tank Zones.

4.5 DISTRIBUTION SYSTEM MODELING

A water model was constructed to simulate and analyze the existing distribution system. As mentioned in **Section 3.10 - Water Modeling Software**, the existing distribution system model was based on the model from the C5 Water Master Plan completed in 2005. However, the C5 was made within the Haestad Method's WaterGems for GIS software, so the model was converted into the Innovyze software H_2ONET Analyzer. The model was verified using as-builts and the City of Kingman Master CAD file. The existing C5 water model was used as a foundation for the existing system model and built upon to more completely represent the existing water system.

The existing model was loaded with the system demands by separating demands according to the existing pressure zones. Then each zone's demand was divided amongst the nodes in that zone. The model consists of the distribution network of pipes, nodes, reservoirs, and flow valves per zone. In the model, the reservoirs provide an endless supply of water at a hydraulic grade line. The hydraulic grade lines in the model were set to equal the head provided by each specific well, tank, or booster pump.

The model demand input for each junction is identified as flow in gallons per minute. For modeling purposes, a junction is considered the same as a node. To calculate the flow per junction, the total number of connections was determined for each zone and a zonal water demand was calculated by adding up the number of connections and multiplying that value by the average water usage per connection design criteria (312 gallons per connection per day). Then, the numbers of nodes in each zone were counted in the model and the flow per junction was calculated by dividing the zonal demand by the number of nodes. Once obtained, the flow per junction was entered into the model database. See **Table 4.7 – Existing Model Demand Calculations** and as well as **Appendix B – Existing Model & Junction Exhibits** for model junction demands used.

Table 4.7 – Existing Model Demand Calculations

Zone	Number of Connections (2017)	Total Demand (MGD)	Total Demand (gpm)	Percentage of Total	Number of Nodes	Flow per Junction (gpm)
Main Tank Zone	**8,260**	**-**	**-**	**43%**	**2,277**	**-**
Downtown Zone 1	179	0.06	39	1%	65	0.6
Downtown Zone 2	735	0.23	159	4%	324	0.5
Ricca Dr. / Hospital Zone	1,930	0.60	418	10%	441	0.9
Fripps Ranch Zone	381	0.12	83	2%	58	1.4
Hualapai Shadows Zone	89	0.03	19	0%	22	0.9
Foothills Regulated Zone	128	0.04	28	1%	29	1.0
Foothills Pneumatic Zone/Hualapai 2	108	0.03	23	1%	189	0.1
Rancho Santa Fe Regulated Zone/2	191	0.06	41	1%	168	0.2
Main Tank Zone (Remaining)	4,519	1.41	979	23%	981	1.0
Camelback Zone	**3,636**	**-**	**-**	**19%**	**772**	**-**
Walleck Ranch Zone	356	0.11	77	2%	35	2.2
Shangri La Improvement District Zone	1,297	0.40	281	7%	262	1.1
Camelback Zone (Remaining)	1,983	0.62	430	10%	475	0.9
Rattlesnake Tank Zone/Vista Bella	**1,055**	**0.33**	**229**	**5%**	**287**	**0.8**
College Tank Zone	**6,371**	**1.99**	**1,380**	**33%**	**1,085**	**1.3**
Total	**19,322**	**6.03**	**4,186**	**100%**	**4,421**	**-**

Flow per junction demand is considered the same across all areas of a zone even though high density subdivisions and low density large lot parcels typically experience different water usage rates. The model accounts for the difference in density by placing more junctions in areas of higher density and fewer junctions in areas of lower density. This naturally occurs as high density areas typically have more street and water line intersections that require nodes. For example, a high density subdivision will typically have more short blocks with nodes at each intersection which equates to a higher density of nodes in the project. Versus a low density development that may have one long half-mile street with two (2) nodes on each end that serve several lots.

The storage tanks and wells that pump directly to the system were modeled as a constant head reservoir. Flow control valves were used on the output of the wells to limit the outflow to the actual flow rates provided by the City.

The models were run at average day, peak day, and peak hour demands scenarios. A fire flow analysis was also modeled on top of peak day flows. See **Appendix B – Existing Model & Junction Exhibits** for the model output of each demand scenario.

4.5.1 Pressure Zones

The existing pressure zones were set up in the existing model to match existing conditions as described in **Section 2.2.1 - Existing Pressure Zones**. Existing interconnections, in the form of check valves, zone valves and pressure reducing valves, were field verified and modeled to match existing conditions. See **Section 2.2.2 - Existing PRV's, Check Valves & Zone Valves** for a complete list of the PRV's and check valves in the existing water system and Existing Model.

There is an excessive amount of segregation within the existing water system. There are four (4) main existing pressure zones as well as twelve (12) existing sub zones within the water system. Many of the existing pressure zones have the same or very similar HGL's and are in very near proximity to each other. Thus, some of the separation between zones have no hydraulic purpose and are creating unnecessary dead-end lines and reducing looping within the system.

There are also areas within the water boundary which are either not assigned to a pressure zone or are assigned to a pressure zone, in which, it would be infeasible to serve given the HGL of the pressure zone. Some areas within the Main Tank Zone; mainly the area on the far west side of the City at the base of the White Cliffs Mountains, are deficient in fire flow pressures. This area is too high in elevation and should not be included within the Main Tank Zone. Likewise, some areas within the College Tank Zone, primarily the area north of Thompson, between the Mohave Wash and Highway 66 have high pressures. This area is too low in elevation and should not be included in the College Tank Zone. Many more examples like these occur throughout the existing system.

4.5.2 Flow Simulations

As discussed in **Section 3.9.1 - Flow Simulations**, steady state and fire flow simulations were conducted on the existing system. Steady state flow simulations were conducted on the system using average day, peak day, and peak hour demands.

Fire flow simulations were conducted on the system at peak day demand on nodes throughout the system (one at a time) to simulate the available fire flow at peak day demand. Model nodes were assigned a fire flow of 1,000 gallons per minute for residential fire flow demand and 3,500 gallons per minute for commercial and industrial fire flow demand. Fire flow was assigned to nodes based on existing infrastructure and the City of Kingman General Plan 2030 Projected Land Use Map. See **Figure 4.1 – Existing Fire Flow Demands** for a depiction of the fire flow assignments of the existing model.

4.5.3 Fire Hydrant Coverage

An analysis of Fire Flow coverage within the water study boundary was completed. Existing fire hydrant locations have historically been based on the fire hydrant spacing requirements set forth in the City of Kingman Utility Regulations Article III: Water System Section 3.7A-3. However, as discussed in **Section 3.9.1 - Flow Simulations**, proposed fire hydrant spacing within the water system is slightly more stringent than the current City standards. Nevertheless, existing fire hydrant spacing was analyzed using the existing spacing requirements set forth in the City of Kingman Utility Regulations, not by the proposed spacing standards. See **Figure 4.2 – Existing Fire Hydrant Coverage** for a depiction of the coverage within the system.

Much of the area within the water service boundary, but outside of the City limits has extremely limited fire hydrant coverage, as shown in **Figure 4.2 – Existing Fire Hydrant Coverage**. The lack of fire hydrants within these areas result in the local fire department resorting to use water trucks for fire extinguishing. However effective water trucks can be, they are also less safe and slower moving than a typical pumper fire truck. Moreover, water trucks are expensive and limited in both quantity of trucks and capacity thereof, which is of concern in the case of multiple or large fire situations.

As discussed in **Section 4.5.2 - Flow Simulations**, steady state and fire flow results are provided in this report for reference. See **Figure 4.3 – Existing Model – Peak Hour Results** for the steady state analysis results and **Figure 4.4 – Existing Model – Fire Flow Results** for the fire flow analysis results of the existing model. See **Appendix B – Existing Model & Junction Exhibits** for the existing model and junction exhibits of each demand scenario.

The results of the existing model show a significant portion of the water system is deficient in fire flow. Regions of the water system, mainly those outside of the City limits, were constructed using 6-inch and smaller water lines. These undersized water lines simply cannot provide enough fire flow due to lack of capacity. Moreover, the separation of pressure zones within the system by way of zone valves has resulted in many dead end lines and therefore reduced looping. Many of the dead end lines created from the use of zone valves cannot meet fire flow because of the friction losses within the pipes taking over the pressure. In addition, the lack of looping in some parts of the system increase the possibility of stagnant water in pipes, in which bacteria can grow.

4.6 IMPROVEMENT RECOMMENDATIONS & COST ESTIMATES

Based on the analysis performed as described in the previous sections, a prioritized list of proposed improvement recommendations (storage tanks, booster pumps, PRV's, line extensions, line size increases, wells, etc.) has been developed to address deficiencies, lack of redundancy, as well as expected growth within the existing water system boundary. Cost estimates for each of these improvements have been developed so they can be added to the City's capital improvement program (CIP).

The proposed improvement recommendations are numbered in sequential order based on the priority of the project. Higher priority projects are those that are correcting system deficiencies or have a necessary immediate impact. Lower priority projects are those that are not needed immediately, are tied to a development that is not emanate, or considered to be development driven projects that only need to be constructed as development occurs.

Recommended improvement projects realign pressure zone lines to more closely resemble the pressure zone design criteria described in **Section 3.9.3 - Proposed Pressure Zones**. It was necessary to realign the existing pressure zones to reduce the amount of segregation within the system. The realignment of the pressure zones, by the use of parallel lines in combination with PRV's, within the system reduces the amount of dead end lines, increases looping, and decreasing the chance of stagnant water within the system. The realignment of the pressure zones also includes the sections within the water system boundary which are currently not assigned to a pressure zone.

Similar to the existing model, the existing improvements model was loaded with the system demands by separating demands according to the proposed pressure zones. The model demand input for each junction is identified as flow in gallons per minute. For modeling purposes, a junction is considered the same as a node. To calculate the flow per junction, the total number of connections was determined for each zone and a zonal water demand was calculated by adding up the number of connections and multiplying that value by the average water usage per connection design criteria (312 gallons per connection per day). Then, the numbers of nodes in each zone were counted in the model and the flow per junction was calculated by dividing the zonal demand by the number of nodes. Once obtained, the flow per junction was entered into the model database. See **Table 4.8 – Existing Improvement Model Demand Calculations** and as well as **Appendix C – Existing Improvements Model & Junction Exhibits** for model junction demands used.

Table 4.8 – Existing Improvement Model Demand Calculations

Zone	Number of Connections (2017)	Total Demand (MGD)	Total Demand (gpm)	Percentage of Total	Number of Nodes	Flow per Junction (gpm)
Foothills Zone	109	0.03	24	1%	54	0.4
Rancho Santa Fe Zone	777	0.24	168	4%	251	0.7
Hualapai Zone	789	0.25	171	4%	165	1.0
White Cliffs Zone	5	0.00	1	0%	7	0.2
Bull Mountain Zone	9	0.00	2	0%	1	2.0
Downtown 1 Zone	177	0.06	38	1%	64	0.6
Downtown 2 Zone	767	0.24	166	4%	306	0.5
Main Tank Zone	3,725	1.16	807	19%	956	0.8
Rattlesnake Zone	4,677	1.46	1,013	24%	1,200	0.8
College Tank Zone	7,908	2.47	1,713	41%	1,032	1.7
Mohave Wash Zone	522	0.16	113	3%	47	2.4
Total	**19,465**	**6.07**	**4,217**	**100%**	**4,083**	**-**

Just like the existing model, flow per junction demand is considered the same across all areas of a zone even though high density subdivisions and low density large lot parcels typically experience different water usage rates. The model accounts for the difference in density by placing more junctions in areas of higher density and fewer junctions in areas of lower density. This naturally occurs as high density areas typically have more street and water line intersections that require nodes. For example, a high density subdivision will typically have more short blocks with nodes at each intersection which equates to a higher density of nodes in the project. Versus a low density development that may have one long half-mile street with two (2) nodes on each end that serve several lots.

The recommended improvements for the existing system include well equipping, main water lines, zone valves, and pressure reducing valve stations. City Well #10 has already been drilled, and is proposed to be equipped as part of the existing improvements. Both the Riata Valley and the Foothills pneumatic tanks are proposed to be adjusted or upgraded to increase the head output as part of the existing improvements. There are no new wells, tanks, or booster pumps proposed as part of the existing improvements. The majority of the recommended improvements for the existing system are on the distribution system. The bulk of the proposed projects on the distribution system address existing fire flow deficiencies. In addition, a few of the projects address the reallocation of zones while addressing fire flow deficiency. One of the proposed improvement projects focuses on the lack of redundancy within the Foothills Zone. Pipe sizing for the existing recommended improvements were governed by system demands for both steady state and fire flow scenarios. A summary of the existing system improvement projects is located in **Table 4.9 – Existing Improvement Project Summary**.

Table 4.9 – Existing Improvement Project Summary

Project #	Purpose	Estimated Total Project Cost
1	Redundant Supply	$664,400
2	Alleviate Fire Flow Deficiency	$2,423,500
3	Alleviate Fire Flow Deficiency & Pressure Zone Reconfiguration	$1,603,400
4	Alleviate Fire Flow Deficiency	$421,400
5	Alleviate Fire Flow Deficiency	$1,013,500
6	Alleviate Fire Flow Deficiency	$1,635,500
7	Alleviate Fire Flow Deficiency	$972,700
8	Alleviate Fire Flow Deficiency & Pressure Zone Reconfiguration	$1,327,100
9	Alleviate Fire Flow Deficiency & Pressure Zone Reconfiguration	$23,868,900
10	Alleviate Fire Flow Deficiency	$7,738,800
11	Alleviate Fire Flow Deficiency	$7,570,200
12	Alleviate Fire Flow Deficiency & Pressure Zone Reconfiguration	$3,205,400
13	Alleviate Fire Flow Deficiency	$1,226,200
14	Alleviate Fire Flow Deficiency	$284,300
15	Alleviate Fire Flow Deficiency	$773,600
16	Alleviate Fire Flow Deficiency	$57,900
17	Alleviate Fire Flow Deficiency	$159,900
18	Alleviate Fire Flow Deficiency	$2,189,800
	Total Cost	**$57,136,500**

Project specific improvements and related cost estimates are detailed in **Section 4.6.1** through **Section 4.6.18**. See **Exhibit 4.1** through **Exhibit 4.18** for project specific improvements. See **Cost Estimate 4.1** through **Cost Estimate 4.18** for estimated costs of the recommended improvements. See **Figure 4.7 – Existing Improvements Project Overview** for recommended improvement projects in the system. See **Cost Estimate 4.19 – Existing Improvements Projects Summary** for the proposed cost of all of the recommended improvements.

Analysis of the coverage of fire hydrants within the existing improvement project areas was also completed. Existing fire hydrant coverage was based on existing fire hydrant locations and the fire hydrant spacing requirements set forth in the City of Kingman Utility Regulations Article III: Water System Section 3.7A-3. Proposed fire hydrants were added at a maximum spacing of 300 feet for commercial or industrial zones and a maximum spacing of 500 feet for rural or residential zones, according to the slightly more stringent proposed design criteria as discussed in **Section 3.9.1 - Flow Simulations**. Quantities for proposed fire hydrants were added to the project cost estimates. See **Figure 4.6 – Existing Improvements Fire Hydrant Coverage** for a depiction of the fire hydrant coverage within the existing improvement system.

The majority of the existing improvement projects focused on large areas within the water system that were deficient in fire flow pressures. Although the existing improvement projects should remedy a bulk of the fire flow deficiencies within the system, there may still be areas within the system that remain fire flow deficient. Areas within the system that remain fire flow deficient consist of dead end lines, areas that are not built-out yet, and undersized water lines. The areas that remain fire flow deficient are highlighted on **Figure 4.11 – Post-Existing Improvements Fire Flow Deficiencies**. Some of these deficiencies can be resolved during the addition of new development. Others will have to be addressed by the City. The City should have a goal of addressing 2 to 3 of the areas identified in Figure 4.11 per year until they are completed.

High velocity and high headloss, which occur in old, steep, and undersized piping, shorten the life-span of water system infrastructure. Many of the areas with high velocity and high headloss should be remediated within the scope of the existing improvement projects. However, a few pipes with high velocity or high headloss may still remain within the water system. The pipes that are not included within the existing improvement projects with high velocities and/or high headloss are detailed in a summary table located in **Appendix C – Existing Improvements Model & Junction Exhibits**.

Equipping of City Well 10 is proposed as part of Existing Improvement Project 1. City Well 10 will become the largest well within the water system; therefore, the total available source in the existing improvement scenario will be 20.88 million gallons per day. This creates an even larger buffer between the total available and minimum required source of 9.81 million gallons per day. It is also a redundant source for the southeast quadrant of the system.

4.6.1 Existing Improvement Project 1

Purpose: Redundant Supply to City Well #11 Forebay Tank

Benefits:

- Additional water supply for City Well #11 Forebay Tank

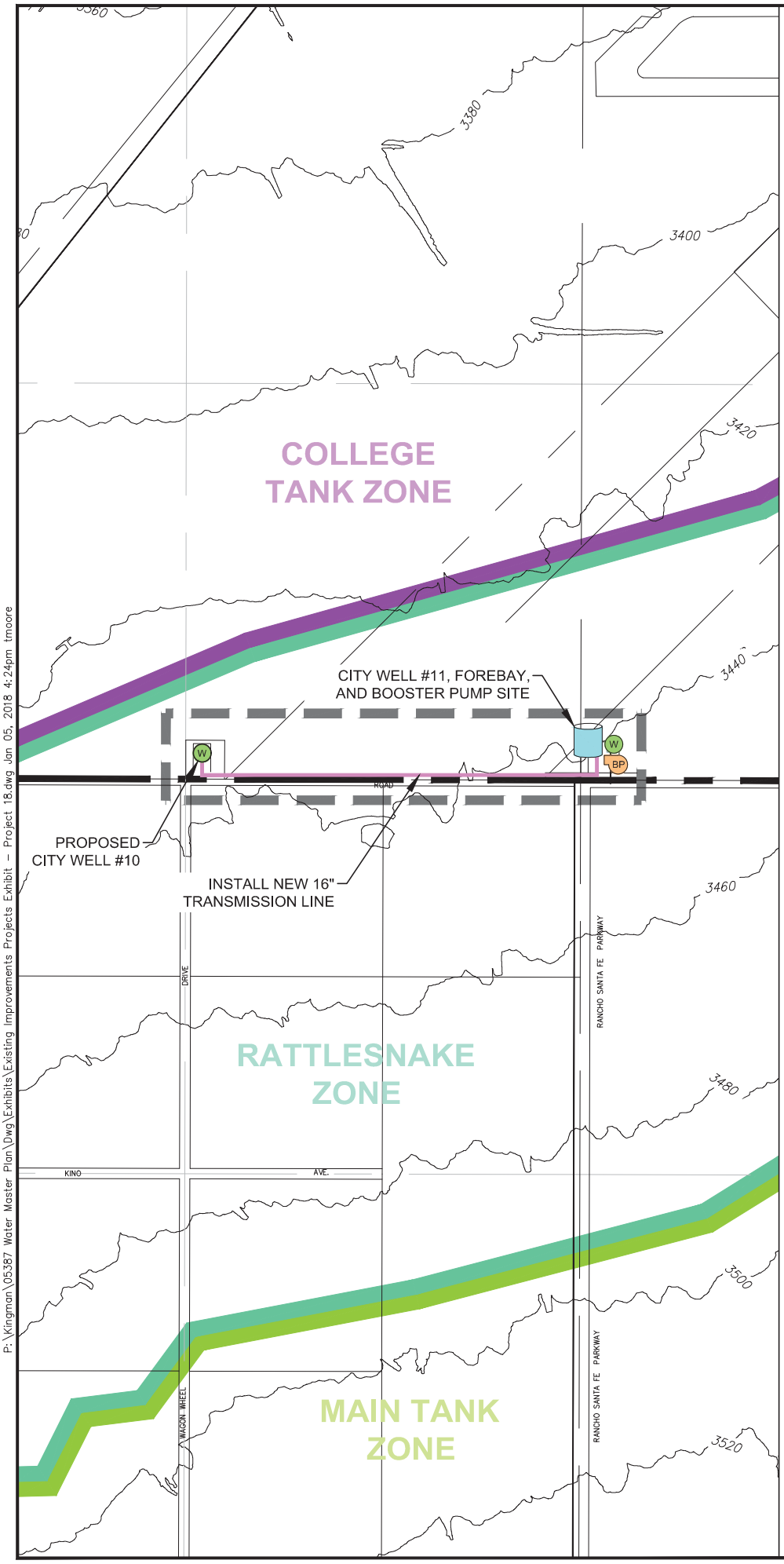
Key Modifications:

- Equipping City Well #10
- Installing 12” line from City Well #10 to City Well #11 Forebay Tank

This improvement project is located on the northeast corner of Wagon Wheel Drive and Berry Road. City Well # 10 has already been drilled, but has yet to be equipped on put on-line. The improvement project includes equipping the proposed City Well #10 and installing a 24” fill line from the new well to the City Well #11 Forebay Tank. In the existing condition, only City Well #11 fills the Well #11 Tank, which feed the Well #11 Booster Pumps, which supplies the Rattlesnake Tank. Rattlesnake Tank feeds the Rattlesnake Booster Pumps, which supply the Rattlesnake Zone as well as the Rancho Santa Fe Tank. The Rancho Santa Fe Tank supplies the Rancho Santa Fe Zone. City Well #10 will act as redundant supply to the Rattlesnake and Rancho Santa Fe Zones. See **Exhibit 4.1 – Existing Improvements Project 1** for more information.

Estimated Total Project Cost: $2,189,200

See **Cost Estimate 4.1 – Existing Improvements Project 1** for cost breakdown.



NORTH

SCALE
0 1000' 2000'
HORIZ: 1" = 1000'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
INCORPORATED 1952
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 1

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 4.1 - EXISTING IMPROVEMENTS PROJECT 1

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.1 - Existing Improvements Project 1
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	0	LF	$55	$0
3	12" Water Line and Surface Restoration	0	LF	$100	$0
4	16" Water Line and Surface Restoration	2,912	LF	$125	$364,000
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	6	EA	$2,500	$14,750
7	Fire Hydrant Assembly with Gate Valve	0	EA	$4,500	$0
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	1	EA	$30,000	$30,000
				Construction Subtotal	**$408,750**
				Traffic Control (5% of Total)	$20,438
				Construction Administration (5% of Total)	$20,438
				Mobilization (15% of Total)	$61,313
				Construction Total	**$510,938**
				Final Engineering and Permitting (10% of Total)	$51,094
				Contingency (20% of Total)	$102,198
				Project Total	**$664,400**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

4.6.2 Existing Improvement Project 2

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

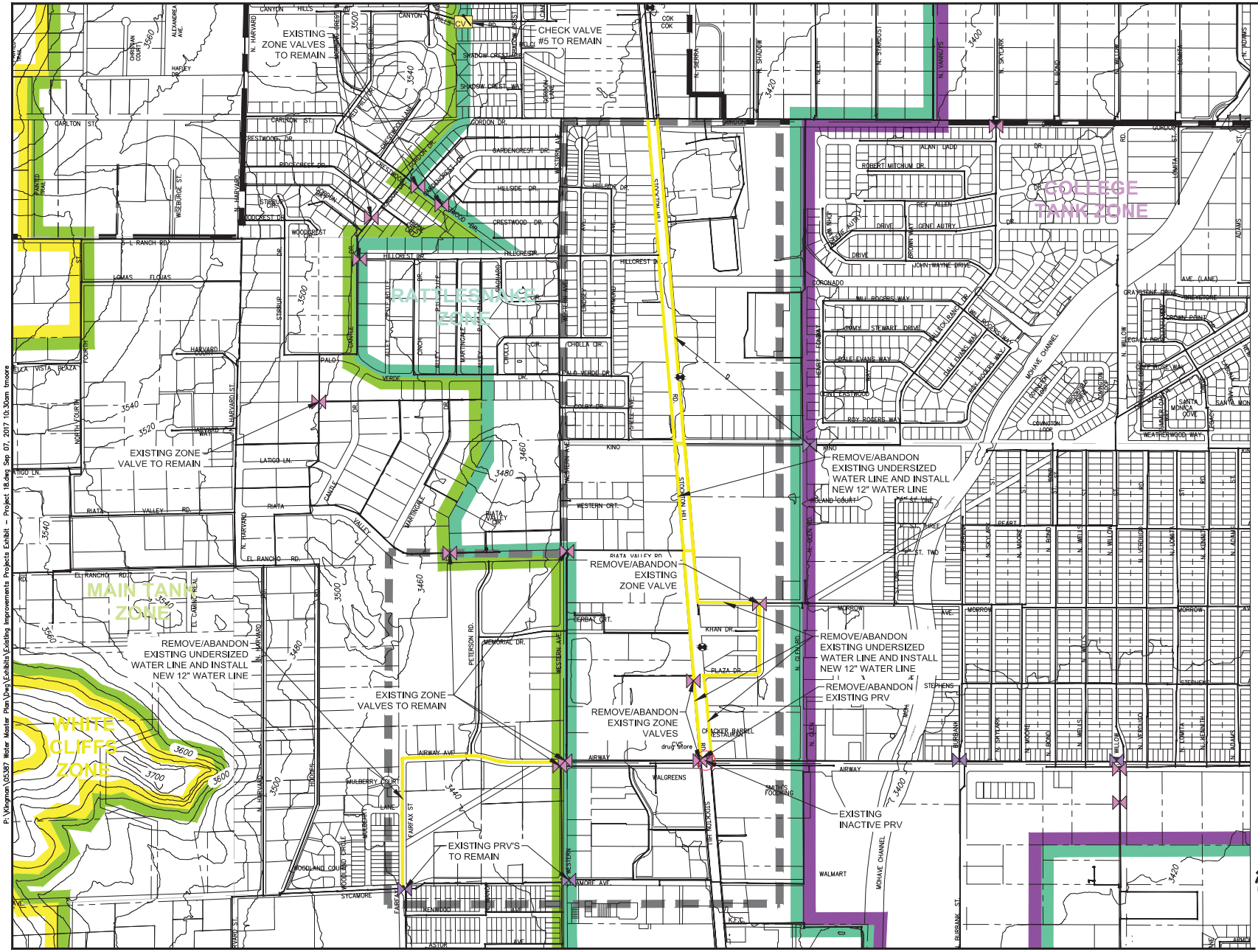
Key Modifications:

- Replace undersized pipes along Stockton Hill Road
- Replace undersized pipes along Fairfax Street

This improvement project is located along Stockton Hill Road from Airway Avenue north to Gordon Drive. The improvement project concentrates on providing fire flow pressures to the commercial properties along Stockton Hill Road. Sufficient fire flow pressures can be provided to the area by upsizing the existing undersized (8”) piping on either side of Stockton Hill Road to 12”. The improvement project also includes the upsizing of undersized (8”) pipes along Fairfax Street and Airway Avenue to provide adequate fire flow pressures within the commercial development. See **Exhibit 4.2 – Existing Improvements Project 2** for more information.

Estimated Total Project Cost: $2,423,500

See **Cost Estimate 4.2 – Existing Improvements Project 2** for cost breakdown.



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NORTH

SCALE
0 750' 1500'
HORIZ: 1" = 750'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS PROJECT 2

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 4.2 - EXISTING IMPROVEMENTS PROJECT 2

SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.2 - Existing Improvements Project 2
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	0	LF	$55	$0
3	12" Water Line and Surface Restoration	14,115	LF	$100	$1,411,500
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	28	EA	$2,500	$70,750
7	Fire Hydrant Assembly with Gate Valve	2	EA	$4,500	$9,000
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$1,491,250**
				Traffic Control (5% of Total)	$74,563
				Construction Administration (5% of Total)	$74,563
				Mobilization (15% of Total)	$223,688
				Construction Total	**$1,864,063**
				Final Engineering and Permitting (10% of Total)	$186,406
				Contingency (20% of Total)	$372,850
				Project Total	**$2,423,500**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

4.6.3 Existing Improvement Project 3

Purpose: Alleviate Fire Flow Deficiency and Pressure Zone Reconfiguration

Benefits:

- Meet required Fire Flow Pressures
- Reconfiguring the Shangri-La and Main Tank Zones

Key Modifications:

- Disconnect the Shangri-La and Main Tank Zones
- Remove one PRV
- Replace undersized 8” pipe with 12” in Sunshine Drive
- Install new 12” pipe at Castle Rock Road and Sunshine Drive
- Replace undersized 8” pipe in Castle Rock Road with 12”
- Replace undersized 2” pipe in Gordon Drive with 12”
- Install new 8” pipe from Wren to Highway 66 in Gordon Drive

This improvement project is located within the commercial and industrial area along State Highway 66, between Airway Avenue and Gordon Drive. The improvement project concentrates on the deficient fire flow pressures within the area as well as the reconfiguring of pressure zones. The improvement project includes removing a PRV and disconnecting the Shangri-La and Main Tank Zones and increasing the undersized (8”) pipe in Sunshine Drive to 12”. The improvement project also includes the addition of a 12” pipe at Castle Rock Road and Sunshine Drive to connect the Shangri-La and College Tank Zones as well as increasing the undersized (8” & 2” respectively) pipe in Castle Rock Road and Gordon Drive to 12” and 8” respectively. The project also includes the installation of a new 8” pipe from Wren to Highway 66 in Gordon Drive. See **Exhibit 4.3 – Existing Improvements Project 3** for more information.

Estimated Total Project Cost: $1,690,400

See **Cost Estimate 4.3 – Existing Improvements Project 3** for cost breakdown.

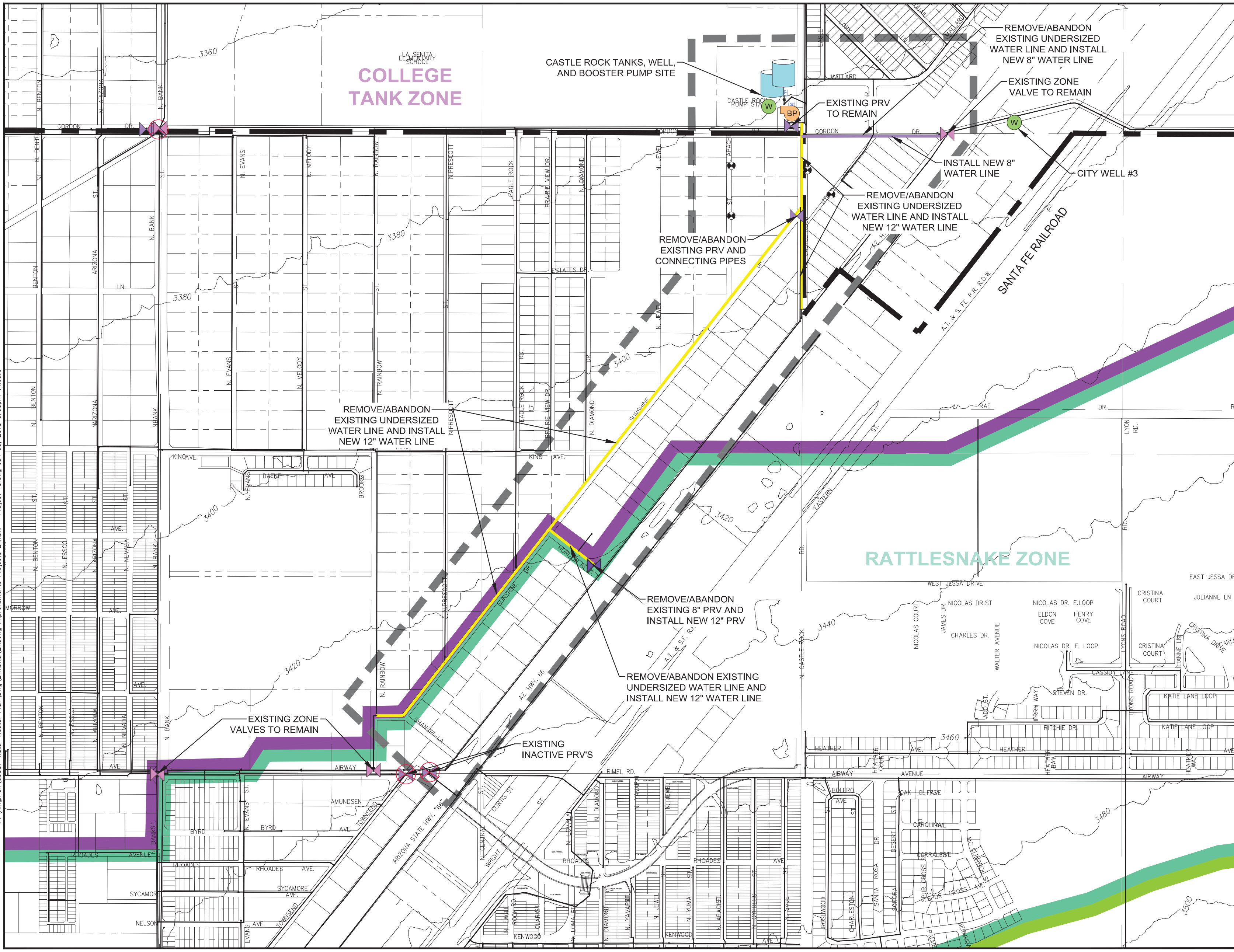

EXHIBIT 4.3 - EXISTING IMPROVEMENTS PROJECT 3

CITY OF KINGMAN

WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 3

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.3 - Existing Improvements Project 3
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	1,190	LF	$55	$65,450
3	12" Water Line and Surface Restoration	7,634	LF	$100	$763,400
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	18	EA	$2,500	$44,250
7	Fire Hydrant Assembly with Gate Valve	3	EA	$4,500	$13,500
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	1	EA	$100,000	$100,000
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$986,600**
				Traffic Control (5% of Total)	$49,330
				Construction Administration (5% of Total)	$49,330
				Mobilization (15% of Total)	$147,990
				Construction Total	**$1,233,250**
				Final Engineering and Permitting (10% of Total)	$123,325
				Contingency (20% of Total)	$246,675
				Project Total	**$1,603,400**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

4.6.4 Existing Improvement Project 4

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

Key Modifications:

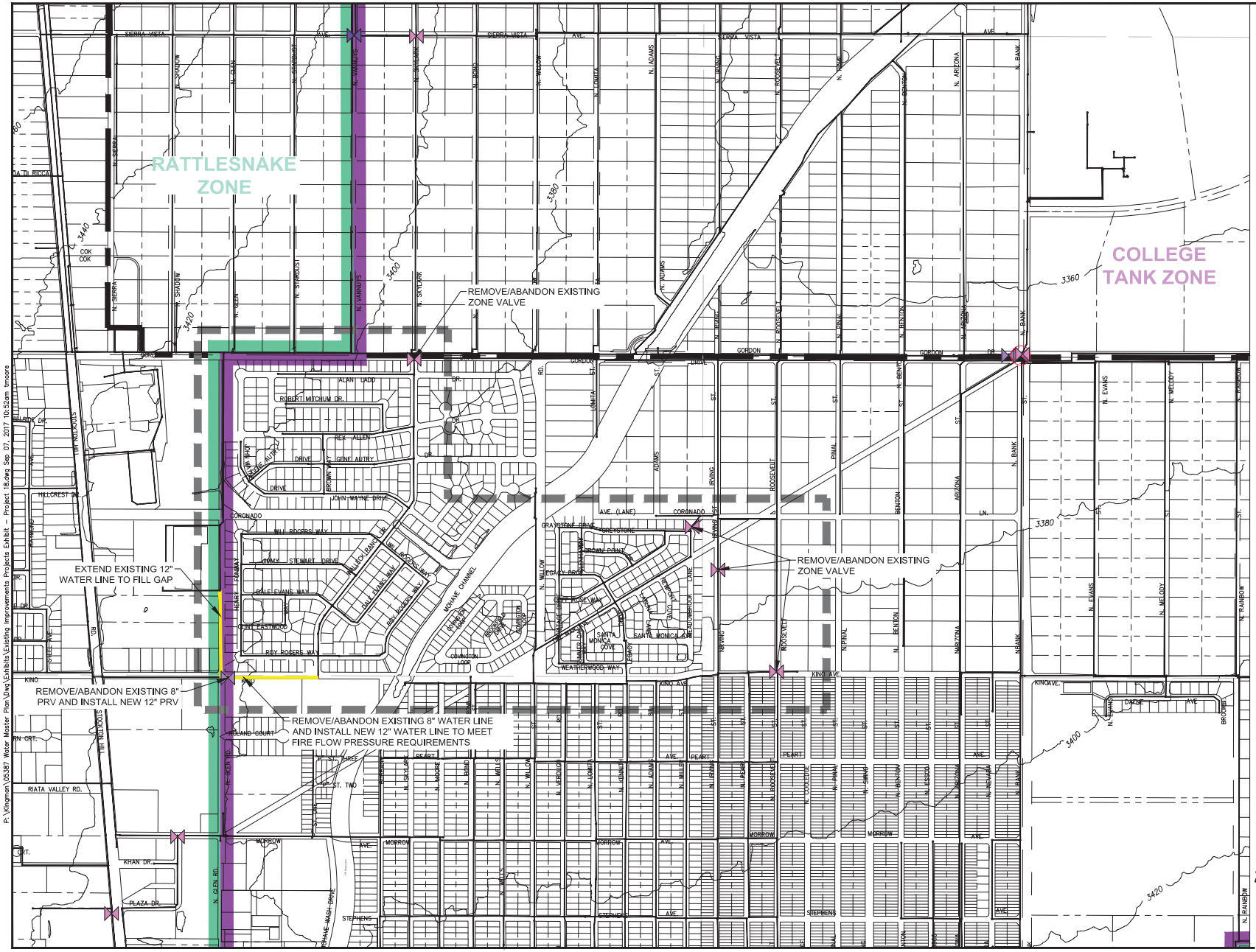
- Extension of 12” pipe within Glen Road
- Replace undersized 8” pipe and PRV in Kino Avenue with 12”
- Remove 5 zone valves

This improvement project is located within the Walleck Ranch and Shangri La Zones which covers the area from Glen Road to Arizona State Highway 66 and from Airway Avenue north to Gordon Drive. The improvement project focuses mainly on the deficiency in Fire Flow pressures within the Walleck Ranch and Shangri La Zones. The improvement project includes the extension of the existing 12” pipe within Glen Road and upsizing the 8” pipe within Kino Avenue as well as the PRV at Glen and Kino to 12” to provide sufficient fire flow pressures to the properties on the corner. To provide adequate fire flow pressures within the Walleck Ranch Zone, the Walleck Ranch Zone can be incorporated into the College Tank Zone by removing the zone valve at Walleck Ranch Drive and Gordon Drive. To provide adequate fire flow pressures within the Shangri La Zone, the Shangri La Zone can be incorporated into the College Tank Zone by removing the four (4) zone valves separating the two zones. See **Exhibit 4.4 – Existing Improvements Project 4** for more information.

Estimated Total Project Cost: $421,400

See **Cost Estimate 4.4 – Existing Improvements Project 4** for cost breakdown.

EXHIBIT 4.4 - EXISTING IMPROVEMENTS PROJECT 4



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NORTH

SCALE
0 750' 1500'
HORIZ: 1" = 750'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 4

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.4 - Existing Improvements Project 4
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	0	LF	$55	$0
3	12" Water Line and Surface Restoration	1,515	LF	$100	$151,462
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	3	EA	$2,500	$7,750
7	Fire Hydrant Assembly with Gate Valve	0	EA	$4,500	$0
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	1	EA	$100,000	$100,000
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$259,212**
				Traffic Control (5% of Total)	$12,961
				Construction Administration (5% of Total)	$12,961
				Mobilization (15% of Total)	$38,882
				Construction Total	**$324,015**
				Final Engineering and Permitting (10% of Total)	$32,402
				Contingency (20% of Total)	$64,809
				Project Total	**$421,400**

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4.6.5 Existing Improvement Project 5

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

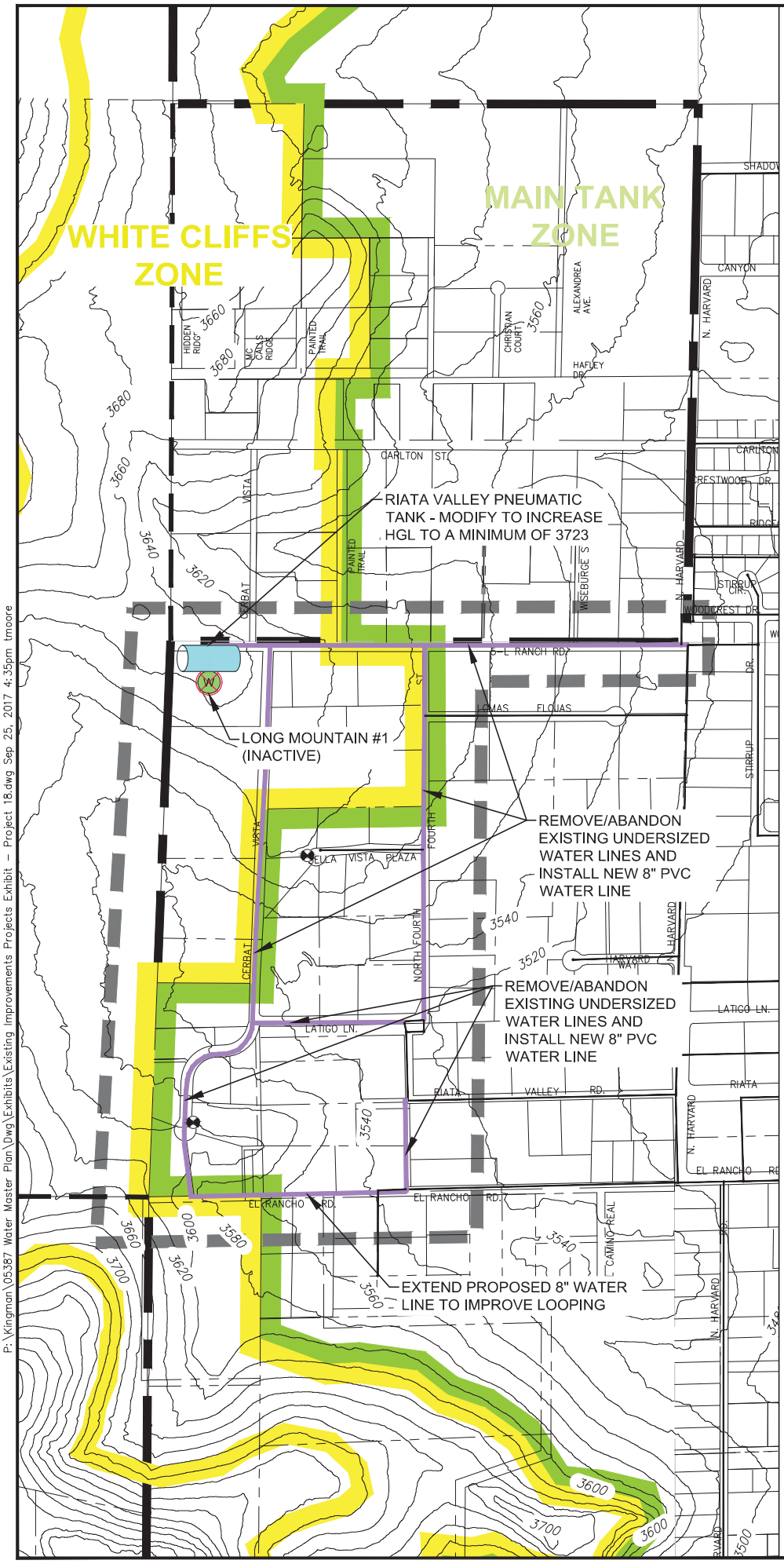
Key Modifications:

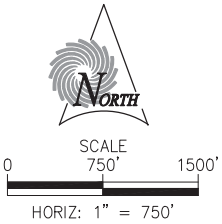
- Replace undersized pipes within Bello Vista Estates and Canyon Vista with 8" lines
- Extend pipes for strategic looping
- Install new tank supplied by Long Mountain Well #1

This improvement project is located within the Bello Vista Estates and Canyon Vista subdivisions. The improvement project focuses on the deficient fire flow pressures within the subdivisions and includes upsizing undersized (6") pipes from Cerbat Vista Drive east to 4th Street and from El Rancho Road north to 5-L Ranch Road as well as along 5-L Ranch Road from Fourth Street to Harvard Street to 8" pipe. The improvement project also includes the extension of a few pipes for strategic looping. Most importantly, the improvement project includes the adjustment of head out of the Riata Valley Pneumatic tank to a minimum of 3723 to provide adequate fire flow pressures within the area. This head adjustment may be achieved by modification or replacement of the existing pneumatic tank. See **Exhibit 4.5 – Existing Improvements Project 5** for more information.

Estimated Total Project Cost: $964,700

See **Cost Estimate 4.5 – Existing Improvements Project 5** for cost breakdown.





LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 5

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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EXHIBIT 4.5 - EXISTING IMPROVEMENTS PROJECT 5

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.5 - Existing Improvements Project 5
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	9,742	LF	$55	$535,810
3	12" Water Line and Surface Restoration	0	LF	$100	$0
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	20	EA	$2,500	$48,750
7	Fire Hydrant Assembly with Gate Valve	2	EA	$4,500	$9,000
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$750,000	$0
12	Modification or Replacement of Pneumatic Tank	1	EA	$30,000	$30,000
				Construction Subtotal	**$623,560**
				Traffic Control (5% of Total)	$31,178
				Construction Administration (5% of Total)	$31,178
				Mobilization (15% of Total)	$93,534
				Construction Total	**$779,450**
				Final Engineering and Permitting (10% of Total)	$77,945
				Contingency (20% of Total)	$155,906
				Project Total	**$1,013,500**

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4.6.6 Existing Improvement Project 6

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

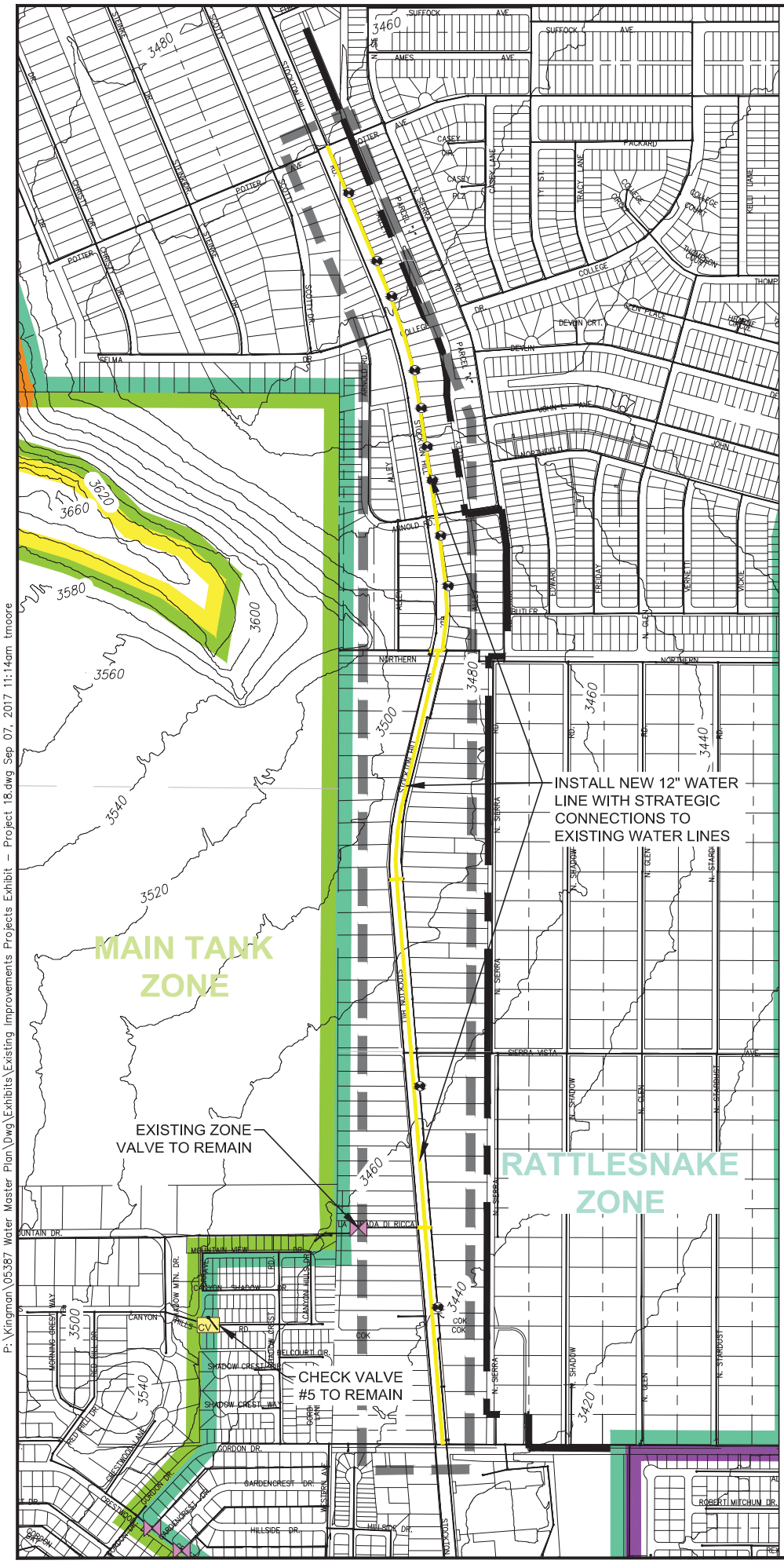
Key Modifications:

- Replace undersized pipes along Stockton Hill Road

This improvement project is located along Stockton Hill Road from Gordon Drive north to Potter Avenue. The improvement project focuses on providing fire flow pressures to the commercial properties along Stockton Hill Road. Sufficient fire flow pressures can be provided to the area by the addition of a 12" line within Stockton Hill Road. The improvement project also includes strategic connections to the existing pipelines within Stockton Hill Road to provide looping within the system. See **Exhibit 4.6 – Existing Improvements Project 6** for more information.

Estimated Total Project Cost: $1,635,500

See **Cost Estimate 4.6 – Existing Improvements Project 6** for cost breakdown.



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NORTH

SCALE
0 1000' 2000'
HORIZ: 1" = 1000'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
INCORPORATED 1952
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 6

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 4.6 - EXISTING IMPROVEMENTS PROJECT 6

SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.6 - Existing Improvements Project 6
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	0	LF	$55	$0
3	12" Water Line and Surface Restoration	9,111	LF	$100	$911,084
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	18	EA	$2,500	$45,750
7	Fire Hydrant Assembly with Gate Valve	11	EA	$4,500	$49,500
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$1,006,334**
				Traffic Control (5% of Total)	$50,317
				Construction Administration (5% of Total)	$50,317
				Mobilization (15% of Total)	$150,950
				Construction Total	**$1,257,918**
				Final Engineering and Permitting (10% of Total)	$125,792
				Contingency (20% of Total)	$251,609
				Project Total	**$1,635,500**

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4.6.7 Existing Improvement Project 7

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

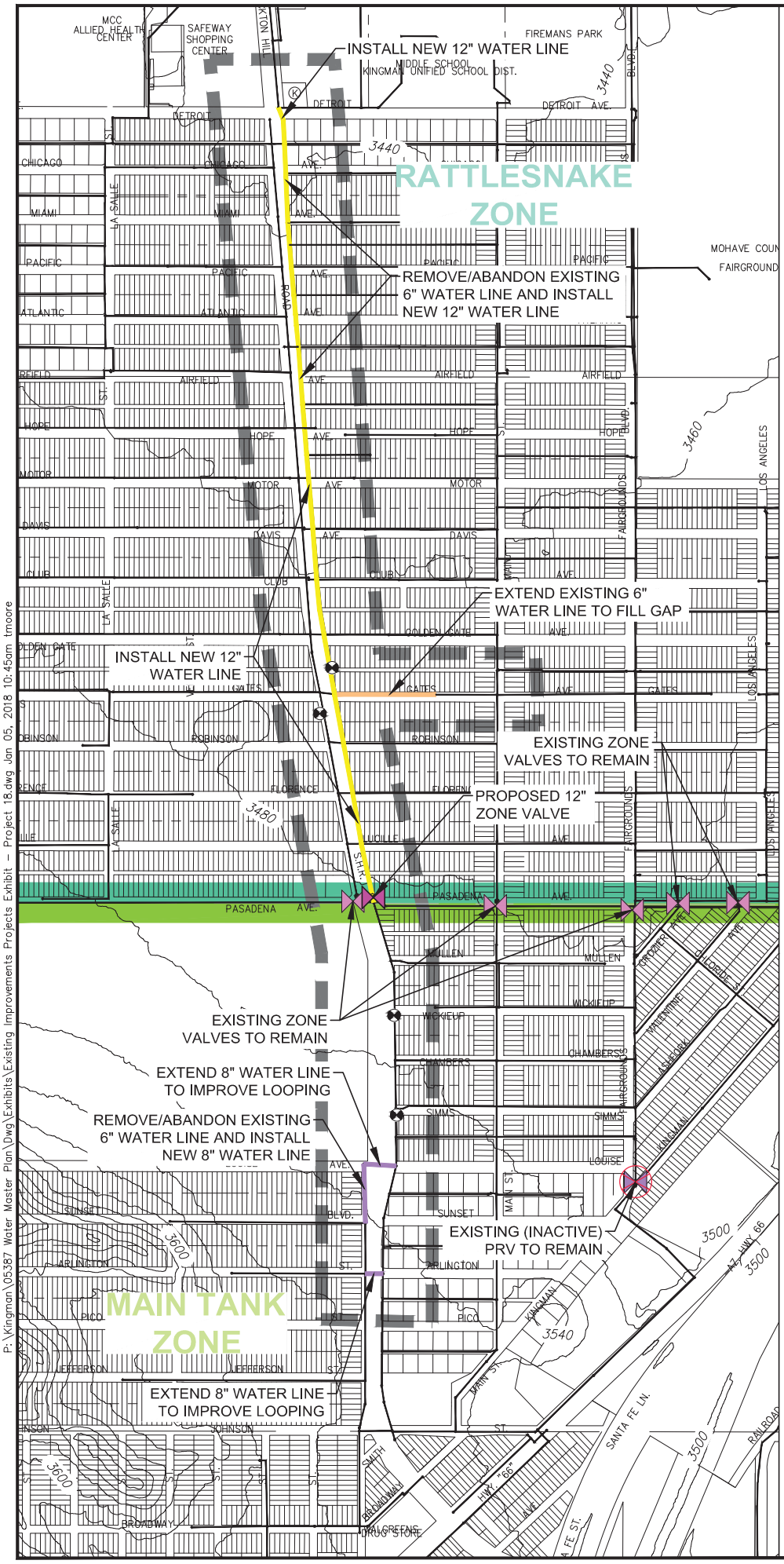
Key Modifications:

- Extend existing line along Stockton Hill Road
- Extend pipes for strategic looping

This improvement project is located along Stockton Hill Road from Sunset Boulevard north to Detroit Avenue. The improvement project concentrates on providing fire flow pressures to the commercial properties along Stockton Hill Road. Sufficient fire flow pressures can be provided to the area by extending the existing 12” line on the east side of Stockton Hill Road from Pasadena Avenue to the existing 6” line just south of Hope Avenue as well as replacing the existing 6” from Hope Avenue north to Detroit Avenue with a new 12” water line. The improvement project also includes the extension of a few pipes for strategic looping. See **Exhibit 4.7 – Existing Improvements Project 7** for more information.

Estimated Total Project Cost: $997,600

See **Cost Estimate 4.7 – Existing Improvements Project 7** for cost breakdown.



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NORTH

SCALE
0 750' 1500'
HORIZ: 1" = 750'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
INCORPORATED 1952
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 7

EXHIBIT 4.7 - EXISTING IMPROVEMENTS PROJECT 7

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.7 - Existing Improvements Project 7
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	509	LF	$45	$22,905
2	8" Water Line and Surface Restoration	549	LF	$55	$30,186
3	12" Water Line and Surface Restoration	4,019	LF	$100	$401,900
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	10	EA	$2,500	$25,500
7	Fire Hydrant Assembly with Gate Valve	4	EA	$4,500	$18,000
8	8" PRV Station	0	EA	$75,000	$0
9	12" Zone Valve	1	EA	$100,000	$100,000
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$598,491**
				Traffic Control (5% of Total)	$29,925
				Construction Administration (5% of Total)	$29,925
				Mobilization (15% of Total)	$89,774
				Construction Total	**$748,113**
				Final Engineering and Permitting (10% of Total)	$74,811
				Contingency (20% of Total)	$149,638
				Project Total	**$972,700**

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4.6.8 Existing Improvement Project 8

Purpose: Alleviate Fire Flow Deficiency and Pressure Zone Reconfiguration

Benefits:

- Meet required Fire Flow Pressures
- Combine Ricca Drive and Rattlesnake Zones

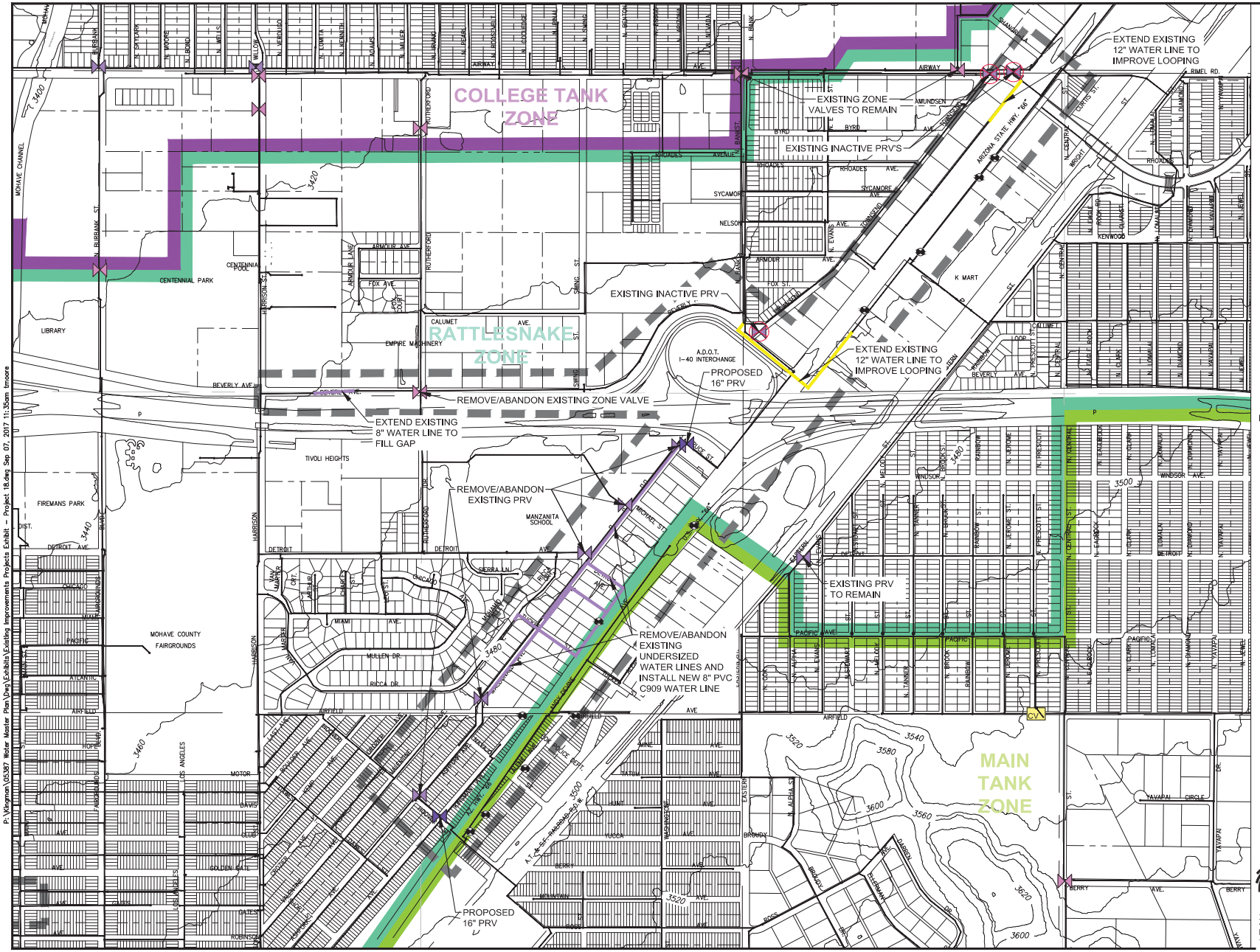
Key Modifications:

- Replace undersized pipes along Macdonald Avenue and Detroit Avenue
- Extend pipes for strategic looping
- Remove 5 PRV's
- Install 2 new PRV's
- Remove 1 zone valve
- Extend pipes to combine Ricca Drive and Rattlesnake Zones
- New pipe under State Highway 66 at Bank Street to improve looping

This improvement project is located within the commercial and industrial area along State Highway 66, near the I-40 interchange. The improvement project concentrates mainly on the deficient fire flow pressures within the area and includes upsizing undersized (4" and 6") pipes along Macdonald Avenue and Detroit Avenue as well as the extension of a few pipes for strategic looping. The improvement project also includes the removal of five (5) PRV's and the addition of two (2) new PRV's to incorporate the commercial/industrial area to the Ricca Drive Zone instead of the Main Tank Zone. The improvement project also includes the removal of one (1) zone valve and the extension of a few more pipes to combine the Ricca Drive and Rattlesnake Zones. The combination of these zones also includes the addition of a 12" pipe under State Highway 66 at Bank Street to improve looping. See **Exhibit 4.8 – Existing Improvements Project 8** for more information.

Estimated Total Project Cost: $1,327,100

See **Cost Estimate 4.8 – Existing Improvements Project 8** for cost breakdown.



CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 8

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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EXHIBIT 4.8 - EXISTING IMPROVEMENTS PROJECT 8

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2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.8 - Existing Improvements Project 8
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	5,417	LF	$55	$297,935
3	12" Water Line and Surface Restoration	1,829	LF	$100	$182,887
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	15	EA	$2,500	$36,250
7	Fire Hydrant Assembly with Gate Valve	11	EA	$4,500	$49,500
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	2	EA	$125,000	$250,000
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$816,572**
				Traffic Control (5% of Total)	$40,829
				Construction Administration (5% of Total)	$40,829
				Mobilization (15% of Total)	$122,486
				Construction Total	**$1,020,715**
				Final Engineering and Permitting (10% of Total)	$102,072
				Contingency (20% of Total)	$204,163
				Project Total	**$1,327,100**

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4.6.9 Existing Improvement Project 9

Purpose: Alleviate Fire Flow Deficiency and Pressure Zone Reconfiguration

Benefits:

- Meet required Fire Flow Pressures
- Zone line redefinition between Rattlesnake Tank Zone and the College Tank Zone

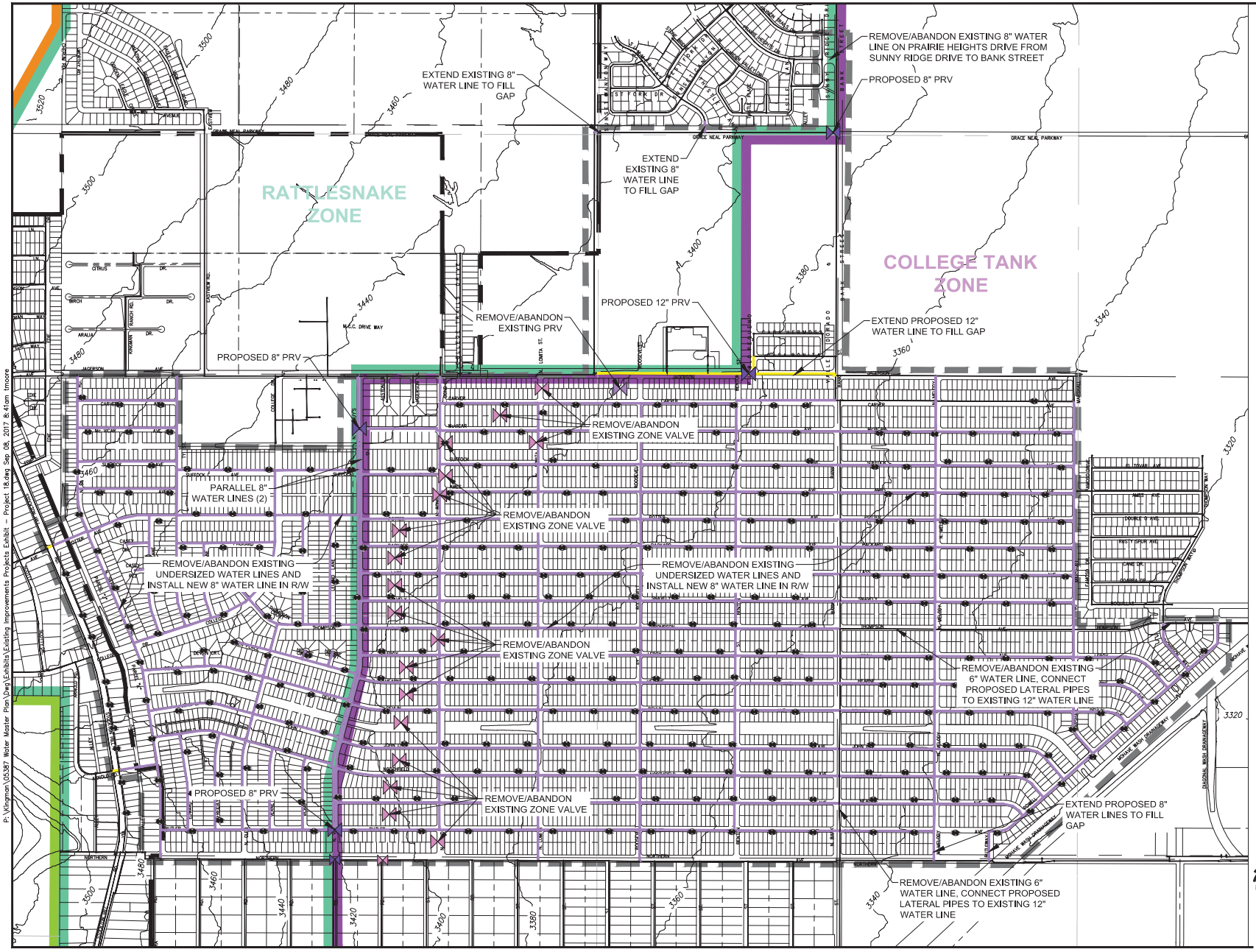
Key Modifications:

- Replace undersized pipes within New Kingman Addition with 8” lines in R/W
- Remove 19 zone valves
- Remove 1 PRV
- Install 4 new PRV’s

This improvement project is located within the New Kingman Addition subdivision and spans from Sierra Road east to the Mohave Wash and from Northern Avenue north to Grace Neal Parkway. The improvement project focuses mainly on the deficiency in Fire Flow pressures within the New Kingman Addition subdivision. The existing undersized (2”, 3” and 6”) pipes are to be replaced with 8” pipes and relocated from the alleys to the right-of-way. The improvement project also creates a defined zone line between the Rattlesnake Tank Zone and the College Tank Zone. This zone line definition includes (2) 8” parallel lines along Van Nuy’s Road, removal of 19 zone valves and one (1) pressure reducing valve (PRV), and the addition of four (4) PRV’s. The improvement project includes the extension of a few pipes for strategic looping as well as an upsizing of the existing 8” pipe on Jagerson in front of the Cerbat Elementary School to 12” to provide adequate fire flow pressures to the school. Finally, the improvement project includes the reallocation of the Prairie Heights subdivision from the College Tank Zone to the Rattlesnake Zone. This is accomplished by the extension of the 8” pipe in Grace Neal Parkway at the southwest corner of the property as well as the extension of the 8” pipe in Summerhaven at Grace Neal Parkway and the removal/abandonment of the existing 8” water line in Prairie Heights from Sunny Ridge to Bank Street on the east side of the property. See **Exhibit 4.9 – Existing Improvements Project 9** for more information.

Estimated Total Project Cost: $23,868,900

See **Cost Estimate 4.9 – Existing Improvements Project 9** for cost breakdown.



NORTH

SCALE
0 1000' 2000'
HORIZ: 1" = 1000'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 9

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 4.9 - EXISTING IMPROVEMENTS PROJECT 9

SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.9 - Existing Improvements Project 9
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	208,650	LF	$55	$11,475,750
3	12" Water Line and Surface Restoration	2,050	LF	$100	$205,000
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	421	EA	$2,500	$1,053,500
7	Fire Hydrant Assembly with Gate Valve	362	EA	$4,500	$1,629,000
8	8" PRV Station	3	EA	$75,000	$225,000
9	12" PRV Station	1	EA	$100,000	$100,000
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$14,688,250**
				Traffic Control (5% of Total)	$734,413
				Construction Administration (5% of Total)	$734,413
				Mobilization (15% of Total)	$2,203,238
				Construction Total	**$18,360,313**
				Final Engineering and Permitting (10% of Total)	$1,836,031
				Contingency (20% of Total)	$3,672,430
				Project Total	**$23,868,900**

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4.6.10 Existing Improvement Project 10

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

Key Modifications:

- Replace undersized pipes within Lake Mohave Country Club Estates with 8” lines
- Install 2 new 8” parallel lines along Van Nuy’s Road
- Install new 12” water line in Northern Avenue
- Remove 3 zone valves
- Install 2 new PRV’s

This improvement project is located within the Lake Mohave Country Club Estates subdivision and extends from Glen Road east to the Mohave Wash and from Gordon Drive north to Northern Avenue. The improvement project centers mainly on the deficiency in Fire Flow pressures within the Lake Mohave Country Club Estates subdivision. The existing undersized (2”, 3” and 6”) pipes are to be replaced with 8” pipes to provide adequate fire flow pressures. The undersized (6” and 8”) pipes within Northern Avenue are to be replaced with 12” pipes as well. The improvement project also creates a defined zone line between the Camelback Tank Zone and the College Tank Zone. This zone line definition includes (2) 8” parallel lines along Van Nuy’s Road, removal of three (3) zone valves, and the addition of two (2) PRV’s. See **Exhibit 4.10 – Existing Improvements Project 10** for more information.

Estimated Total Project Cost: $7,738,800

See **Cost Estimate 4.10 – Existing Improvements Project 10** for cost breakdown.

SCALE
0 750' 1500'
HORIZ: 1" = 750'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 10

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 4.10 - EXISTING IMPROVEMENTS PROJECT 10

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.10 - Existing Improvements Project 10
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	56,420	LF	$55	$3,103,100
3	12" Water Line and Surface Restoration	7,931	LF	$100	$793,100
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	129	EA	$2,500	$322,000
7	Fire Hydrant Assembly with Gate Valve	82	EA	$4,500	$369,000
8	8" PRV Station	1	EA	$75,000	$75,000
9	12" PRV Station	1	EA	$100,000	$100,000
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$4,762,200**
				Traffic Control (5% of Total)	$238,110
				Construction Administration (5% of Total)	$238,110
				Mobilization (15% of Total)	$714,330
				Construction Total	**$5,952,750**
				Final Engineering and Permitting (10% of Total)	$595,275
				Contingency (20% of Total)	$1,190,669
				Project Total	**$7,738,800**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

4.6.11 Existing Improvement Project 11

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

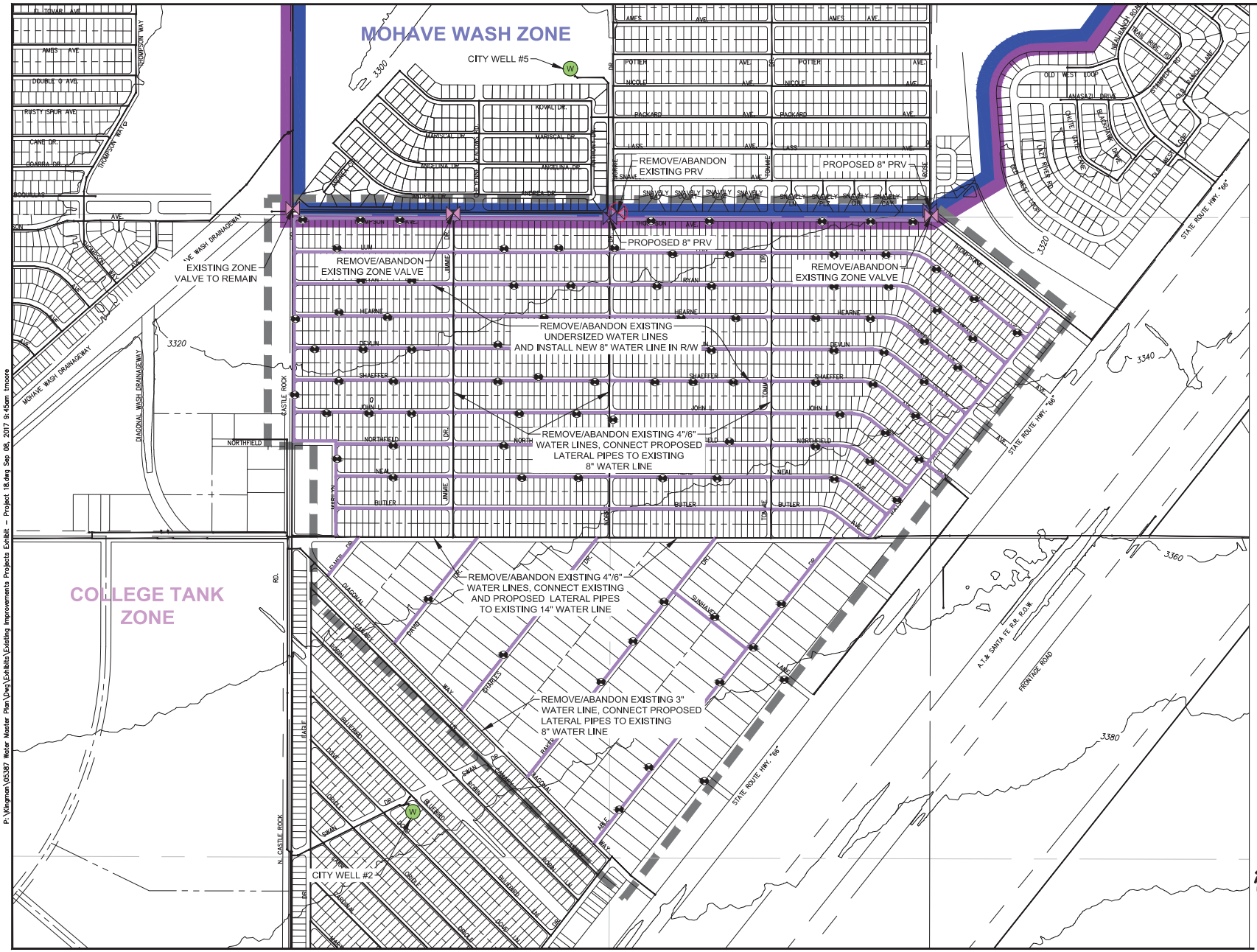
Key Modifications:

- Replace undersized pipes in New Kingman Addition and Sunhaven with 8” lines in R/W
- Abandon lines and connect laterals to existing main
- Remove 2 zone valves
- Install 2 new PRV’s
- Extend pipes for strategic looping

This improvement project is located within the New Kingman Addition and Sunhaven subdivisions and spans from Castle Rock Road east to the State Route Highway 66 and from Diagonal Way north to Thompson Avenue. The improvement project focuses mainly on the deficiency in Fire Flow pressures within the New Kingman Addition and Sunhaven subdivisions. The existing undersized (2”, 3” and 6”) pipes are to be replaced with 8” pipes and relocated from the alleys to the right-of-way. Existing undersized (3”, 4” and 6”) pipes within Northern Avenue, Diagonal Way, Jimmie Drive, Norrie Drive, and Tommie Drive are to be abandoned and all existing lateral pipes should connect to the main existing in the road (14” in Northern and 8” in Diagonal, Jimmie, Norrie, and Tommie). The improvement project also creates a defined zone line between the existing College Tank Zone and the proposed Mohave Wash Zone. This zone line definition includes the removal of two (2) zone valves and the addition of two (2) PRV’s. The improvement project includes the extension of a few pipes for strategic looping as well. See **Exhibit 4.11 – Existing Improvements Project 11** for more information.

Estimated Total Project Cost: $7,570,200

See **Cost Estimate 4.11 – Existing Improvements Project 11** for cost breakdown.



NORTH

SCALE
0 750' 1500'
HORIZ: 1" = 750'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
IW		INACTIVE WELL
BW		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 11

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
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TEL 480.768.8600 · FAX 480.768.8609
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EXHIBIT 4.11 - EXISTING IMPROVEMENTS PROJECT 11

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.11 - Existing Improvements Project 11
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	69,890	LF	$55	$3,843,950
3	12" Water Line and Surface Restoration	0	LF	$100	$0
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	140	EA	$2,500	$349,500
7	Fire Hydrant Assembly with Gate Valve	70	EA	$4,500	$315,000
8	8" PRV Station	2	EA	$75,000	$150,000
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$4,658,450**
				Traffic Control (5% of Total)	$232,923
				Construction Administration (5% of Total)	$232,923
				Mobilization (15% of Total)	$698,768
				Construction Total	**$5,823,063**
				Final Engineering and Permitting (10% of Total)	$582,306
				Contingency (20% of Total)	$1,164,729
				Project Total	**$7,570,200**

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4.6.12 Existing Improvement Project 12

Purpose: Alleviate Fire Flow Deficiency and Pressure Zone Reconfiguration

Benefits:

- Meet required Fire Flow Pressures
- Create a defined zone line between the Main Tank and Foothills Regulated Zones

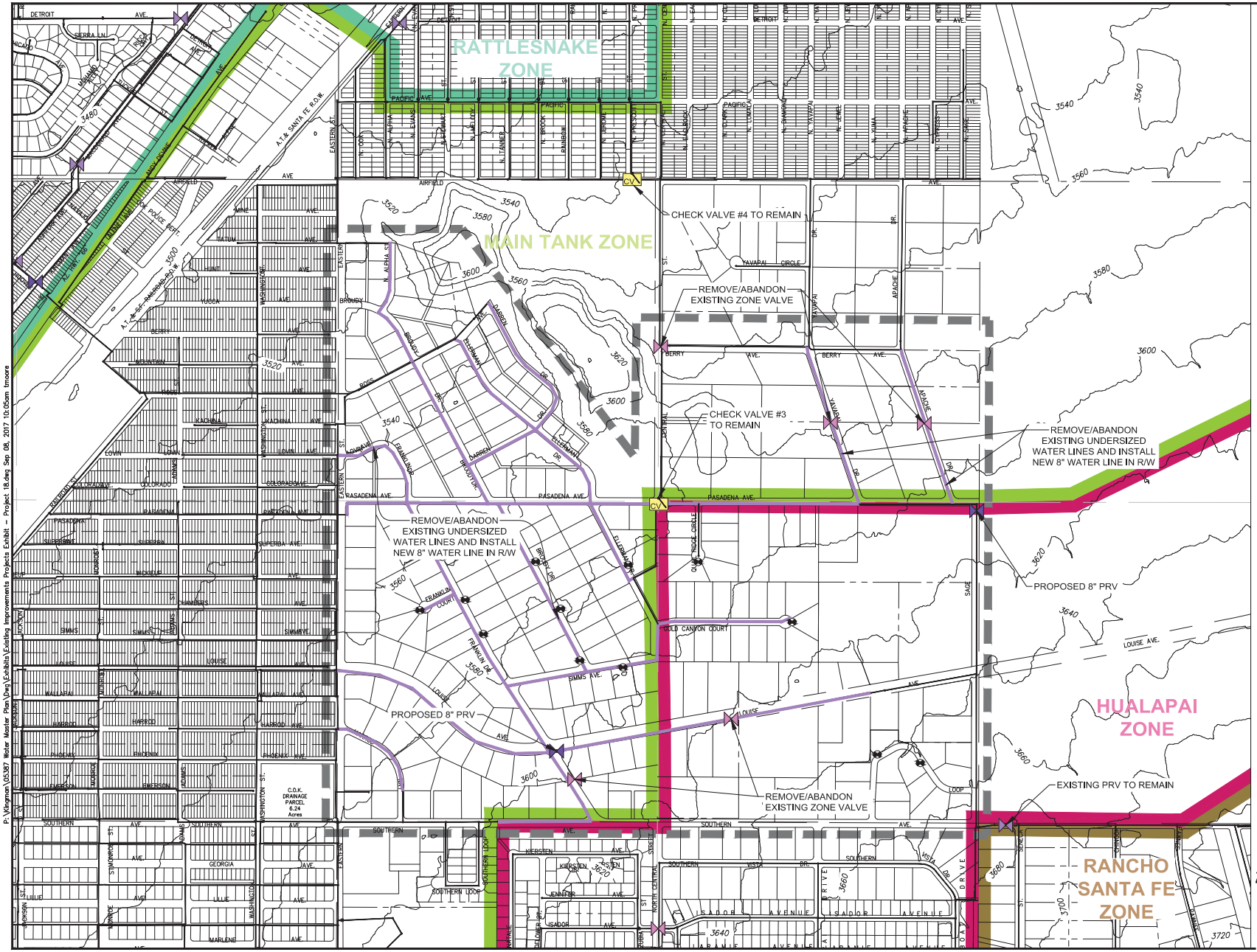
Key Modifications:

- Replace undersized pipes within Kingman Park Estates with 8” lines in R/W
- Replace old 8” CL 150 PVC pipe with new 8” lines in Pasadena Avenue
- Remove 6 zone valves
- Install 2 new PRV’s
- Extend pipes for strategic looping

This improvement project is located within the Kingman Park Estates subdivision which encompasses Section 17 of Township 21 North, Range 16 West. The improvement project concentrates mainly on the deficiency in Fire Flow pressures within the Kingman Park Estates subdivision. The existing undersized (2”, 3”, 4” and 6”) pipes are to be replaced with 8” pipes and relocated from the alleys to the right-of-way. The improvement project also includes the replacement of old 8” CL 150 PVC pipe with new 8” water line in Pasadena Avenue from Eastern Street to Yavapai Drive. The improvement project also creates a defined zone line between the Main Tank Zone and the Foothills Regulated Zone. This zone line definition includes removal of six (6) zone valves and the addition of two (2) PRV’s. The improvement project also includes the extension of a few pipes for strategic looping. See **Exhibit 4.12 – Existing Improvements Project 12** for more information.

Estimated Total Project Cost: $3,205,400

See **Cost Estimate 4.12 – Existing Improvements Project 12** for cost breakdown.



NORTH

SCALE
0 750' 1500'
HORIZ: 1" = 750'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
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CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 12

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 4.12 - EXISTING IMPROVEMENTS PROJECT 12

SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.12 - Existing Improvements Project 12
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	29,322	LF	$55	$1,612,710
3	12" Water Line and Surface Restoration	0	LF	$100	$0
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	59	EA	$2,500	$146,750
7	Fire Hydrant Assembly with Gate Valve	14	EA	$4,500	$63,000
8	8" PRV Station	2	EA	$75,000	$150,000
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$1,972,460**
				Traffic Control (5% of Total)	$98,623
				Construction Administration (5% of Total)	$98,623
				Mobilization (15% of Total)	$295,869
				Construction Total	**$2,465,575**
				Final Engineering and Permitting (10% of Total)	$246,558
				Contingency (20% of Total)	$493,164
				Project Total	**$3,205,400**

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4.6.13 Existing Improvement Project 13

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

Key Modifications:

- Replace undersized pipes within College Heights with 8” lines

This improvement project is located within the College Heights subdivision, which is on the northwest corner of Jagerson Avenue and Edie Drive. The improvement project concentrates on the insufficiency of Fire Flow pressures within the subdivision. The existing undersized pipes (2”, 3” and 6”) pipes are to be replaced with 8” pipes to achieve acceptable fire flow pressures. See **Exhibit 4.13 – Existing Improvements Project 13** for more information.

Estimated Total Project Cost: $1,226,200

See **Cost Estimate 4.13 – Existing Improvements Project 13** for cost breakdown.

NORTH

SCALE
0 500' 1000'
HORIZ: 1" = 500'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
INCORPORATED 1952
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 13

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 4.13 - EXISTING IMPROVEMENTS PROJECT 13

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.13 - Existing Improvements Project 13
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	11,222	LF	$55	$617,210
3	12" Water Line and Surface Restoration	0	LF	$100	$0
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	23	EA	$2,500	$56,250
7	Fire Hydrant Assembly with Gate Valve	18	EA	$4,500	$81,000
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$754,460**
				Traffic Control (5% of Total)	$37,723
				Construction Administration (5% of Total)	$37,723
				Mobilization (15% of Total)	$113,169
				Construction Total	**$943,075**
				Final Engineering and Permitting (10% of Total)	$94,308
				Contingency (20% of Total)	$188,634
				Project Total	**$1,226,200**

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4.6.14 Existing Improvement Project 14

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

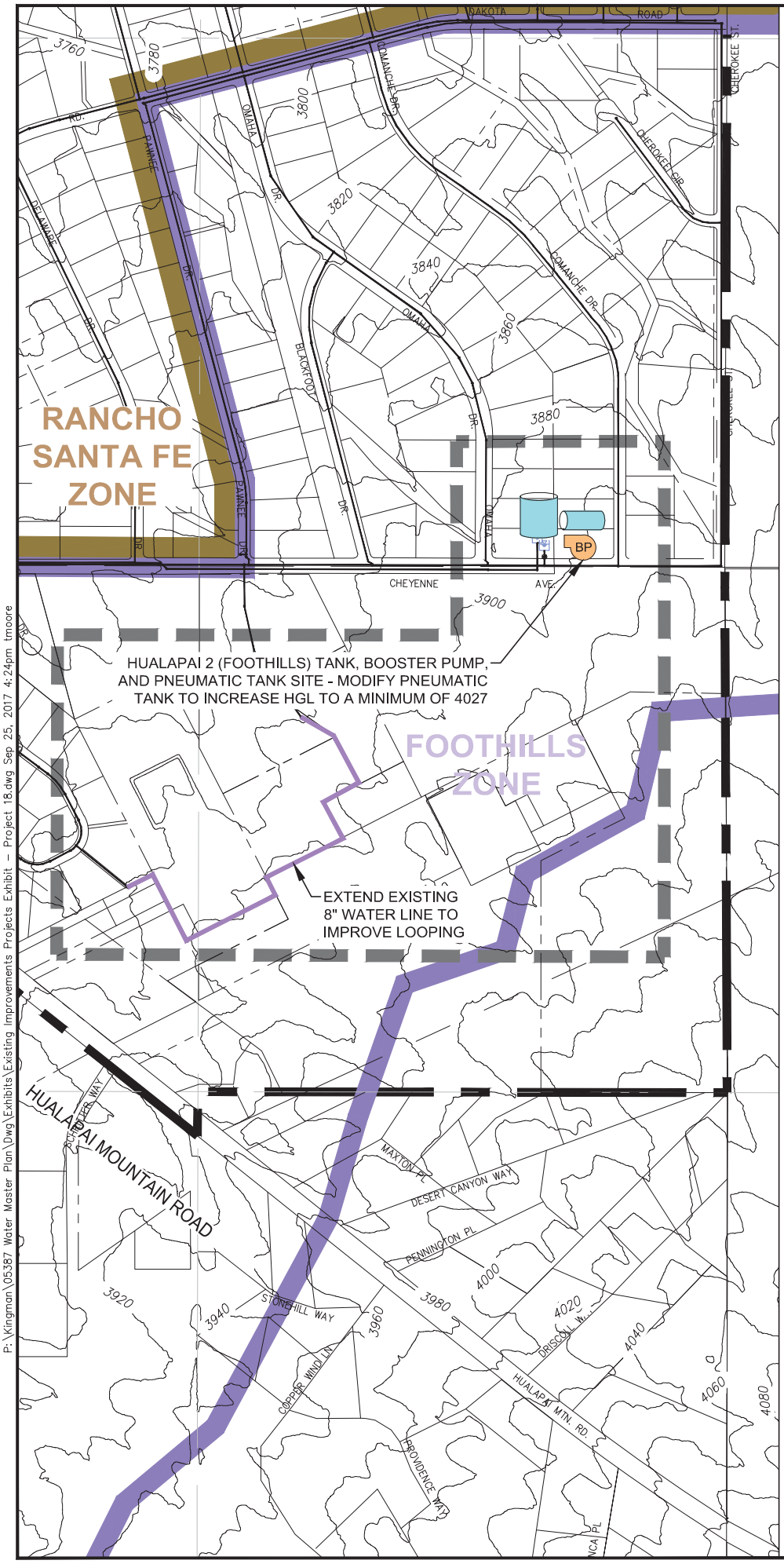
Key Modifications:

- Looping 8” line from North Ridge Estates to Hualapai Foothills

This improvement project is located within the Hualapai 2 (Foothills) Zone. The improvement project focuses on providing adequate fire flow pressures within the Hualapai Foothills and North Ridge Estates subdivisions. The improvement project includes increasing the HGL in the Foothills Pneumatic Tank from 3992 to a minimum of 4027 as well as looping the 8” line from the North Ridge Estates subdivision to the Hualapai Foothills subdivision. The HGL adjustment may be achieved by modification or replacement of the existing pneumatic tank. See **Exhibit 4.14 – Existing Improvements Project 14** for more information.

Estimated Total Project Cost: $276,200

See **Cost Estimate 4.14 – Existing Improvements Project 14** for cost breakdown.



NORTH

SCALE
0 750' 1500'
HORIZ: 1" = 750'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
INCORPORATED 1952
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 14

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 4.14 - EXISTING IMPROVEMENTS PROJECT 14

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.14 - Existing Improvements Project 14
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	2,411	LF	$55	$132,629
3	12" Water Line and Surface Restoration	0	LF	$100	$0
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	5	EA	$2,500	$12,250
7	Fire Hydrant Assembly with Gate Valve	0	EA	$4,500	$0
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$750,000	$0
12	Modification or Replacement of Pneumatic Tank	1	EA	$30,000	$30,000
				Construction Subtotal	**$174,879**
				Traffic Control (5% of Total)	$8,744
				Construction Administration (5% of Total)	$8,744
				Mobilization (15% of Total)	$26,232
				Construction Total	**$218,598**
				Final Engineering and Permitting (10% of Total)	$21,860
				Contingency (20% of Total)	$43,724
				Project Total	**$284,300**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

4.6.15 Existing Improvement Project 15

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

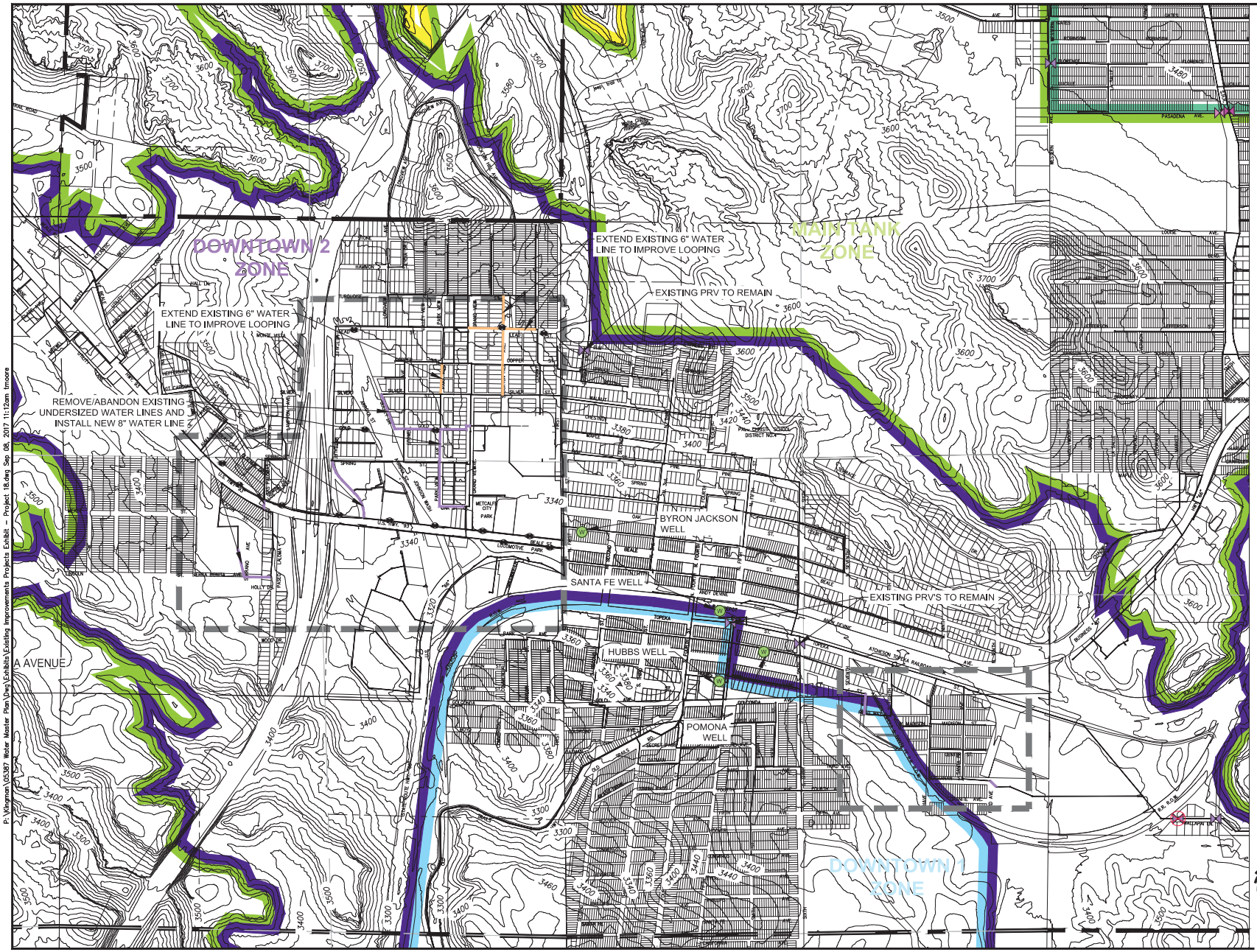
Key Modifications:

- Replace undersized pipes within the Downtown 2 Zone with 8” lines
- Extension of pipes for strategic looping

This improvement project is located within the Downtown 2 Zone. The improvement project focuses on the deficient fire flow pressures within the Downtown 2 Zone and includes upsizing of undersized (4” and 6”) pipes to 8” and extension of pipes for strategic looping. See **Exhibit 4.15 – Existing Improvements Project 15** for more information.

Estimated Total Project Cost: $773,600

See **Cost Estimate 4.15 – Existing Improvements Project 15** for cost breakdown.



NORTH

SCALE
0 1000' 2000'
HORIZ: 1" = 1000'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 15

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 4.15 - EXISTING IMPROVEMENTS PROJECT 15

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.15 - Existing Improvements Project 15
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	2,176	LF	$45	$97,934
2	8" Water Line and Surface Restoration	4,991	LF	$55	$274,505
3	12" Water Line and Surface Restoration	0	LF	$100	$0
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	14	EA	$2,500	$36,000
7	Fire Hydrant Assembly with Gate Valve	15	EA	$4,500	$67,500
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$475,939**
				Traffic Control (5% of Total)	$23,797
				Construction Administration (5% of Total)	$23,797
				Mobilization (15% of Total)	$71,391
				Construction Total	**$594,923**
				Final Engineering and Permitting (10% of Total)	$59,492
				Contingency (20% of Total)	$118,997
				Project Total	**$773,600**

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4.6.16 Existing Improvement Project 16

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

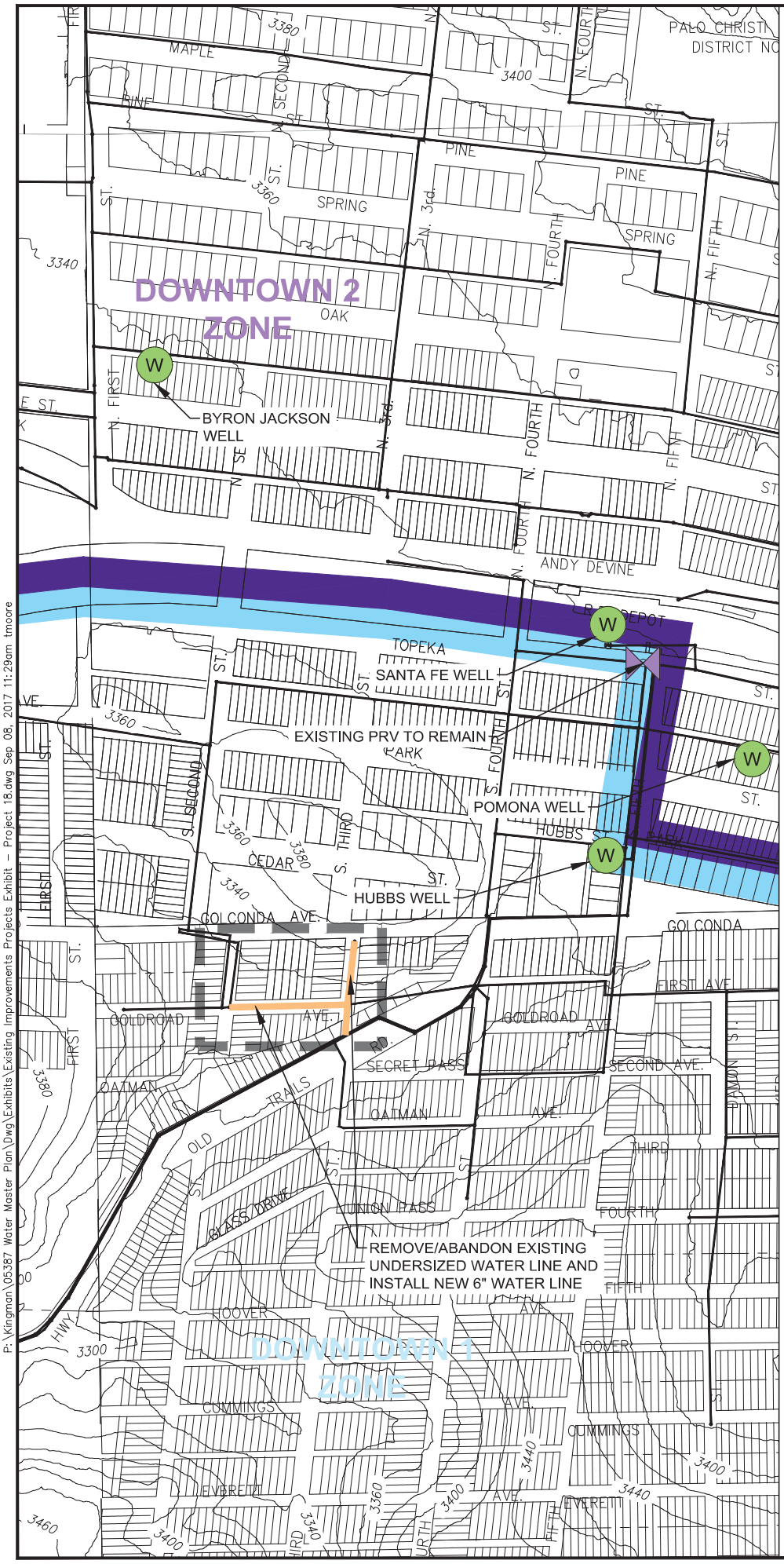
Key Modifications:

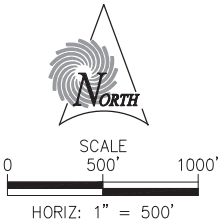
- Replace undersized pipes within the Downtown 1 Zone with 6” lines

This improvement project is located within the Downtown 1 Zone. The improvement project focuses on the deficient fire flow pressures within the Downtown 1 Zone and includes upsizing of undersized (2”) pipes to 6”. See **Exhibit 4.16 – Existing Improvements Project 16** for more information.

Estimated Total Project Cost: $57,900

See **Cost Estimate 4.16 – Existing Improvements Project 16** for cost breakdown.





LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN

WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 16

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 4.16 - EXISTING IMPROVEMENTS PROJECT 16

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.16 - Existing Improvements Project 16
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	707	LF	$45	$31,817
2	8" Water Line and Surface Restoration	0	LF	$55	$0
3	12" Water Line and Surface Restoration	0	LF	$100	$0
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	2	EA	$2,500	$3,750
7	Fire Hydrant Assembly with Gate Valve	0	EA	$4,500	$0
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$35,567**
				Traffic Control (5% of Total)	$1,778
				Construction Administration (5% of Total)	$1,778
				Mobilization (15% of Total)	$5,335
				Construction Total	**$44,459**
				Final Engineering and Permitting (10% of Total)	$4,446
				Contingency (20% of Total)	$8,893
				Project Total	**$57,900**

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4.6.17 Existing Improvement Project 17

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

Key Modifications:

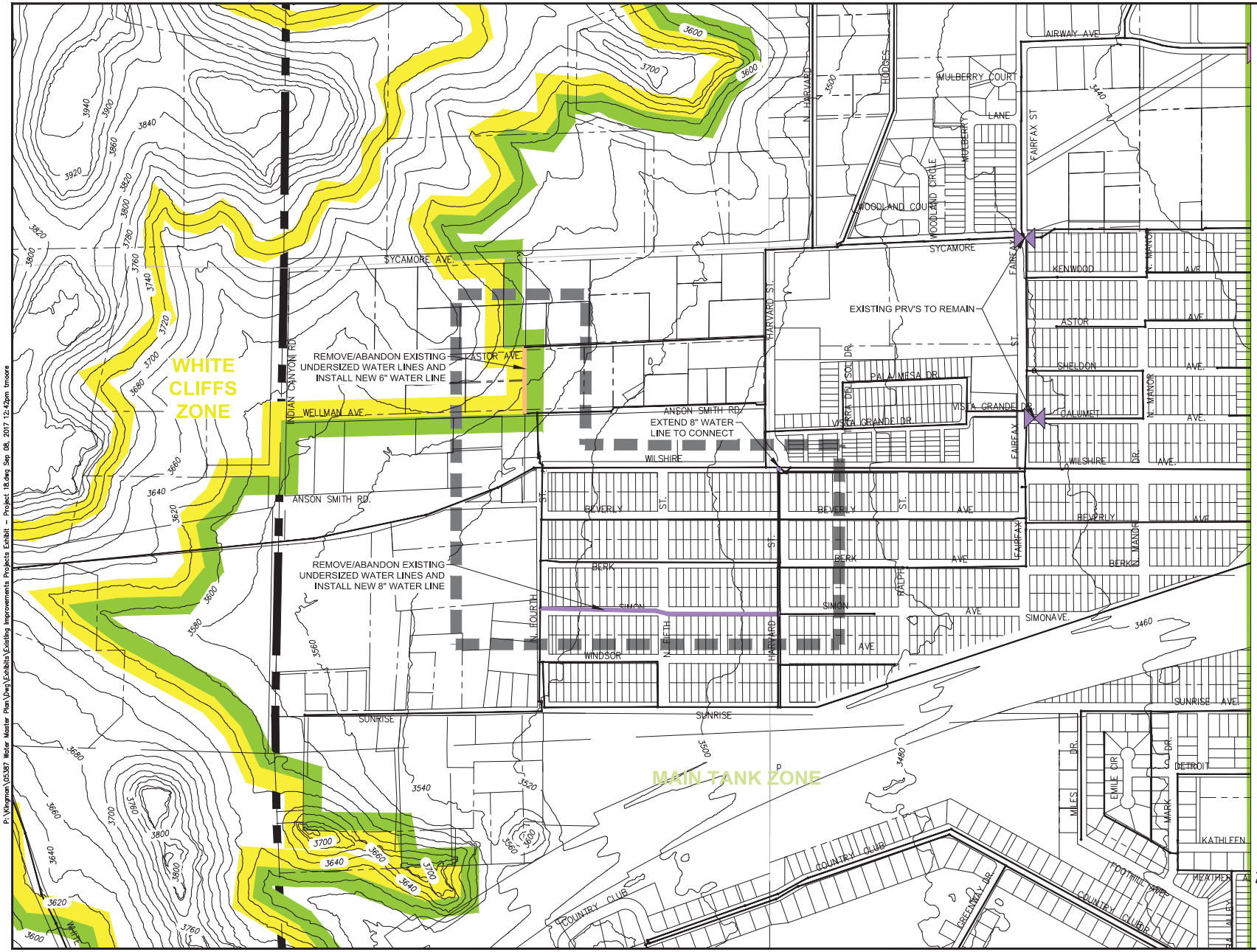
- Replace undersized pipes within Valley Slope with 8” lines
- Extend pipes for strategic looping
- Abandon undersized pipes within Wilshire Avenue and connect laterals to existing main

This improvement project is located within the Valley Slope subdivision from Fourth Street east to Harvard Street and from Simon Avenue north to Astor Avenue. The improvement project concentrates on the deficient fire flow pressures within the area and includes upsizing undersized (2”, 3”) pipes along Simon Avenue and Fourth Street. The improvement project also includes the extension of a few pipes for strategic looping. Existing undersized (2” and 3”) pipes within Wilshire Avenue are to be abandoned and all existing lateral pipes should connect to the 16” existing main in the north side of the road. See **Exhibit 4.17 – Existing Improvements Project 17** for more information.

Estimated Total Project Cost: $200,500

See **Cost Estimate 4.17 – Existing Improvements Project 17** for cost breakdown.

EXHIBIT 4.17 - EXISTING IMPROVEMENTS PROJECT 17



NORTH

SCALE
0 500' 1000'
HORIZ: 1" = 500'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 17

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

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2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.17 - Existing Improvements Project 17
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	365	LF	$45	$16,425
2	8" Water Line and Surface Restoration	1,334	LF	$55	$73,370
3	12" Water Line and Surface Restoration	0	LF	$100	$0
4	16" Water Line and Surface Restoration	0	LF	$125	$0
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	3	EA	$2,500	$8,500
7	Fire Hydrant Assembly with Gate Valve	0	EA	$4,500	$0
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$98,295**
				Traffic Control (5% of Total)	$4,915
				Construction Administration (5% of Total)	$4,915
				Mobilization (15% of Total)	$14,744
				Construction Total	**$122,869**
				Final Engineering and Permitting (10% of Total)	$12,287
				Contingency (20% of Total)	$24,576
				Project Total	**$159,900**

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4.6.18 Existing Improvement Project 18

Purpose: Alleviate Fire Flow Deficiency

Benefits:

- Meet required Fire Flow Pressures

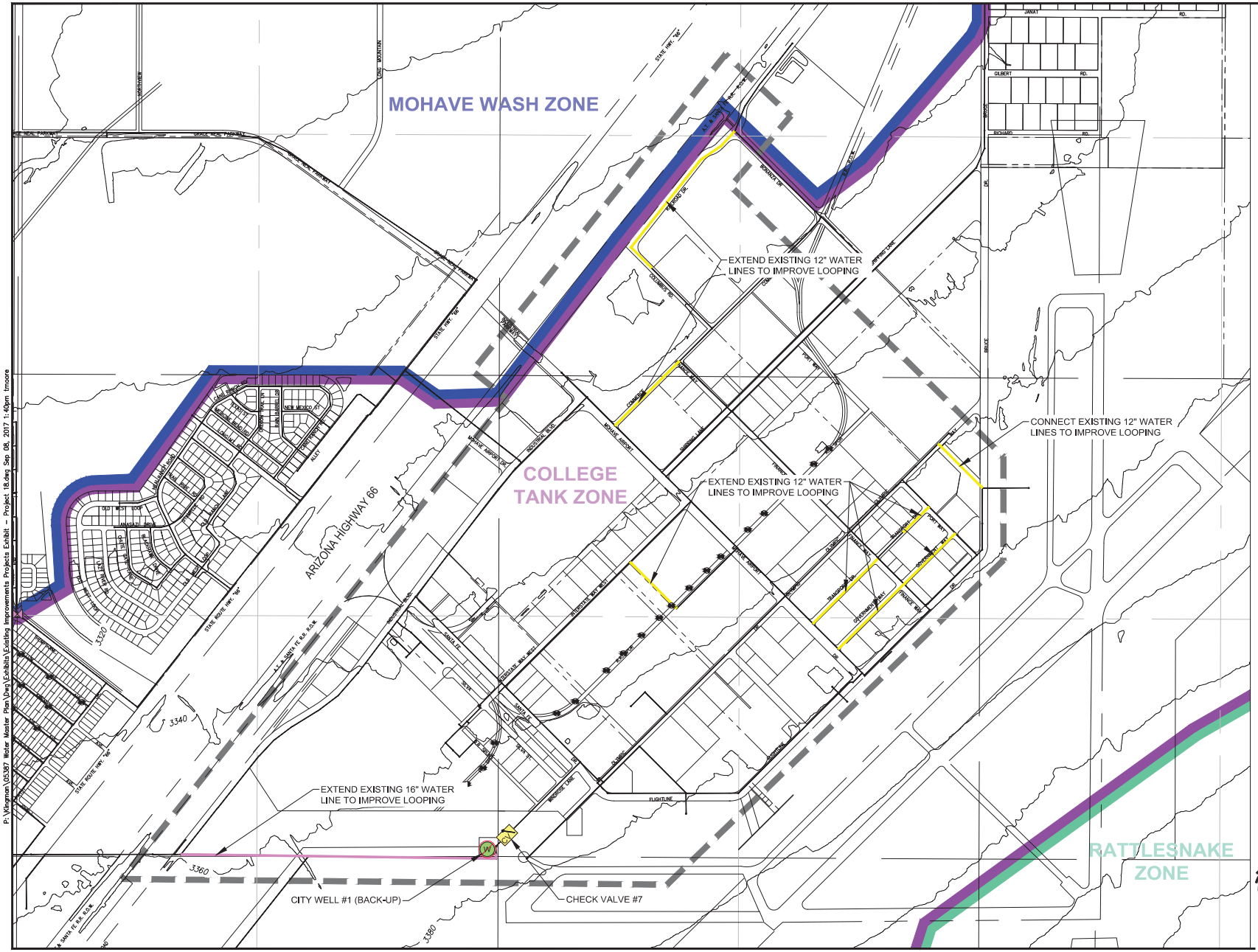
Key Modifications:

- Extend and add new pipes for strategic looping

This improvement project is located within the Kingman Airport commercial and industrial park and includes the area from State Route Highway 66 east to Bruce Drive and from Northern Avenue north to approximately Richard Road. The improvement project focuses mainly on the deficiency in Fire Flow pressures within the Kingman Airport commercial and industrial park. The existing pipes are to be extended and pipes are to be added strategically to improve looping. Most importantly, the existing 16" pipe within the Northern Avenue alignment should be extended between Industrial Boulevard and the site of City Well #1 (approximately 3,500 feet). See **Exhibit 4.18 – Existing Improvements Project 18** for more information.

Estimated Total Project Cost: $2,189,800

See **Cost Estimate 4.18 – Existing Improvements Project 18** for cost breakdown.



NORTH

SCALE
0 1000' 2000'
HORIZ: 1" = 1000'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
WATER MASTER PLAN
EXISTING IMPROVEMENTS
PROJECT 18

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 4.18 - EXISTING IMPROVEMENTS PROJECT 18

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.18 - Existing Improvements Project 18
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	0	LF	$45	$0
2	8" Water Line and Surface Restoration	0	LF	$55	$0
3	12" Water Line and Surface Restoration	7,671	LF	$100	$767,100
4	16" Water Line and Surface Restoration	3,511	LF	$125	$438,875
5	24" Water Line and Surface Restoration	0	LF	$200	$0
6	Water Valve, Box and Cover	22	EA	$2,500	$56,000
7	Fire Hydrant Assembly with Gate Valve	19	EA	$4,500	$85,500
8	8" PRV Station	0	EA	$75,000	$0
9	12" PRV Station	0	EA	$100,000	$0
10	16" PRV Station	0	EA	$125,000	$0
11	Well Equipping	0	EA	$30,000	$0
				Construction Subtotal	**$1,347,475**
				Traffic Control (5% of Total)	$67,374
				Construction Administration (5% of Total)	$67,374
				Mobilization (15% of Total)	$202,121
				Construction Total	**$1,684,344**
				Final Engineering and Permitting (10% of Total)	$168,434
				Contingency (20% of Total)	$336,902
				Project Total	**$2,189,800**

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2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

Existing Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 4.19 - Existing Improvements Projects Summary
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	6" Water Line and Surface Restoration	3,757	LF	$45	$169,081
2	8" Water Line and Surface Restoration	399,948	LF	$55	$21,997,154
3	12" Water Line and Surface Restoration	57,064	LF	$100	$5,706,433
4	16" Water Line and Surface Restoration	3,511	LF	$125	$438,875
5	24" Water Line and Surface Restoration	2,912	LF	$200	$582,318
6	Water Valve, Box and Cover	935	EA	$2,500	$2,338,250
7	Fire Hydrant Assembly with Gate Valve	613	EA	$4,500	$2,758,500
8	8" PRV Station	8	EA	$75,000	$600,000
9	12" PRV Station	5	EA	$100,000	$500,000
10	16" PRV Station	2	EA	$125,000	$250,000
11	Well Equipping	1	EA	$750,000	$750,000
12	Modification or Replacement of Pneumatic Tank	2	EA	$30,000	$60,000
				Construction Subtotal	**$36,150,611**
				Traffic Control (5% of Total)	$1,807,531
				Construction Administration (5% of Total)	$1,807,531
				Mobilization (15% of Total)	$5,422,592
				Construction Total	**$45,188,264**
				Final Engineering and Permitting (10% of Total)	$4,518,826
				Contingency (20% of Total)	$9,038,557
				Project Total	**$58,745,800**

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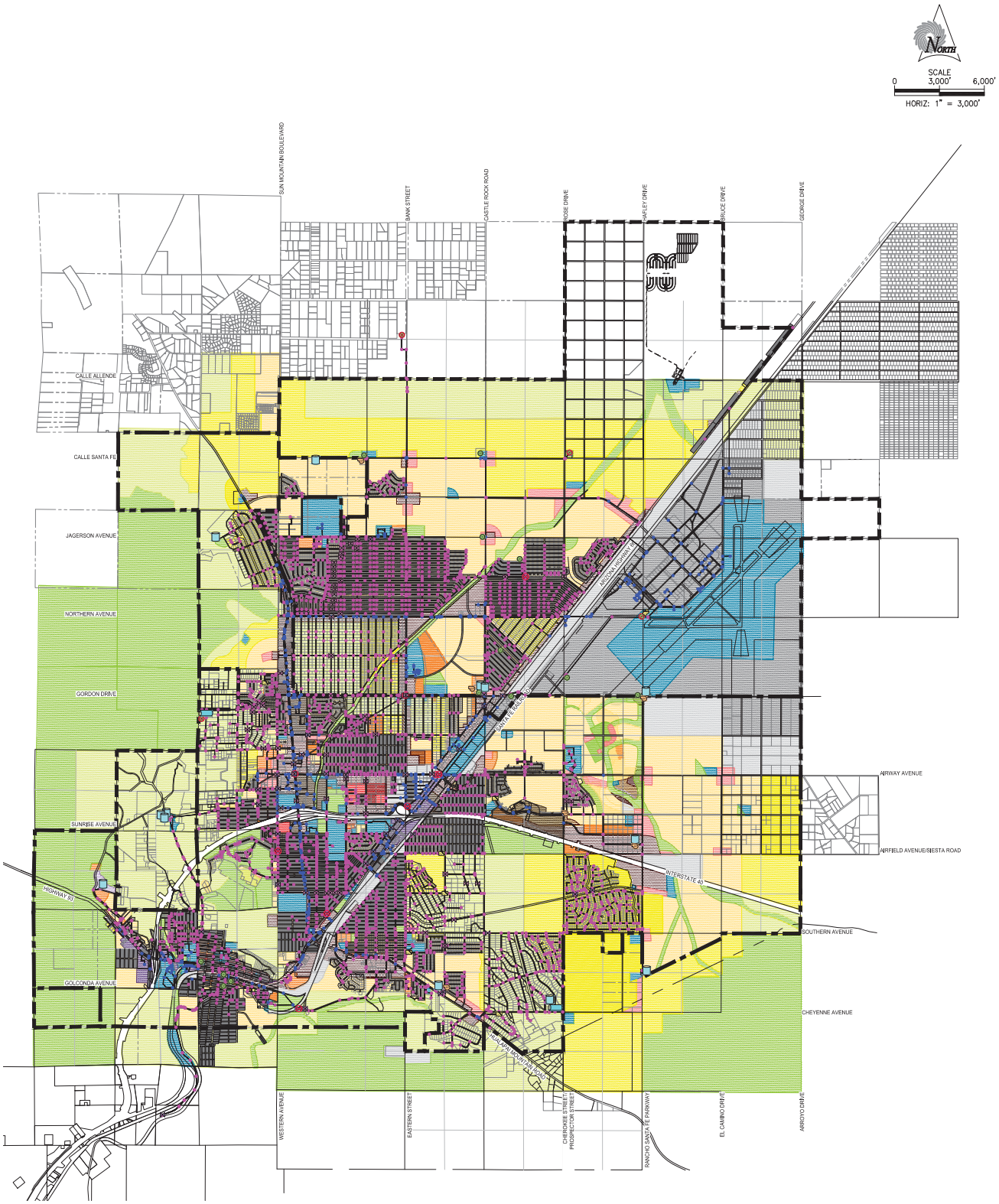
SECTION 4 FIGURES

Figure 4.1 – Existing Fire Flow Demands
Figure 4.2 – Existing Fire Hydrant Coverage
Figure 4.3 – Existing Model – Peak Hour Results
Figure 4.4 – Existing Model – Fire Flow Results
Figure 4.5 – Existing Improvements Fire Flow Demands
Figure 4.6 – Existing Improvements Fire Hydrant Coverage
Figure 4.7 – Existing Improvements Project Overview
Figure 4.8 – Proposed Pressure Zones
Figure 4.9 – Existing Improvements Model – Peak Hour Results
Figure 4.10 – Existing Improvements Model – Fire Flow Results
Figure 4.11 – Post-Existing Improvements Fire Flow Deficiencies



LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING PROPOSED

- WELL
- INACTIVE WELL
- BACKUP WELL
- TANK
- PNEUMATIC TANK
- BOOSTER PUMP
- PRESSURE REDUCING VALVE (PRV)
- INACTIVE PRV
- ZONE VALVE
- CHECK VALVE

- 1,000 GPM (RESIDENTIAL)
- 3,500 GPM (COMMERCIAL & INDUSTRIAL)

LAND USE DESIGNATION LEGEND

- RURAL DENSITY RESIDENTIAL (1 DU OR LESS/AC)
- LOW DENSITY RESIDENTIAL (1–2 DU/AC)
- MEDIUM DENSITY RESIDENTIAL (3–8 DU/AC)
- INTERMEDIATE DENSITY RESIDENTIAL (9–16 DU/AC)
- HIGH DENSITY RESIDENTIAL (17–28 DU/AC)
- NEIGHBORHOOD COMMERCIAL
- COMMUNITY COMMERCIAL
- REGIONAL COMMERCIAL
- HIGHWAY SERVICE COMMERCIAL
- LIGHT INDUSTRIAL
- MANUFACTURING INDUSTRIAL
- PUBLIC/QUASI–PUBLIC
- PARKS/OPEN SPACE

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 4.1
EXISTING MODEL
FIRE FLOW DEMANDS

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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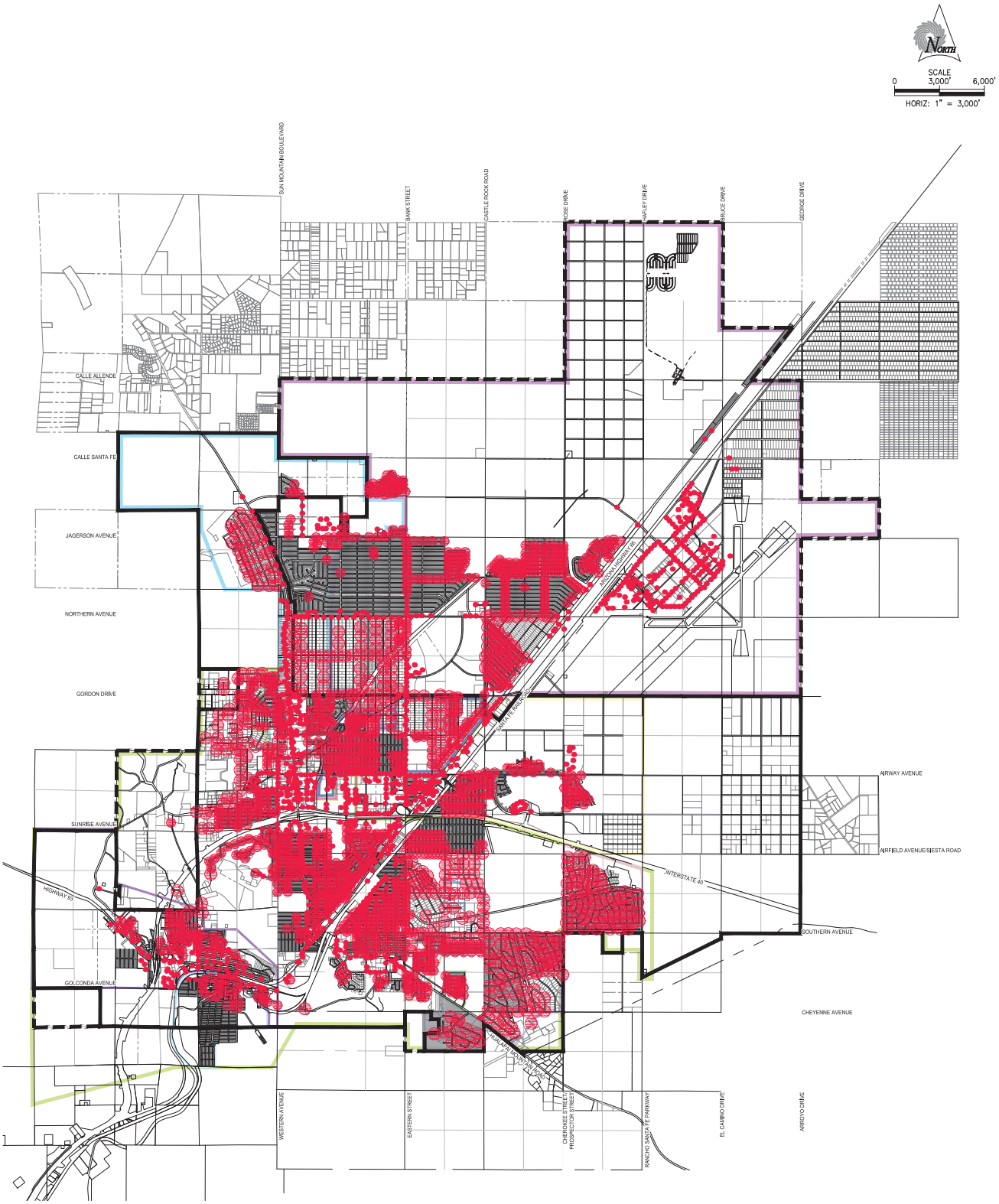

LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)
- EXISTING FIRE HYDRANT LOCATION (300 FT RADIUS) INDUSTRIAL AND COMMERCIAL ZONING
- EXISTING FIRE HYDRANT LOCATION (600 FT RADIUS) RESIDENTIAL ZONING
- EXISTING FIRE HYDRANT LOCATION (800 FT RADIUS) RURAL ZONING

EXISTING PRESSURE ZONE LEGEND

- MAIN TANK ZONE
  - DOWNTOWN ZONE 1
  - DOWNTOWN ZONE 2
  - RICCA DR / HOSPITAL ZONE
  - FRIPPS RANCH ZONE
  - HUALAPAI SHADOW ZONE
  - FOOTHILLS REGULATED ZONE
  - FOOTHILLS PNEUMATIC ZONE
  - FOOTHILLS (HUALAPAI 2) ZONE
  - RANCHO SANTA FE REGULATED ZONE
- CAMELBACK TANK ZONE
  - WALLECK RANCH ZONE
  - SHANGRI LA IMPROVEMENT DISTRICT ZONE
- COLLEGE TANK ZONE
- RATTLESNAKE ZONE

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 4.2
EXISTING FIRE HYDRANT COVERAGE

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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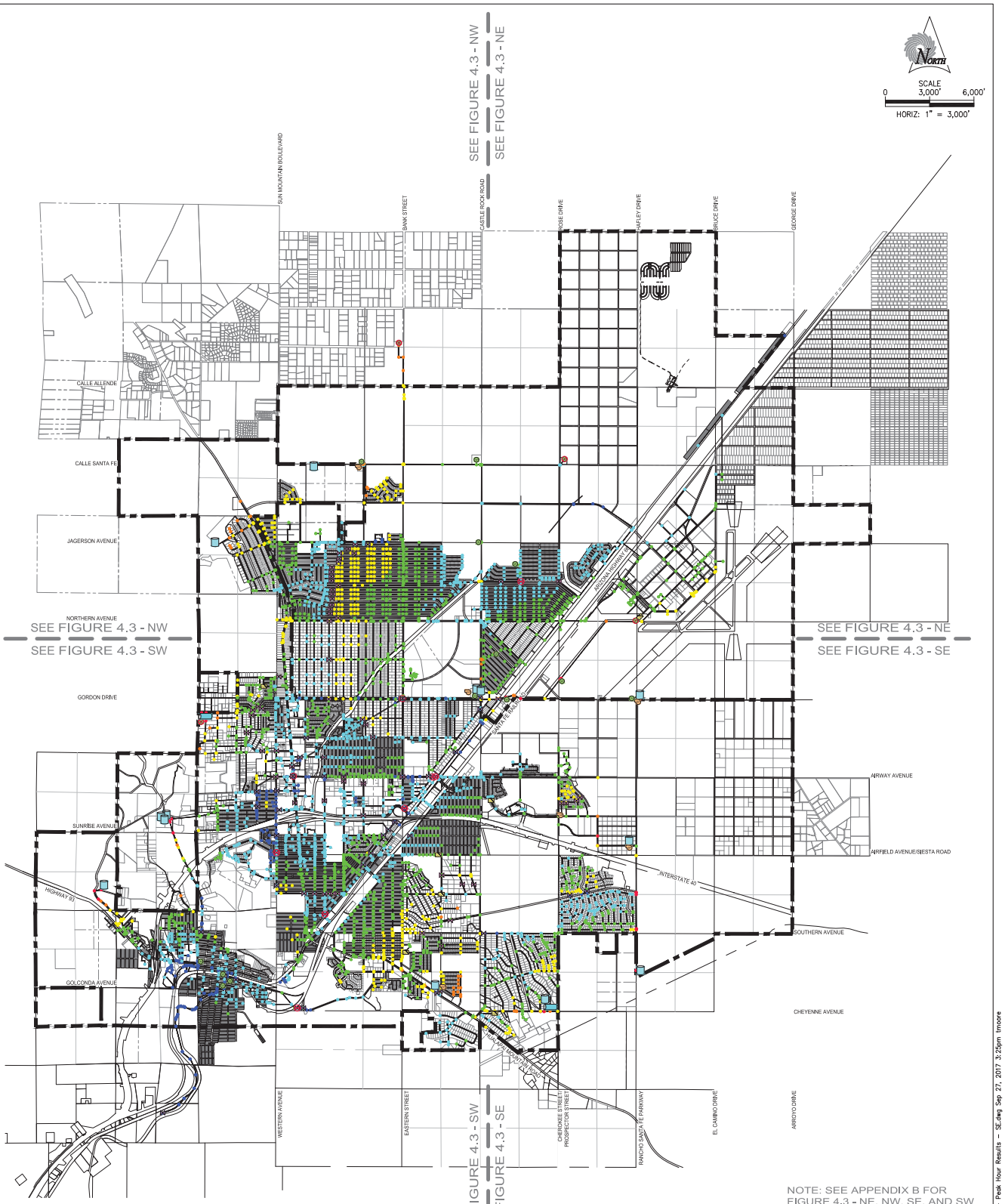

NOTE: SEE APPENDIX B FOR FIGURE 4.3 - NE, NW, SE, AND SW

LEGEND

CITY BOUNDARY	
STUDY LIMITS (WATER BOUNDARY)	
EXISTING / PROPOSED	
WELL	
INACTIVE WELL	
BACKUP WELL	
TANK	
PNEUMATIC TANK	
BOOSTER PUMP	
PRESSURE REDUCING VALVE (PRV)	
INACTIVE PRV	
ZONE VALVE	
CHECK VALVE	

< 20.00 PSI
20.00 – 40.00 PSI
40.00 – 60.00 PSI
60.00 – 80.00 PSI
80.00 – 100.00 PSI
> 100.00 PSI

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 4.3
EXISTING MODEL
PEAK HOUR RESULTS

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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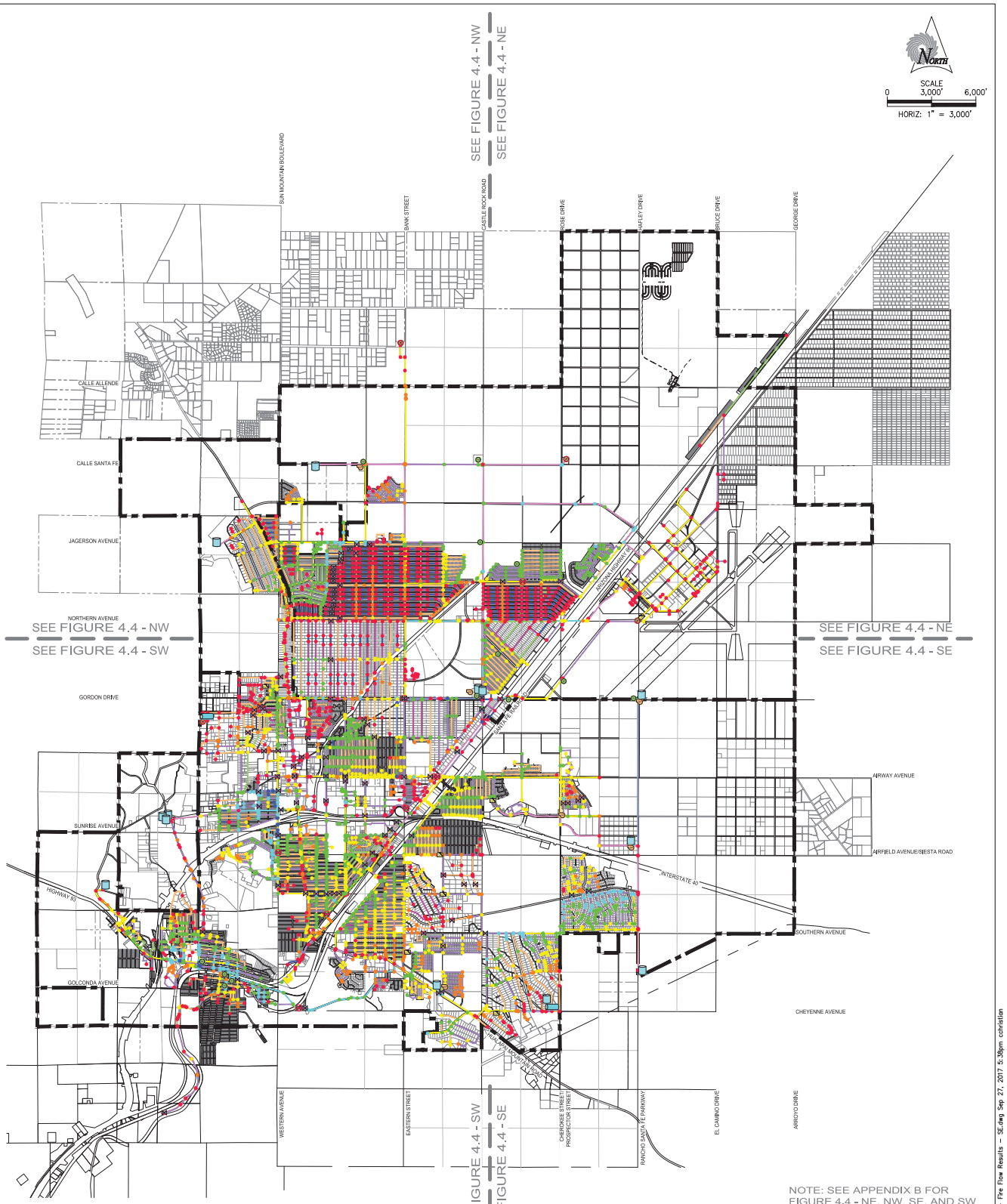

NOTE: SEE APPENDIX B FOR FIGURE 4.4 - NE, NW, SE, AND SW

LEGEND

CITY BOUNDARY	< 20.00 PSI
STUDY LIMITS (WATER BOUNDARY)	20.00 – 40.00 PSI
EXISTING / PROPOSED	40.00 – 60.00 PSI
WELL	60.00 – 80.00 PSI
INACTIVE WELL	80.00 – 100.00 PSI
BACKUP WELL	> 100.00 PSI
TANK	
PNEUMATIC TANK	
BOOSTER PUMP	
PRESSURE REDUCING VALVE (PRV)	
INACTIVE PRV	
ZONE VALVE	
CHECK VALVE	

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 4.4
EXISTING MODEL
FIRE FLOW RESULTS

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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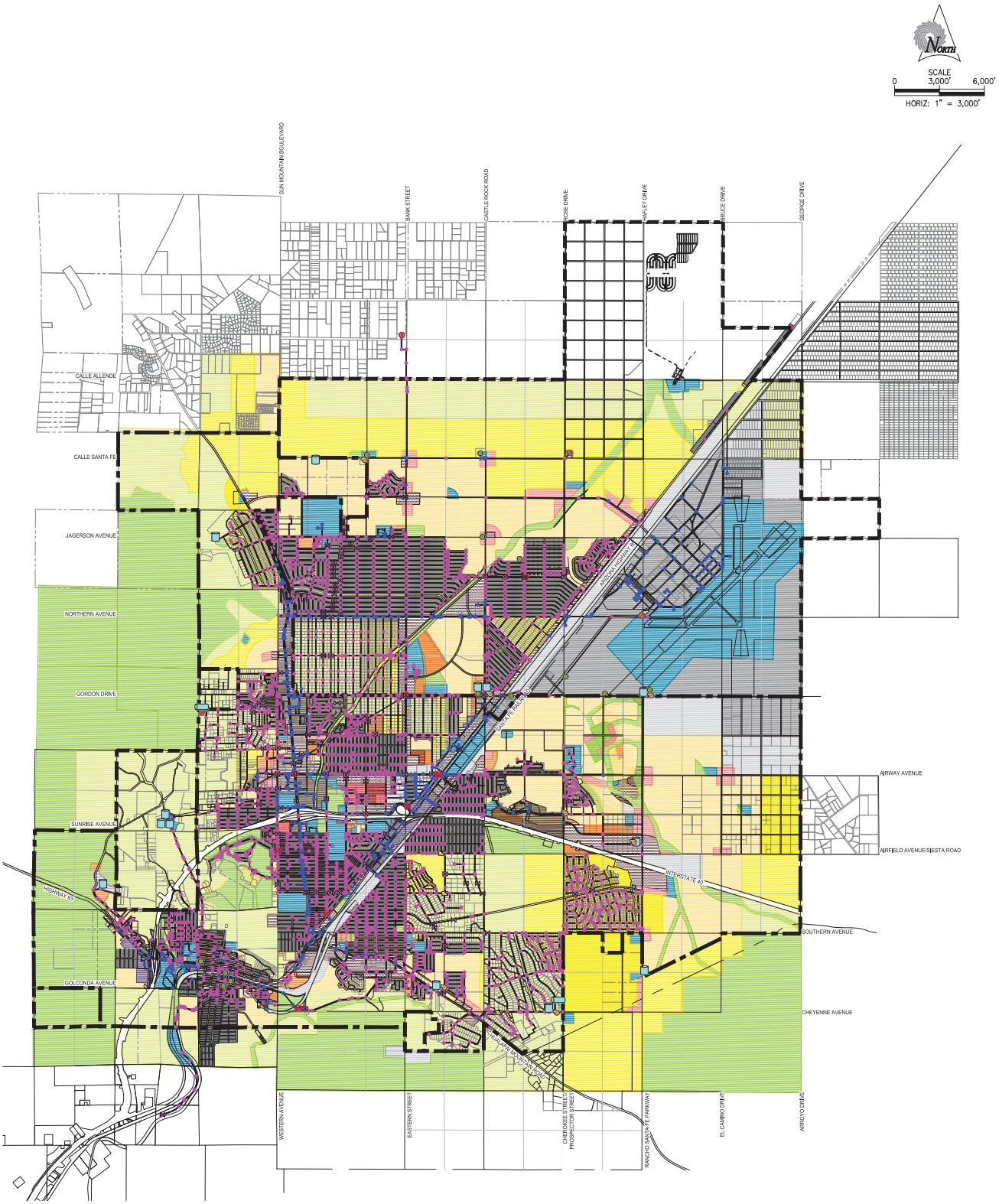

LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE

- 1,000 GPM (RESIDENTIAL)
- 3,500 GPM (COMMERCIAL & INDUSTRIAL)

LAND USE DESIGNATION LEGEND

- RURAL DENSITY RESIDENTIAL (1 DU OR LESS/AC)
- LOW DENSITY RESIDENTIAL (1–2 DU/AC)
- MEDIUM DENSITY RESIDENTIAL (3–8 DU/AC)
- INTERMEDIATE DENSITY RESIDENTIAL (9–16 DU/AC)
- HIGH DENSITY RESIDENTIAL (17–28 DU/AC)
- NEIGHBORHOOD COMMERCIAL
- COMMUNITY COMMERCIAL
- REGIONAL COMMERCIAL
- HIGHWAY SERVICE COMMERCIAL
- LIGHT INDUSTRIAL
- MANUFACTURING INDUSTRIAL
- PUBLIC/QUASI–PUBLIC
- PARKS/OPEN SPACE

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 4.5
EXISTING IMPROVEMENTS
FIRE FLOW DEMANDS

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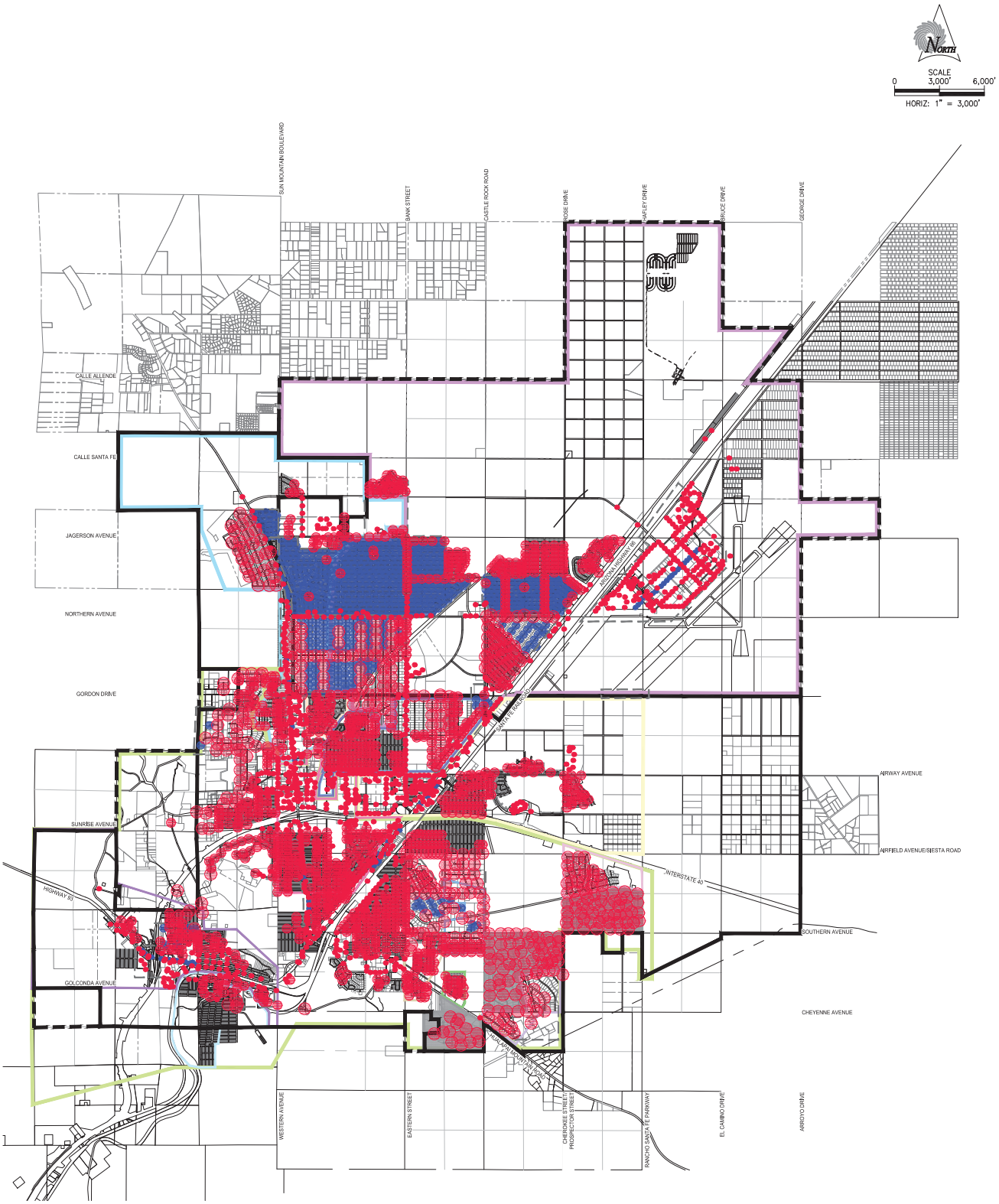

LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)
- EXISTING FIRE HYDRANT LOCATION (300 FT RADIUS) INDUSTRIAL AND COMMERCIAL ZONING
- EXISTING FIRE HYDRANT LOCATION (600 FT RADIUS) RESIDENTIAL ZONING
- EXISTING FIRE HYDRANT LOCATION (800 FT RADIUS) RURAL ZONING
- PROPOSED FIRE HYDRANT LOCATION (300 FT RADIUS) INDUSTRIAL AND COMMERCIAL ZONING
- PROPOSED FIRE HYDRANT LOCATION (500 FT RADIUS) RESIDENTIAL AND RURAL ZONING

EXISTING PRESSURE ZONE LEGEND

- MAIN TANK ZONE
  - DOWNTOWN ZONE 1
  - DOWNTOWN ZONE 2
  - RICCA DR / HOSPITAL ZONE
  - FRIPPS RANCH ZONE
  - HUALAPAI SHADOW ZONE
  - FOOTHILLS REGULATED ZONE
  - FOOTHILLS PNEUMATIC ZONE
  - FOOTHILLS (HUALAPAI 2) ZONE
  - RANCHO SANTA FE REGULATED ZONE
- CAMELBACK TANK ZONE
  - WALLECK RANCH ZONE
  - SHANGRI LA IMPROVEMENT DISTRICT ZONE
- COLLEGE TANK ZONE
- RATTLESNAKE ZONE

NOTES:
1. FIRE HYDRANTS ARE ONLY PROPOSED AS PART OF THE EXISTING IMPROVEMENT PROJECTS AND ARE THEREFORE ONLY PROPOSED WITHIN PROJECT BOUNDARIES.
2. PROPOSED FIRE HYDRANT QUANTITIES ARE SHOWN WITHIN EXISTING IMPROVEMENT PROJECTS COST ESTIMATES.

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CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 4.6
EXISTING IMPROVEMENTS
FIRE HYDRANT COVERAGE

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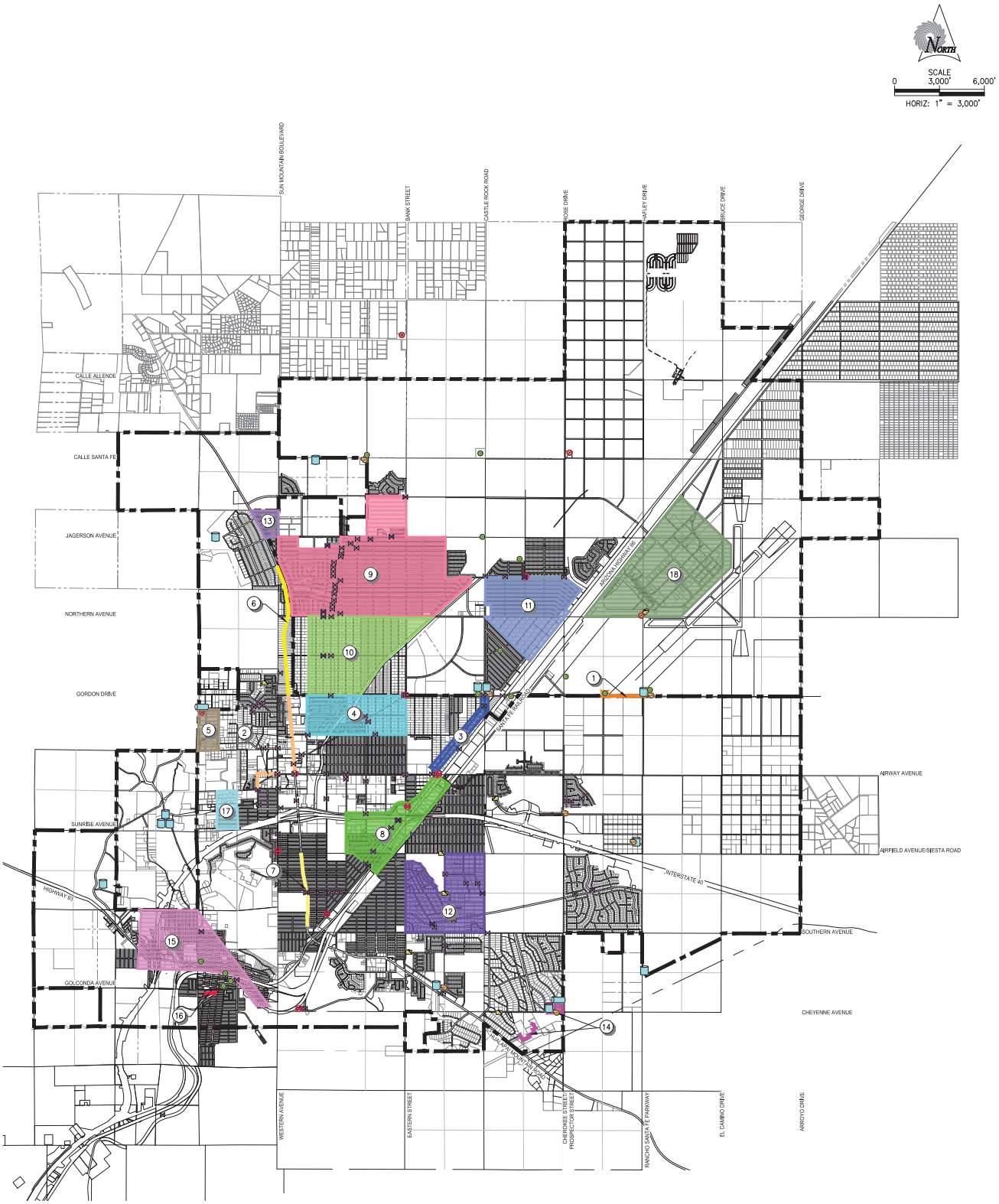

LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE
		PROJECT ID NUMBER

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 4.7
EXISTING IMPROVEMENTS
PROJECT OVERVIEW

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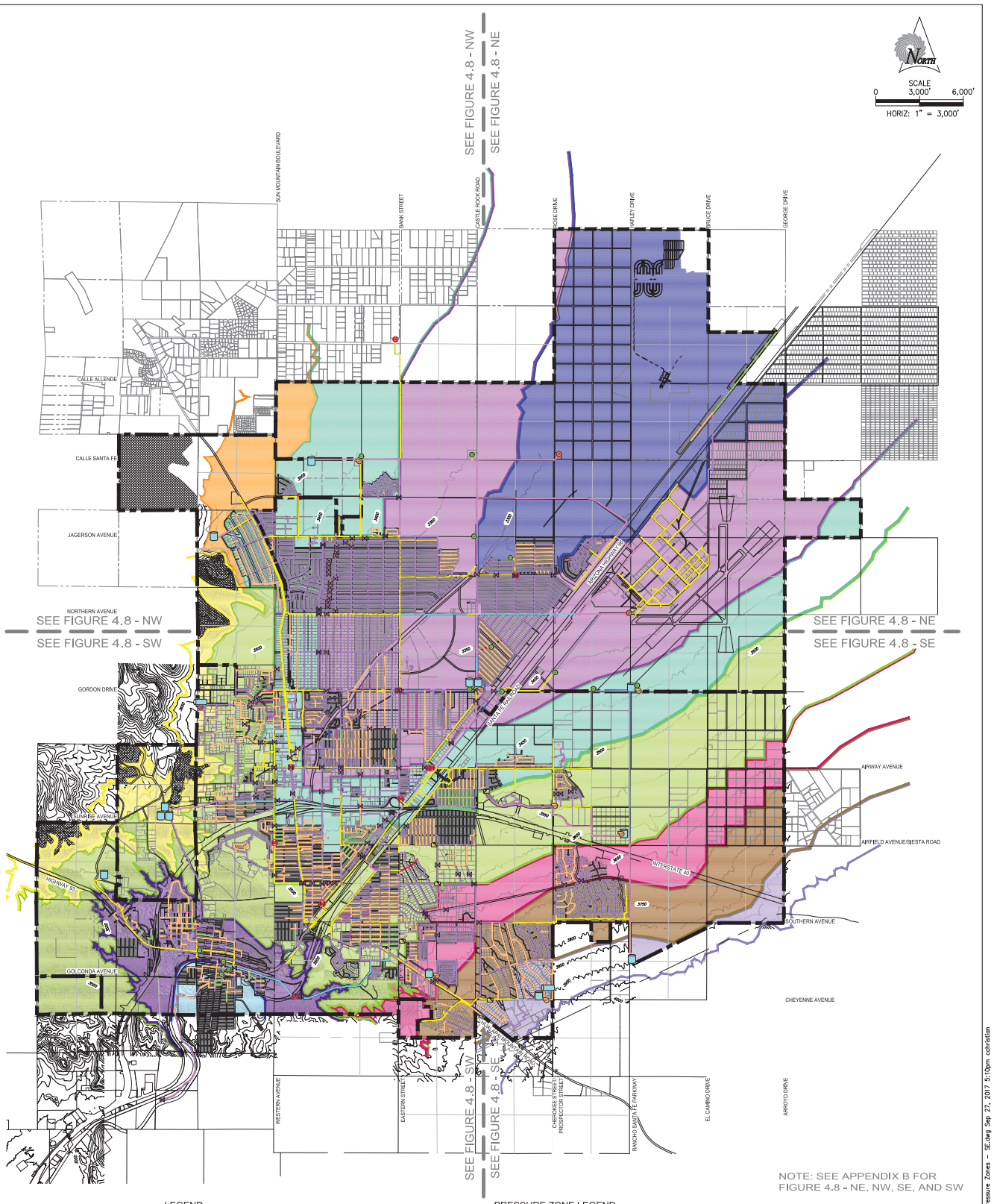

NOTE: SEE APPENDIX B FOR FIGURE 4.8 - NE, NW, SE, AND SW

LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE

- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE

PRESSURE ZONE LEGEND

- FOOTHILLS ZONE
- RANCHO SANTA FE ZONE
- HUALAPAI ZONE
- WHITE CLIFFS ZONE
- BULL MOUNTAIN ZONE
- DOWNTOWN ZONE 1
- DOWNTOWN ZONE 2
- MAIN TANK ZONE
- RATTLESNAKE ZONE
- COLLEGE TANK ZONE
- MOHAVE WASH ZONE
- AREA NOT LIKELY TO BE DEVELOPED (PER WWMP)

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CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 4.8
PROPOSED PRESSURE ZONES

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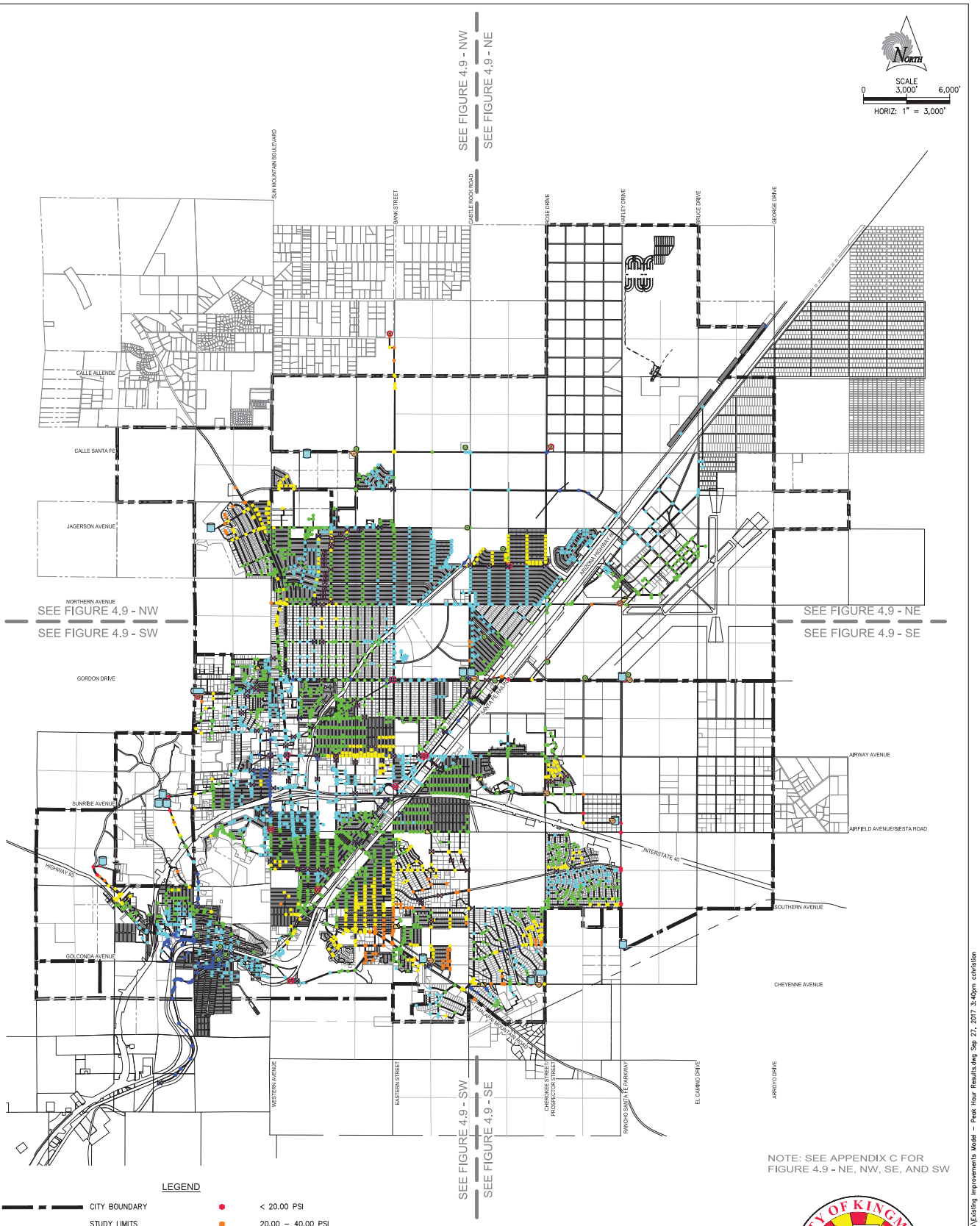

NOTE: SEE APPENDIX C FOR FIGURE 4.9 - NE, NW, SE, AND SW

LEGEND

	CITY BOUNDARY
	STUDY LIMITS (WATER BOUNDARY)
EXISTING / PROPOSED	WELL
	INACTIVE WELL
	BACKUP WELL
	TANK
	PNEUMATIC TANK
	BOOSTER PUMP
	PRESSURE REDUCING VALVE (PRV)
	INACTIVE PRV
	ZONE VALVE
	CHECK VALVE

- < 20.00 PSI
- 20.00 – 40.00 PSI
- 40.00 – 60.00 PSI
- 60.00 – 80.00 PSI
- 80.00 – 100.00 PSI
- > 100.00 PSI

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WATER MASTER PLAN
FIGURE 4.9
EXISTING IMPROVEMENTS MODEL
PEAK HOUR RESULTS

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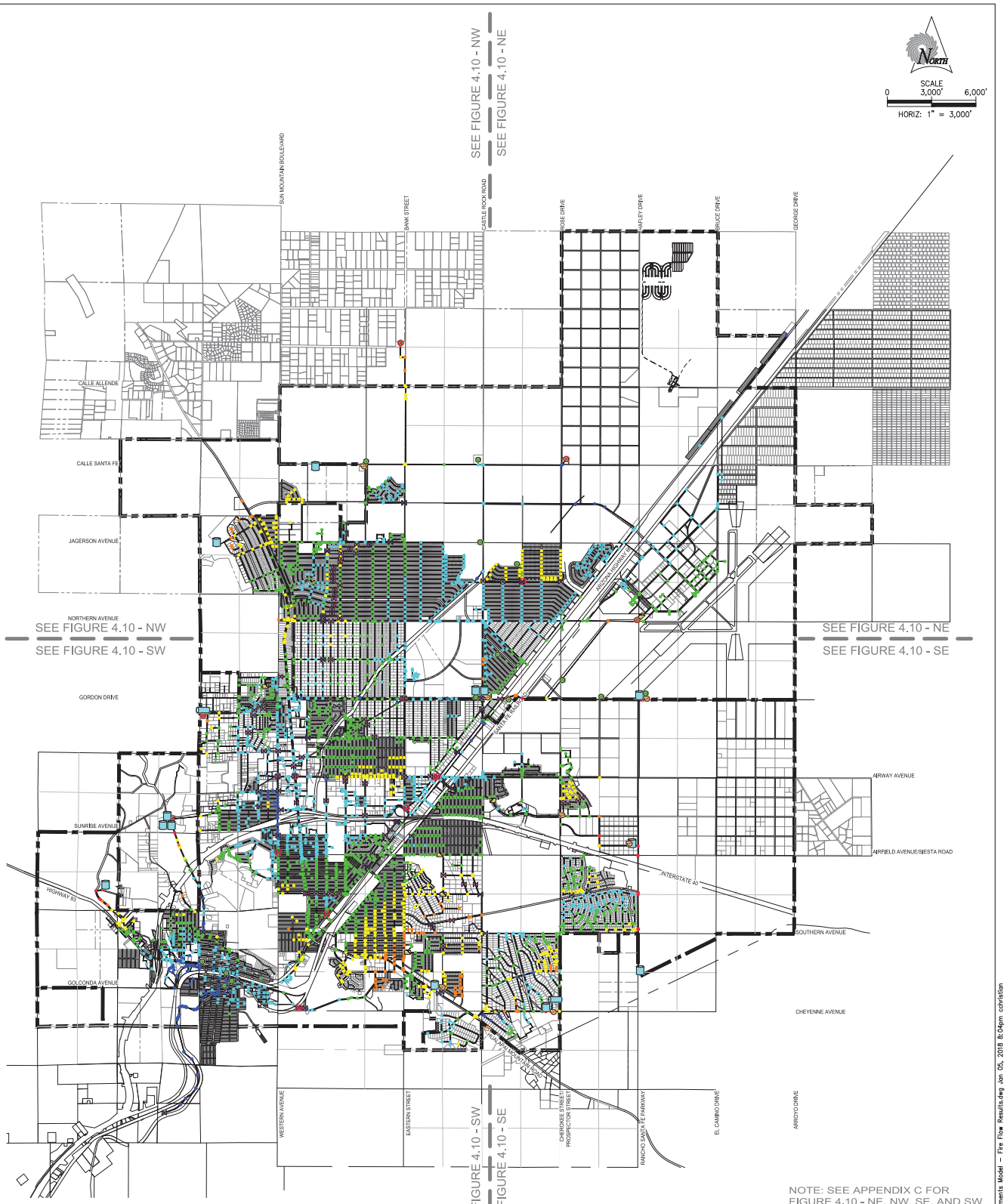

NOTE: SEE APPENDIX C FOR FIGURE 4.10 - NE, NW, SE, AND SW

LEGEND

	CITY BOUNDARY
	STUDY LIMITS (WATER BOUNDARY)
EXISTING / PROPOSED	WELL
	INACTIVE WELL
	BACKUP WELL
	TANK
	PNEUMATIC TANK
	BOOSTER PUMP
	PRESSURE REDUCING VALVE (PRV)
	INACTIVE PRV
	ZONE VALVE
	CHECK VALVE

- < 20.00 PSI
- 20.00 – 40.00 PSI
- 40.00 – 60.00 PSI
- 60.00 – 80.00 PSI
- 80.00 – 100.00 PSI
- > 100.00 PSI

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FIGURE 4.10
EXISTING IMPROVEMENTS MODEL
FIRE FLOW RESULTS

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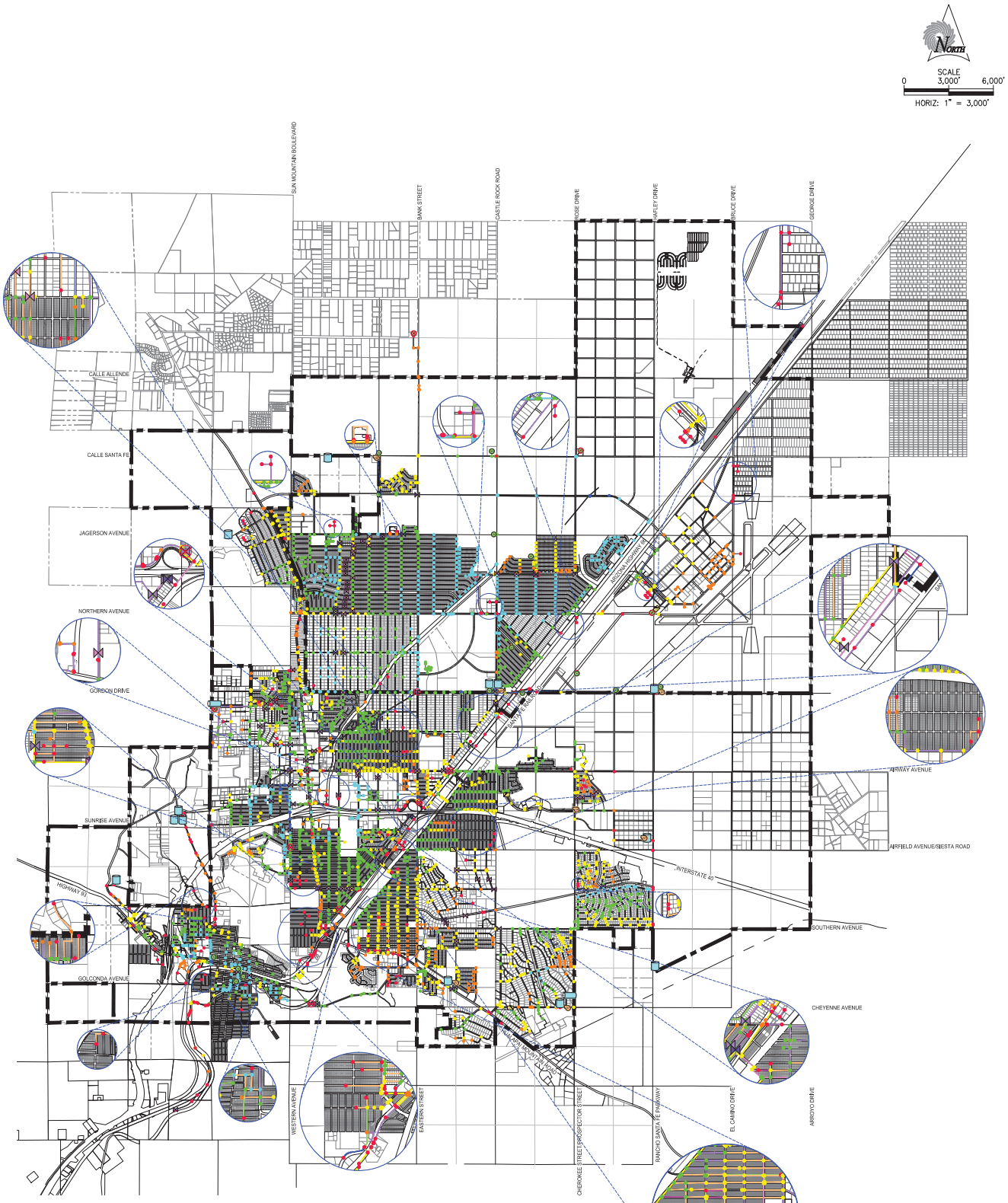

LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE

- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE

- < 20.00 PSI
- 20.00 – 40.00 PSI
- 40.00 – 60.00 PSI
- 60.00 – 80.00 PSI
- 80.00 – 100.00 PSI
- > 100.00 PSI

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FIGURE 4.11
POST-EXISTING IMPROVEMENTS
FIRE FLOW DEFICIENCIES

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5.0 10-YEAR (2027) WATER SYSTEM ANALYSIS

The proposed 10-year water system was analyzed and compared to the design criteria presented in **Section 3.0 - Design Criteria** in regards to available water system source, storage, and booster pump demands. Zonal distribution of source, storage and booster pump capacity was evaluated as to determine need and safety, in the form of redundancy, within the system and projected 10-year demands. The 10-year water distribution system was examined to provide adequate pressures on an average day, month, year as well as in fire flow conditions. An H2ONet model was created for the 10-year water system analysis. The 10-year model used the existing improvements model as a foundation and was revised per the recommended improvements proposed for the 10-year water system based on the projected growth discussed in the following sections.

5.1 CONNECTIONS & POPULATION PROJECTIONS

Projected 10-year connections are determined by projecting existing connections (accounts) with an estimated growth rate of 2.5% over 10 years. Projected population is based off estimated accounts multiplied by 2.5 people per account. People per account from the City of Kingman Utility Regulations Section 7.5 is determined as 3.5. The value for people per account of 2.5 was determined by comparison with current census data and through City staff input. Projected connections and population are shown in **Table 5.1 - 10-Year Connection & Population Projections**.

Table 5.1 - 10-Year Connection & Population Projections

Year	Estimated Accounts	Estimated Population
2017	19,047	47,618
2018	19,523	48,808
2019	20,011	50,028
2020	20,512	51,279
2021	21,024	52,561
2022	21,550	53,875
2023	22,089	55,222
2024	22,641	56,602
2025	23,207	58,017
2026	23,787	59,468
2027	24,382	60,954

5.2 WATER DEMAND ANALYSIS

Projected water demand was calculated from projected connections multiplied by average water usage per connection. The City provided 2015 monthly consumption data for the water system for the existing demand analysis. The existing system demand analysis produced an estimated average water usage per account per day of 312 gallons per connection. In general, daily water usage decreases over time as users and technology become more water-conscious and therefore water-conservative. However; for our analysis, average water usage per account per day is assumed the same. This assumption will act as a safety-factor in our analysis. See **Table 5.2 - 10-Year Demand Projections** for the 10-year total system demand calculations.

Table 5.2 - 10-Year Demand Projections

Year	Estimated Accounts	Average Water Usage per Account per Day (gal/conn/day)	Average Day (MGD)	Maximum Day (x1.5) (MGD)	Peak Day (x2.0) (MGD)	Peak Hour (x3.0) (MGD)
2017	19,047	312	5.94	8.91	11.89	17.83
2018	19,523	312	6.09	9.14	12.18	18.27
2019	20,011	312	6.24	9.37	12.49	18.73
2020	20,512	312	6.40	9.60	12.80	19.20
2021	21,024	312	6.56	9.84	13.12	19.68
2022	21,550	312	6.72	10.09	13.45	20.17
2023	22,089	312	6.89	10.34	13.78	20.68
2024	22,641	312	7.06	10.60	14.13	21.19
2025	23,207	312	7.24	10.86	14.48	21.72
2026	23,787	312	7.42	11.13	14.84	22.26
2027	24,382	312	7.61	11.41	15.21	22.82

5.3 WATER SOURCE ANALYSIS

Along with population and demand projections, infrastructure requirements versus existing capacity was estimated. The minimum required water source for the system is maximum day demand plus 10 percent with the largest well out of service, as defined in **Section 3.0 - Design Criteria**. The maximum day factor is 1.5 times average day water demands. The required minimum source for 2027 was calculated to be 12.55 million gallons per day of source water. Following the recommended improvements to the existing system, which included the equipping of City Well 10, the wells in the water system can deliver 25.17 million gallons per day of water. This total capacity does not include City Well 1 and Long Mountain Well 6, which are backup wells, as well as Bank Street Well and Long Mountain Well 1 which are inactive wells. The largest well in the system is City Well 10, which has a capacity of 4.29 million gallons per day. With City Well 10 out of service, the existing wells in the system can deliver 20.88 million gallons of water per day. The existing system delivers enough source water to meet minimum design criteria for existing demand. The activation of backup wells would increase the available source by another 3.17 million gallons. For minimum required source calculations, see **Table 5.3 – 10-Year Water Source Analysis**.

Table 5.3 – 10-Year Water Source Analysis

	Capacity (GPM)	Capacity (MGD)
Total Source	17,480	25.17
Total Available Source*	**14,500**	**20.88**
Minimum Required	8,716	12.55

**Largest Well out of Service*

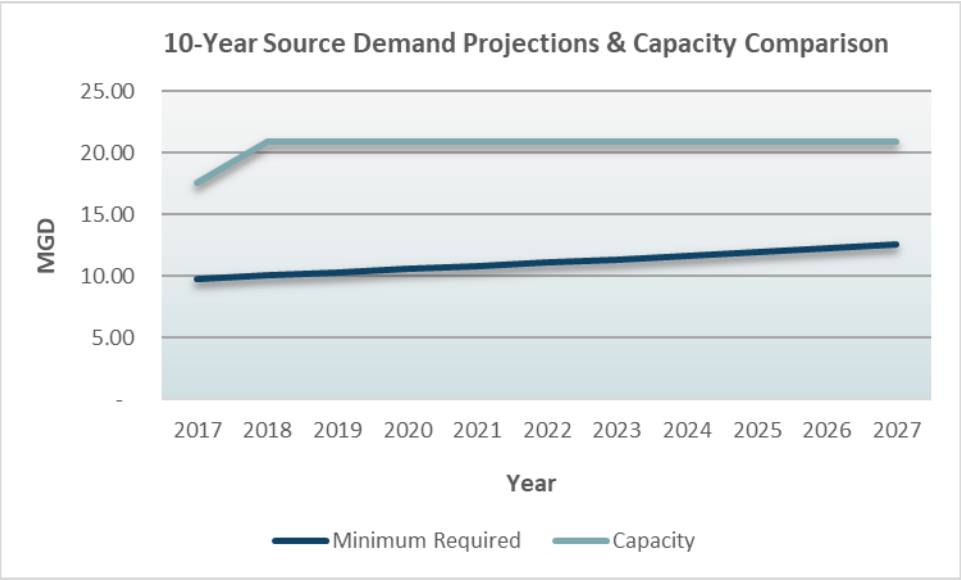
See **Table 5.4 - 10-Year Source Demand Projections & Capacity Comparison** and **Graph 5.1 - 10-Year Source Demand Projections & Capacity Comparison** for a yearly comparison of the projected minimum required source and system source capacity.

Table 5.4 - 10-Year Source Demand Projections & Capacity Comparison

Year	Minimum Required Source (MGD)	Source Capacity (MGD)	Addition (MGD)
2017	9.81	17.57	3.31*
2018	10.05	20.88	
2019	10.30	20.88	
2020	10.56	20.88	
2021	10.82	20.88	
2022	11.09	20.88	
2023	11.37	20.88	
2024	11.66	20.88	
2025	11.95	20.88	
2026	12.25	20.88	
2027	12.55	20.88	

* In the existing system, City Well 5 or 7 was the largest well. With the equipping of City Well 10, City Well 10 becomes the largest well in the system. According to the required source design standards set forth in **Section 3.6 - Source**, one of the margins of safety is calculating the source capacity with the largest well out of service for maintenance, repair, or other reasons. City Well 10 effectively activates 3.31 MGD of capacity (from either City Well 5 or 7) and it's 4.29 MGD is not included in the available capacity calculation.

Graph 5.1 - 10-Year Source Demand Projections & Capacity Comparison



All but four (4) of the wells within the water system are located north of the City boundary. The four (4) wells within City limits are all located within the downtown area and supply the downtown zones. The equipping of City Well #10, which was included in the existing improvement projects provided redundancy in source for the Rattlesnake and Rancho Santa Fe Zones.

5.4 WATER STORAGE ANALYSIS

Water storage for the projected 10-year connections was checked against storage criteria as defined in **Section 3.0 - Design Criteria**. Required storage is the sum of the equalization storage, emergency storage, and fire storage. Equalization storage is 25 percent of maximum day demand. Emergency storage is 20 percent of maximum demand. Fire storage is calculated as the volume equal to two (2) commercial fires and two (2) residential fires. Commercial fire storage is defined as 3,500 gallons per minute over a four (4) hour period per fire. The total system wide commercial fire flow storage requirement is equal to 1.68 million gallons. Residential fire storage is defined as the volume equal to 1,000 gallons per minute over a two (2) hour period per fire. The total system wide residential fire flow storage requirement is equal to 240,000 gallons. Total system wide combined residential and commercial fire flow storage is 1.92 million gallons. Adding fire flow to emergency storage and equalization storage, in 2027 the 10-year condition storage requirement is approximately 7.05 million gallons. No additional storage facilities are proposed within the existing improvement projects; however, the storage tanks in the existing system in 2017 have a total capacity of 13.18 million gallons. Therefore, the system has adequate storage capacity within the system for 2027 requirements. For minimum required storage calculations see **Table 5.5 – 10-Year Water Storage Analysis**.

Table 5.5 – 10-Year Water Storage Analysis

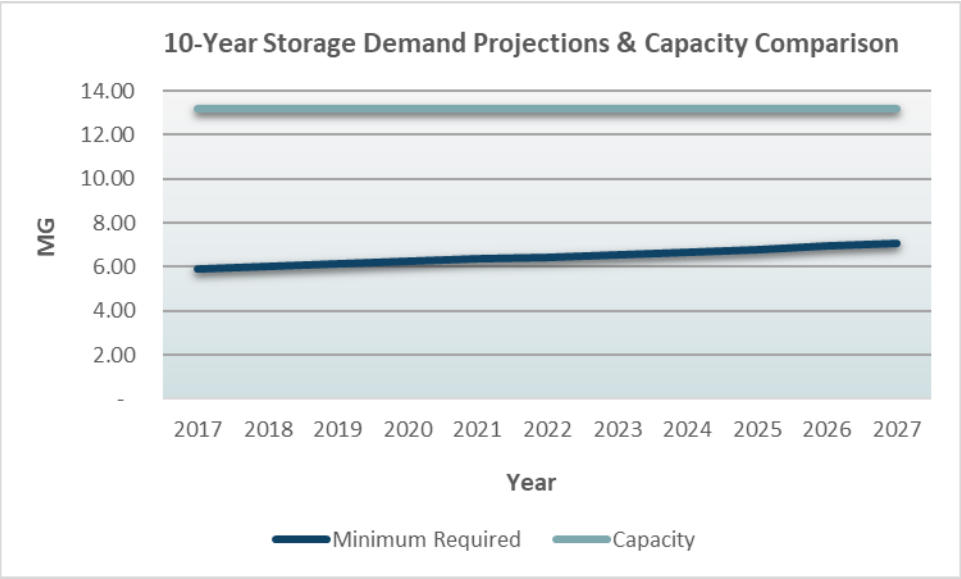
	Capacity (gallons)	Capacity (MG)
Total Available Storage	**13,176,000**	**13.18**
Minimum Required	7,054,801	7.05

See **Table 5.6 - 10-Year Storage Demand Projections & Capacity Comparison** and **Graph 5.2 - 10-Year Storage Demand Projections & Capacity Comparison** for a yearly comparison of the projected minimum required storage and system storage capacity.

Table 5.6 - 10-Year Storage Demand Projections & Capacity Comparison

Year	Minimum Required Storage (MG)	Storage Capacity (MG)	Addition (MG)
2017	5.93	13.18	
2018	6.03	13.18	
2019	6.13	13.18	
2020	6.24	13.18	
2021	6.35	13.18	
2022	6.46	13.18	
2023	6.57	13.18	
2024	6.69	13.18	
2025	6.81	13.18	
2026	6.93	13.18	
2027	7.05	13.18	

Graph 5.2 - 10-Year Storage Demand Projections & Capacity Comparison



Even though the system as a whole has nearly double the required storage, some of the pressure zones have considerable excess storage while others are deficient, specifically the Foothills, White Cliffs, and Bull Mountain Zones. The Foothills and White Cliffs Zones do not currently have dedicated storage within the zones, they are both dependent on pneumatic tanks in the existing condition. The Bull Mountain Zone is minimally developed in the existing condition and therefore the timeliness of required storage for the Bull Mountain Zone will be based on the development of the area.

Having storage redundancy either within specific zones or across zones is especially important in fire flow conditions. Redundancy is not available in some of the zones, specifically the Foothills, Rancho Santa Fe, or College Tank Zones.

5.5 BOOSTER PUMP ANALYSIS

Booster pumping capacity of the 10-year system was checked against booster pump criteria as defined in **Section 3.0 - Design Criteria**. Booster pumps must be able to supply peak hour demand with the largest pump out of service. Peak hour demand is 3.0 times average day demand. The booster pump capacity after the largest pump is taken out of service is the firm capacity. The firm capacity is calculated for every pump site. The firm capacity of the total system is the sum of the firm capacity for each pump site. In 2027, the projected booster pump capacity required is 22.82 million gallons per day. The system has a firm booster pump capacity of 34.42 million gallons per day. No additional booster pumps are proposed within the existing improvement projects; even so, the water system provides enough booster pump capacity in the 10-year scenario required to meet design criteria. For minimum required booster pump calculations see **Table 5.7 – 10-Year Booster Pump Analysis**.

Table 5.7 – 10-Year Booster Pump Analysis

	Capacity	Firm Capacity*
Total Available Booster Capacity (GPM)	31,410	23,905
Total Available Booster Capacity (MGD)	**45.23**	**34.42**
Minimum Required (MGD)	-	22.82

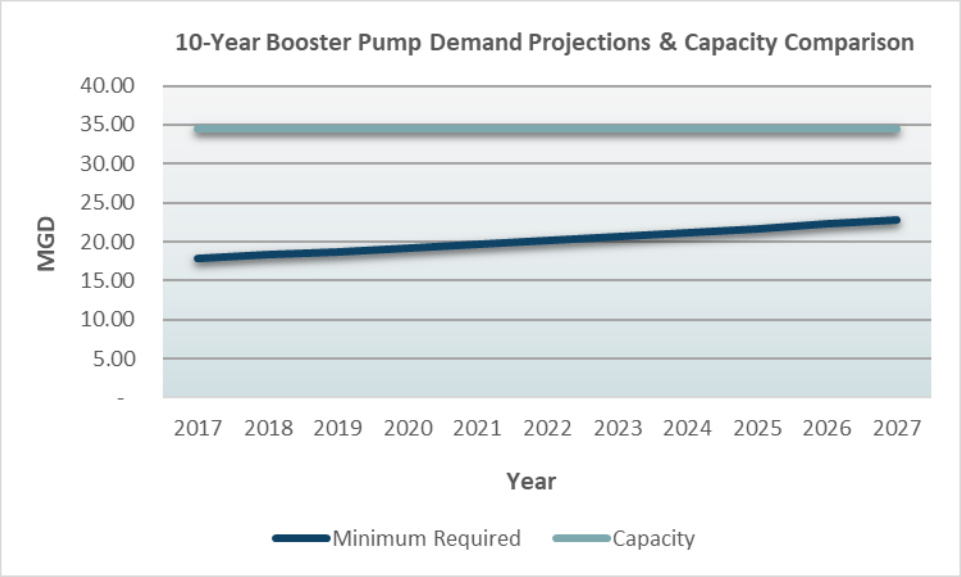
**Largest Pump out of Service*

See **Table 5.8 - 10-Year Booster Pump Demand Projections & Capacity Comparison** and **Graph 5.3 - 10-Year Booster Pump Demand Projections & Capacity Comparison** for a yearly comparison of the projected minimum required booster pump capacity and system booster pump capacity.

Table 5.8 - 10-Year Booster Pump Demand Projections & Capacity Comparison

Year	Minimum Required Booster Pump Capacity (MGD)	Booster Pump Capacity (MGD)	Addition (MGD)
2017	17.83	34.42	
2018	18.27	34.42	
2019	18.73	34.42	
2020	19.20	34.42	
2021	19.68	34.42	
2022	20.17	34.42	
2023	20.68	34.42	
2024	21.19	34.42	
2025	21.72	34.42	
2026	22.26	34.42	
2027	22.82	34.42	

Graph 5.3 - 10-Year Booster Pump Demand Projections & Capacity Comparison



Booster pumps within the water system serve a variety of uses. The booster pumps within the existing system either feed directly to the distribution system, feed to the distribution system via PRV's, or boost to storage tanks within the system. Some booster pump stations have a combination of uses, such as the Rattlesnake Booster Station, in which two (2) of the booster pumps are dedicated to filling the Rancho Santa Fe Tank and two (2) of the booster pumps are dedicated to feeding the Rattlesnake Tank Zone.

Some of the booster pumps are not utilized in the most efficient or cost effective manners. For example, the Castlerock Booster Station serves many zones within the system including the Main Tank, College Tank, Shangri La (within the Camelback Tank Zone), and Rattlesnake Tank Zones. However, these zones are located within different areas of the water system, have different elevations in which to serve, and therefore require different Hydraulic Grade Lines (HGL) to feed the areas within each zone. In the existing condition, the Castlerock Booster Station has one outlet pressure, which matches the Main Tank Zone. Consequently, the HGL of the water must be reduced in order for the Castlerock Booster Station to serve the College Tank, Shangri La, and Rattlesnake Tank Zones. No improvements to the booster pumps are proposed in the existing improvements, therefore the booster pumps within the system remain inefficient after the existing improvements have been made.

5.6 DISTRIBUTION SYSTEM MODELING

A water model was constructed to simulate and analyze the projected 10-year distribution system. The projected 10-year system used the existing improvements model as a foundation and modified for the 10-year projections and recommended improvements.

The storage tanks and wells that pump directly to the system were modeled as a constant head reservoir. Flow control valves were used on the output of the wells to limit the outflow to the actual flow rates provided by the City.

The models were run at average day, peak day, and peak hour demands scenarios. A fire flow analysis was also modeled on top of peak day flows. See **Appendix D – 10-Year Model & Junction Exhibits** for the 10-Year model and junction exhibits of each demand scenario.

5.6.1 Pressure Zones

Given that the 10-year model was a copy of the existing improvements model, the pressure zones in the model were set up as described in **Section 4.5.1 - Pressure Zones**. Existing improvement projects re-aligned pressure zone lines to more closely resemble the proposed pressure zones as described in **Section 4.6 - Improvement Recommendations & Cost Estimates**.

5.6.2 Flow Simulations

As discussed in **Section 3.9.1 - Flow Simulations**, steady state and fire flow simulations were conducted on the 10-year system. Steady state flow simulations were conducted on the system using average day, peak day, and peak hour demands.

Fire flow simulations were conducted on the system at peak day demand on nodes throughout the system (one at a time) to simulate the available fire flow at peak day demand. Model nodes were assigned a fire flow of 1,000 gallons per minute for residential fire flow demand and 3,500 gallons per minute for commercial and industrial fire flow demand. Fire flow was assigned to nodes based on existing infrastructure and the City of Kingman General Plan 2030 Projected Land Use Map. See **Figure 5.1 – 10-Year Fire Flow Demands** for a depiction of the fire flow assignments of the 10-year model.

Potential growth areas have been established with the use of the City of Kingman General Plan 2030 Figure 3-1 and City staff input. The potential growth areas determined were used as a guideline when proposing growth in the 10-year model and calculating zonal and junction demand therein. Pipe sizing for 10-year recommended improvements were governed by system demands for both steady state and fire flow scenarios.

5.7 IMPROVEMENT RECOMMENDATIONS & COST ESTIMATES

Based on the analysis performed as described in the previous sections, a prioritized list of proposed improvement recommendations (storage tanks, booster pumps, PRV's, line extensions, line size increases, wells, etc.) have been developed to address the growth needs within the existing water system boundary. Unlike the existing improvement projects, the 10-year improvement projects are a fusion between City driven CIP projects and development projects. Some of the projects urgency and timing will be dictated by development within potential growth areas. Cost estimates for each of these improvements have been developed so they can be added to the City's capital improvement program (CIP).

The first six (6) proposed improvement projects are numbered in sequential order based on the priority of the project. Higher priority projects are those that are correcting system deficiencies or have a necessary immediate impact. Lower priority projects are those that are considered not needed immediately. Proposed improvement projects numbered 7 through 15 are not in sequential order as they are improvements solely based on need as dictated by growth within the City. Therefore, the order of these projects may change according to the development within potential growth areas.

Recommended improvement projects re-aligned pressure zone lines to more closely resemble the pressure zone design criteria described in **Section 3.9.3 - Proposed Pressure Zones**. The 10-year improvement projects re-aligned pressure zone lines even more so, but in agreement with the existing improvements. The continued realignment of the pressure zones within the system reduces the amount of dead end lines, increases looping, and decreasing the chance of stagnant water within the system.

The 10-year model was set-up very similarly to the existing and existing improvements models. The model was loaded with the system demands by separating demands according to the existing pressure zones. The model consists of the distribution network of pipes, nodes, reservoirs, and flow valves per zone. In the model, the reservoirs provide an endless supply of water at a hydraulic grade line. The hydraulic grade lines in the model were set to equal the head provided by each specific well, tank, or booster pump.

The model demand input for each junction is identified as flow in gallons per minute. For modeling purposes, a junction is considered the same as a node. To calculate the flow per junction, the total number of connections was determined for each zone and a zonal water demand was calculated by adding up the number of connections and multiplying that value by the average water usage per connection design criteria (312 gallons per connection per day). Then, the numbers of nodes in each zone were counted in the model and the flow per junction was calculated by dividing the zonal demand by the number of nodes. Once obtained, the flow per junction was entered into the model database. See **Table 5.9 – 10-Year Model Demand Calculations** and **Appendix D – 10-Year Model & Junction Exhibits** for model junction demands used.

Table 5.9 – 10-Year Model Demand Calculations

Zone	Number of Connections (2017)	Number of Connections (2027)	Total Demand (MGD)	Total Demand (GPM)	Percentage of Total	Number of Nodes	Flow per Junction (gpm)
Foothills Zone	109	140	0.04	30	1%	58	0.5
Rancho Santa Fe Zone	777	995	0.31	216	4%	258	0.8
Hualapai Zone	789	1,010	0.32	219	4%	172	1.3
White Cliffs Zone	5	6	0.00	1	0%	7	0.2
Bull Mountain Zone	9	12	0.00	2	0%	10	0.2
Downtown 1 Zone	177	227	0.07	49	1%	64	0.8
Downtown 2 Zone	767	982	0.31	213	4%	306	0.7
Main Tank Zone	3,725	4,768	1.49	1,033	19%	1,021	1.0
Rattlesnake Zone	4,677	5,987	1.87	1,297	24%	1,152	1.1
College Tank Zone	7,908	10,123	3.16	2,193	41%	1,032	2.1
Mohave Wash Zone	522	668	0.21	145	3%	50	2.9
Total	**19,465**	**24,917**	**7.77**	**5,399**	**100%**	**4,130**	**-**

Flow per junction demand is considered the same across all areas of a zone even though high density subdivisions and low density large lot parcels typically experience different water usage rates. The model accounts for the difference in density by placing more junctions in areas of higher density and fewer junctions in areas of lower density. This naturally occurs as high density areas typically have more street and water line intersections that require nodes. For example, a high density subdivision will typically have more short blocks with nodes at each intersection which equates to a higher density of nodes in the project. Versus a low density development that may have one long half-mile street with two (2) nodes on each end that serve several lots.

The recommended improvements for the 10-year system include well re-equipping, storage tanks, booster pump stations, main water lines, and pressure reducing valve stations. Proposed water lines within improvement projects, of which the main focus is to provide zone-specific infrastructure improvements for imminent growth, are assumed along the simplest alignments. These alignments may be subject to change according to development. Moreover, some of the proposed improvement projects show parallel mains along pressure zone boundaries. Parallel mains may not be necessary depending upon development; however, the intent of showing parallel mains is to emphasize the importance of keeping the pressure zones separated. Additionally, the cost of development of parallel mains is generally less than the construction and maintenance costs of a single main with PRV's on either side of the pressure zone boundary.

Long Mountain Well 1 is an existing inactive well, and is proposed to be re-equipped as part of the 10-year recommended improvements. The re-equipping of this well will provide source to the newly established White Cliffs Zone which was previously part of the Main Tank Zone, but was deficient in fire flow because of its high elevation.

The re-equipping of Long Mountain Well 1 is proposed as part of the recommended improvements to the 10-year system. Long Mountain Well 1 will add 2.88 million gallons per day of source to the system, making the total available source 23.76 million gallons per day. The additional source provided by the re-equipping of Long Mountain Well 1 creates an even larger buffer between the total available and minimum required source of 12.55 million gallons per day, providing source for continued growth in the system. There are no new wells proposed as part of the existing improvements.

Three new tanks and three new booster pump stations are proposed as part of the 10-year recommended improvements as well as a reconstruction/rehabilitation of the Castlerock Booster Station. The three new tanks and three new booster pump stations will provide storage for the area proposed as the new Foothills Zone (which does not currently have storage) and the newly established White Cliffs and Bull Mountain Zones. The Bull Mountain Zone is a part of the water service area, which is minimally developed, but in a potential growth area, in an unincorporated area north of the City, which currently does not have source or storage. Therefore, the construction of the tank and booster pump for this zone is considered development driven.

The three storage tanks recommended in the 10-year system analysis are the 500,000 gallon Northridge Tank, the 300,000 gallon White Cliffs Tank, and the 1,000,000 gallon Bull Mountain Tank. The construction of these tanks makes an additional 1.8 million gallons available for storage within the water system, bringing the total available storage to 14.98 million gallons which provides storage for sustained growth within the system.

The three booster pump stations recommended in the 10-year system analysis are the Rancho Santa Fe which feeds the proposed Northridge Tank, Long Mountain 1 which feeds the proposed the White Cliffs Tank, and College which feeds the proposed Bull Mountain Tank. The proposed capacity of the

booster pump stations is calculated based on the capacity to fill the proposed tank in 18 hours. The proposed capacities for the Rancho Santa Fe, Long Mountain 1, and College booster pump stations are 500 gpm, 300 gpm, and 1,000 gpm respectively. Each booster pump station will have duplex pumps for cycling and redundancy. The construction of these booster pumps provides an additional 5.20 million gallons per day of booster pump capacity within the water system, increasing the firm capacity by 2.60 million gallons per day which is enough booster pump capacity for future growth in the system.

One 10-year recommended improvement project that will have a significant impact on the water system is the reconstruction/rehabilitation of the Castlerock Booster Station. The existing booster station is running in an inefficient manner. The recommended improvement project will improve the booster station's production capacity and cost effectiveness considerably.

A summary of the 10-year system improvement projects is located in **Table 5.10 – 10-Year Improvement Project Summary**.

Table 5.10 – 10-Year Improvement Project Summary

Project #	Purpose	Estimated Total Project Cost
1	Dedicated Supply to Main Tanks	$6,766,900
2	Main Tank Zone Feed to East of Route 66	$3,704,200
3	Provide Storage for Foothills Zone	$3,690,900
4	Zone-Specific Infrastructure Improvements for Imminent Growth	$4,279,900
5	Provide Source for the Proposed White Cliff Zone	$4,173,600
6	Replace the Castlerock Booster Pump Station	$9,851,700
7	Provide Source for the Proposed Bull Mountain Zone	$4,928,100
8	Tank Level Stabilization	$2,299,900
9	Zone-Specific Infrastructure Improvements for Imminent Growth	$6,637,800
10	Zone-Specific Infrastructure Improvements for Imminent Growth	$4,986,900
11	Zone-Specific Infrastructure Improvements for Imminent Growth	$3,302,900
12	Zone-Specific Infrastructure Improvements for Imminent Growth	$1,267,400
13	Zone-Specific Infrastructure Improvements for Imminent Growth	$3,438,000
14	Zone-Specific Infrastructure Improvements for Imminent Growth	$1,372,100
15	Zone-Specific Infrastructure Improvements for Imminent Growth	$1,170,000
	Total Cost	**$61,870,300**

Project specific improvements and related cost estimates are detailed in **Section 5.7.1** through **Section 5.7.15**. See **Figure 5.2 – 10-Year Improvements Projects Overview** for recommended improvement projects in the system. See **Exhibit 5.1** though **Exhibit 5.15** for project specific improvements. See **Cost Estimate 5.1** through **Cost Estimate 5.15** for estimated costs of the recommended improvements. See **Cost Estimate 5.16 – 10-Year Improvements Projects Summary** for the proposed cost of all of the recommended improvements.

As discussed in **Section 3.9.1 - Flow Simulations**, steady state and fire flow results are provided in this report for reference. See **Figure 5.3 – 10-Year Model – Peak Hour Results** for the steady state analysis results and **Figure 5.4 – 10-Year Model – Fire Flow Results** for the fire flow analysis results of the existing model. See **Appendix D – 10-Year Model & Junction Exhibits** for the 10-Year model and junction exhibits of each demand scenario.

5.7.1 10-Year Improvement Project 1

Purpose: Dedicated Supply to Main Tanks

Benefits:

- More efficient way to convey flow from Castlerock Booster Station to the Main Tanks

Key Modifications:

- New 24" dedicated transmission main from Castlerock Booster Station to the Main Tanks

The City currently does not have a dedicated fill line to the main tanks and at critical times the system struggles to fill these tanks. This improvement project is a continuation of the 24" transmission main from Castlerock Booster Station to the Main Tanks. The improvement project picks up at the end of the existing 24" water main at Arizona Street and Kino Avenue, follows the proposed alignment given by the City, and connects to the Main Tanks at White Cliffs Road and Anson Smith Road. See **Exhibit 5.1 – 10-Year Improvements Project 1** for more information.

Estimated Total Project Cost: $6,766,900

See **Cost Estimate 5.1 – 10-Year Improvements Project 1** for cost breakdown.

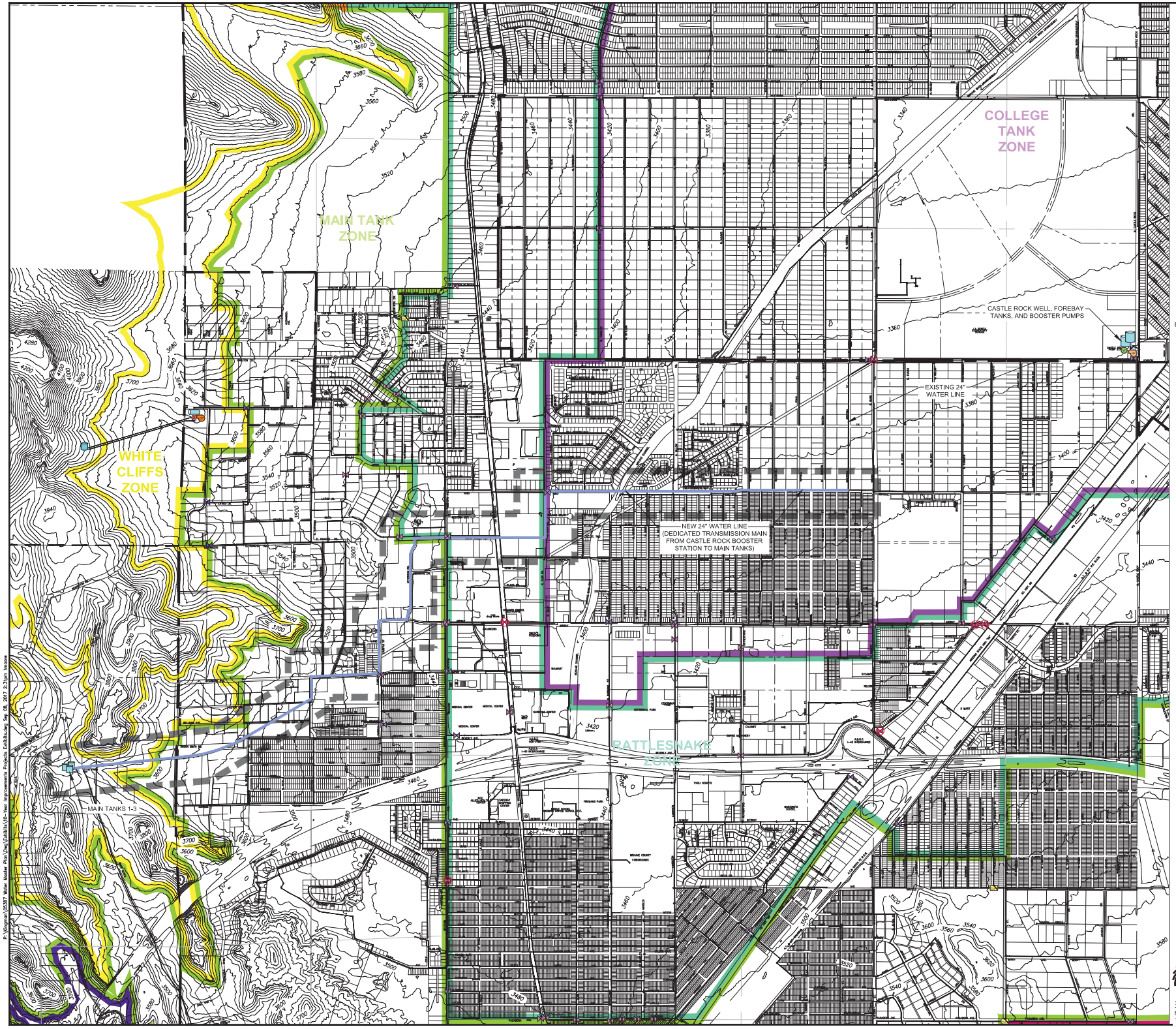


EXHIBIT 5.1 - 10-YEAR IMPROVEMENTS PROJECT 1

CITY OF KINGMAN
WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 1

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.1 - 10-Year Improvements Project 1
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	0	LF	$55	$0
2	12" Water Line and Surface Restoration	0	LF	$100	$0
3	16" Water Line and Surface Restoration	0	LF	$125	$0
4	24" Water Line and Surface Restoration	19,614	LF	$185	$3,628,590
5	Water Valve, Box and Cover	20	EA	$15,000	$295,500
6	8" PRV Station	0	EA	$50,000	$0
7	12" PRV Station	0	EA	$75,000	$0
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	0	EA	$250,000	$0
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	0	GAL	$1	$0
12	Well Equipping	0	EA	$750,000	$0
13	Air/Vaccum Relief Valves	12	EA	$20,000	$240,000
				Construction Subtotal	**$4,164,090**
				Traffic Control (5% of Total)	$208,205
				Construction Administration (5% of Total)	$208,205
				Mobilization (15% of Total)	$624,614
				Construction Total	**$5,205,113**
				Final Engineering and Permitting (10% of Total)	$520,511
				Contingency (20% of Total)	$1,041,127
				Project Total	**$6,766,900**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

5.7.2 10-Year Improvement Project 2

Purpose: Main Tank Zone Feed to East of Route 66

Benefits:

- Help feed water from the west side of Route 66 to the east in the Main Tank Zone
- Create a clear zone separation between the Main Tank Zone and the Rattlesnake Zone

Key Modifications:

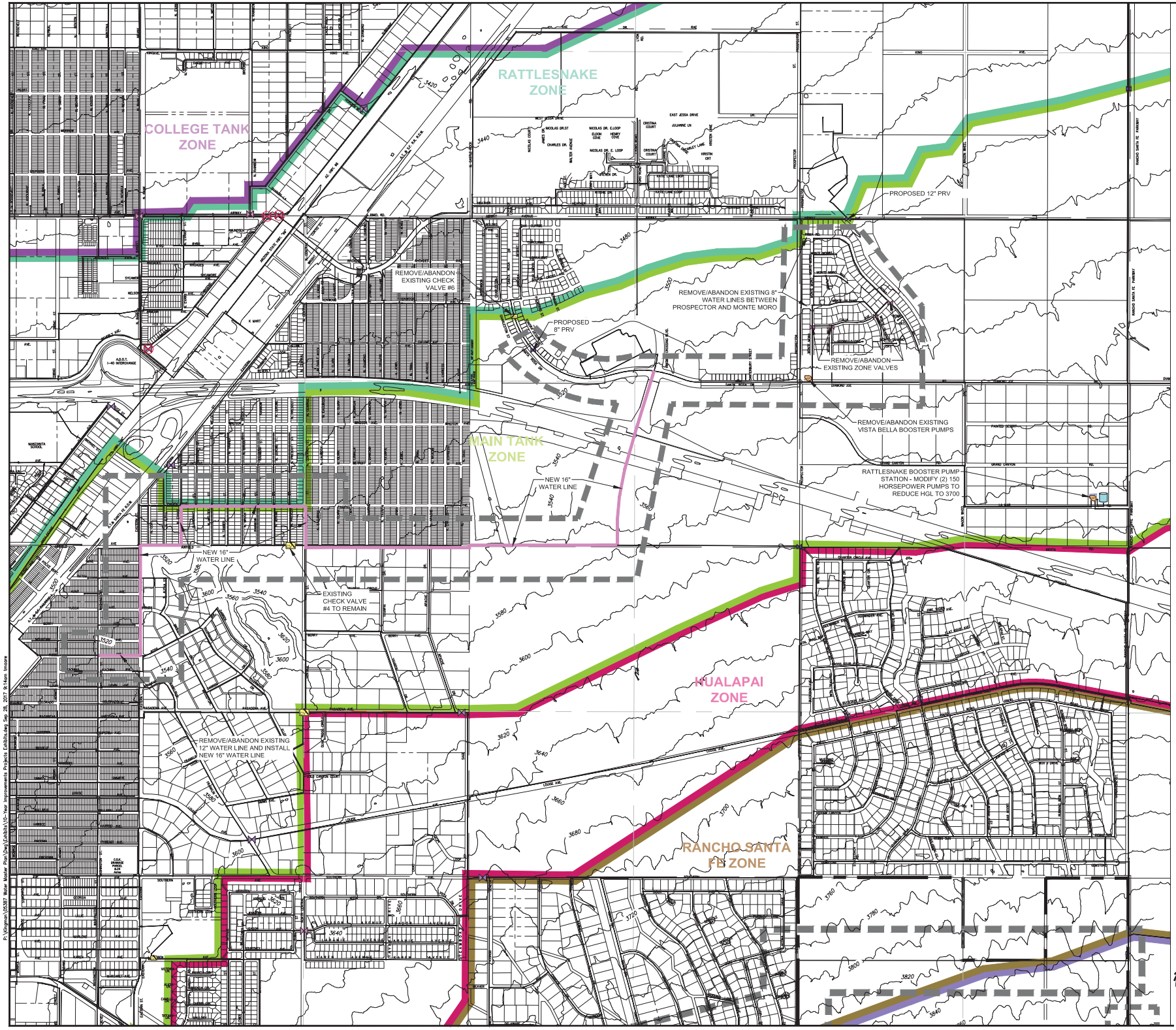
- New 16" dedicated transmission main from west side of Route 66 to the east in the Main Tank Zone to the Hospital area
- Remove Check Valve #6
- Add new 8" PRV to separate Main Tank and Rattlesnake Zones
- Remove Vista Bella Boosters & four (4) zone valves associated
- Modify the two (2) 150 horsepower Rattlesnake Boosters to feed the Main Tank Zone

This improvement project is located within the Main Tank Zone on the East side of Route 66. The improvement project concentrates on conveying flow from the west side of the Main Tank Zone to the east. The improvements include connecting to an existing 16" main at Washington Street and Ross Avenue, removing/abandoning the 12" line in Ross Avenue from Washington Street to Eastern Street and replacing it with a new 16" water line. The existing services in Ross Avenue as well as mains at the Eastern Street and Ross Avenue intersection will be reconnected to this new main. A new 16" line would then continue north along Eastern Street and then east along Airfield Avenue, north along Evans Street, East along Pacific Avenue, south along Central Street and then continue east along Airfield Avenue. The 16" line would then continue to the proposed alignment of an I-40 crossing, which will convey flow north to the hospital on Santa Rosa Drive. The improvement project also includes the removal of Check Valve #6 and the installation of a new 8" PRV on Santa Rosa Drive at the end of the existing 16" line just west of the hospital. The removal of the Vista Bella Booster Pumps, the removal of four (4) zone valves along Italia Avenue, and the removal/abandonment of lines in Roma Road and Monte Silvano Avenue will separate the Main Tank Zone and the Rattlesnake Zone. Finally, the two (2) 150 horsepower (hp) booster pumps that currently feed the Hospital during Fire Flow conditions will be modified to feed the Main Tank Zone. The modification of the booster pumps will need to lower the output HGL to around 3700 to match the Main Tanks. See **Exhibit 5.2 – 10-Year Improvements Project 2** for more information.

Estimated Total Project Cost: $3,344,200

See **Cost Estimate 5.2 – 10-Year Improvements Project 2** for cost breakdown.

EXHIBIT 5.2 - 10-YEAR IMPROVEMENTS PROJECT 2



CITY OF KINGMAN
WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 2

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.2 - 10-Year Improvements Project 2
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	0	LF	$55	$0
2	12" Water Line and Surface Restoration	0	LF	$100	$0
3	16" Water Line and Surface Restoration	14,263	LF	$125	$1,782,875
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	29	EA	$2,500	$71,500
6	8" PRV Station	1	EA	$50,000	$50,000
7	12" PRV Station	1	EA	$75,000	$75,000
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	0	EA	$250,000	$0
10	Booster Pump Modification	2	EA	$150,000	$300,000
11	Tank	0	GAL	$1	$0
12	Well Equipping	0	EA	$750,000	$0
				Construction Subtotal	**$2,279,375**
				Traffic Control (5% of Total)	$113,969
				Construction Administration (5% of Total)	$113,969
				Mobilization (15% of Total)	$341,906
				Construction Total	**$2,849,219**
				Final Engineering and Permitting (10% of Total)	$284,922
				Contingency (20% of Total)	$569,901
				Project Total	**$3,704,200**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

5.7.3 10-Year Improvement Project 3

Purpose: Provide storage for the Foothills Zone

Benefits:

- Provide flow to the Foothills zone and have enough source and storage to deliver flow to more customers with adequate pressures

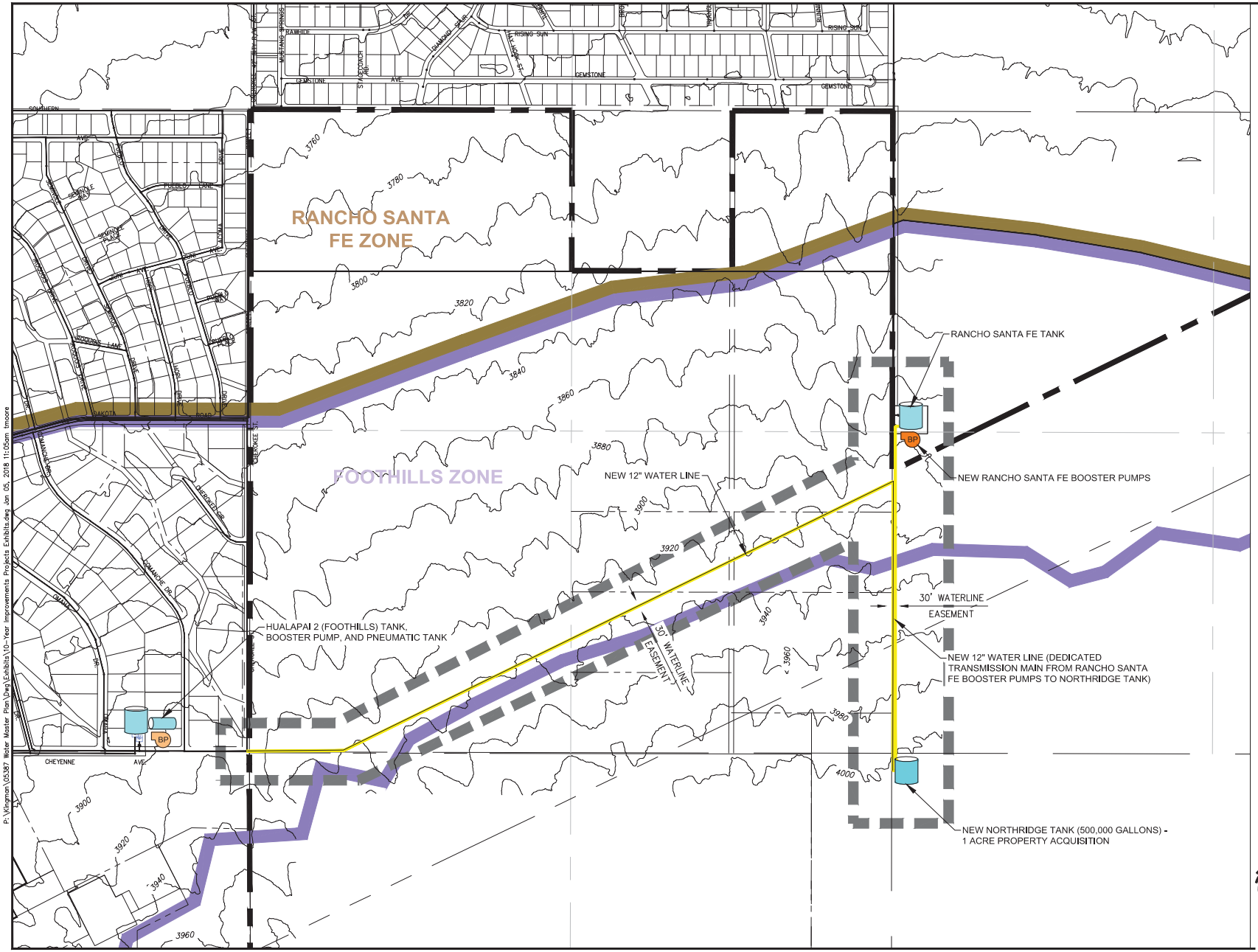
Key Modifications:

- New Rancho Santa Fe Booster Pumps
- New 12” Transmission Main
- New 500,000 gallon Northridge Tank
- New 12” Distribution Main

This improvement project is located within the Foothills Zone on the far southeast side of the City. The improvement project includes new booster pumps at the Rancho Santa Fe Tank site, a 12” dedicated transmission main to convey water from the new booster pumps to the new 500,000 gallon Northridge Tank. The improvement project also includes a 12” main to convey water from the Northridge Tank to the distribution system along the southern border of the Foothills Pressure Zone. The proposed tank has an HGL of 4027 to provide flow to areas within the City that the existing Foothills Zone cannot supply due to insufficient pressures. See **Exhibit 5.3 – 10-Year Improvements Project 3** for more information.

Estimated Total Project Cost: $3,690,900

See **Cost Estimate 5.3 – 10-Year Improvements Project 3** for cost breakdown.



NORTH

SCALE
0 750' 1500'
HORIZ: 1" = 750'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

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CITY OF KINGMAN
WATER MASTER PLAN
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PROJECT 3

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 5.3 - 10-YEAR IMPROVEMENTS PROJECT 3

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.3 - 10-Year Improvements Project 3
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	0	LF	$55	$0
2	12" Water Line and Surface Restoration	11,152	LF	$100	$1,115,200
3	16" Water Line and Surface Restoration	0	LF	$125	$0
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	22	EA	$2,500	$56,000
6	8" PRV Station	0	EA	$50,000	$0
7	12" PRV Station	0	EA	$75,000	$0
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	1	EA	$250,000	$250,000
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	500,000	GAL	$1	$500,000
12	Well Equipping	0	EA	$750,000	$0
13	Site Property Acquisition	1	AC	$50,000	$50,000
14	Waterline Easement Acquisition	6	AC	$50,000	$300,000
				Construction Subtotal	**$2,271,200**
				Traffic Control (5% of Total)	$113,560
				Construction Administration (5% of Total)	$113,560
				Mobilization (15% of Total)	$340,680
				Construction Total	**$2,839,000**
				Final Engineering and Permitting (10% of Total)	$283,900
				Contingency (20% of Total)	$567,857
				Project Total	**$3,690,900**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

5.7.4 10-Year Improvement Project 4

Purpose: Zone-specific infrastructure improvements for imminent growth

Benefits:

- Provide zone-specific infrastructure improvements to allow for impending growth within the Rancho Santa Fe Zone

Key Modifications:

- New water mains along key street alignments and section lines
- New 8” PRV to separate Rancho Santa Fe and Hualapai Zones

This improvement project is located within the Rancho Santa Fe Zone. The improvement project includes a new 8” water main connecting the existing Hualapai Shadows and Hualapai Foothills zones at Duval Avenue and Dakota Avenue, respectively, as well as a new 8” PRV at Duval Avenue and Yavapai Street. The new 8” PRV will provide separation between the Rancho Santa Fe and Hualapai Zones. The project includes a new 12” main from Dakota Road and Cherokee Street to Louise Avenue and Mountain Trail, which includes upsizing approximately 435’ of 8” water line to 12”. The project also includes a new 12” main from Diamond Spur Street and Louise Avenue, east to the easement just west of the Sandstone Street alignment and continuing south through the easement to connect to the existing 12” water line within Pinto Road. Lastly, the project includes a new 12” main loop from Rancho Santa Fe Parkway, east along the southern pressure zone boundary to El Camino Drive, North to I-40, and west, back to Rancho Santa Fe Parkway, along the northern pressure zone boundary. See **Exhibit 5.4 – 10-Year Improvements Project 4** for more information.

Estimated Total Project Cost: $4,279,900

See **Cost Estimate 5.4 – 10-Year Improvements Project 4** for cost breakdown.

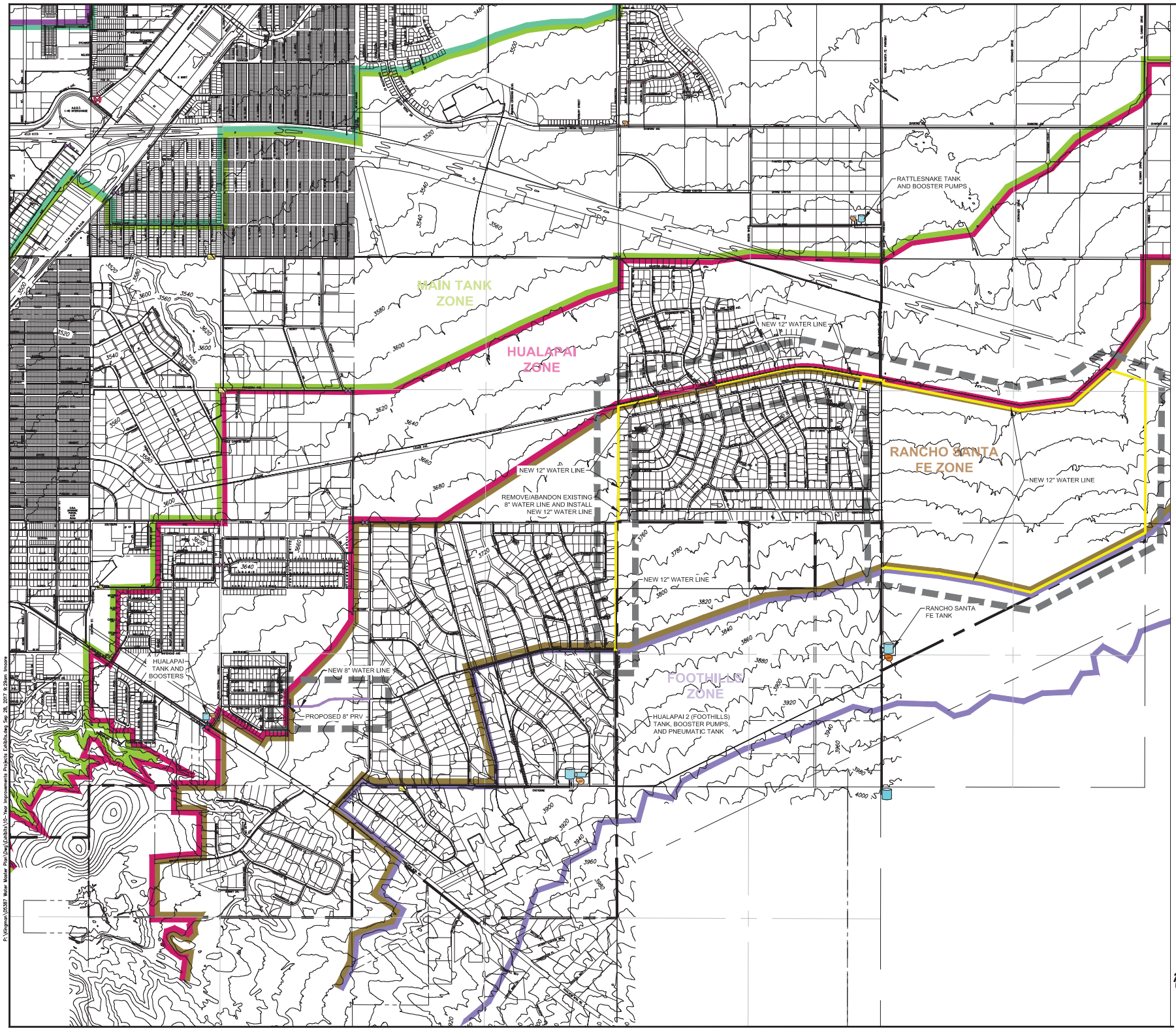

EXHIBIT 5.4 - 10-YEAR IMPROVEMENTS PROJECT 4

CITY OF KINGMAN
WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 4

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.4 - 10-Year Improvements Project 4
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	1,682	LF	$55	$92,510
2	12" Water Line and Surface Restoration	23,644	LF	$100	$2,364,400
3	16" Water Line and Surface Restoration	0	LF	$125	$0
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	51	EA	$2,500	$126,750
6	8" PRV Station	1	EA	$50,000	$50,000
7	12" PRV Station	0	EA	$75,000	$0
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	0	EA	$250,000	$0
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	0	GAL	$1	$0
12	Well Equipping	0	EA	$750,000	$0
				Construction Subtotal	**$2,633,660**
				Traffic Control (5% of Total)	$131,683
				Construction Administration (5% of Total)	$131,683
				Mobilization (15% of Total)	$395,049
				Construction Total	**$3,292,075**
				Final Engineering and Permitting (10% of Total)	$329,208
				Contingency (20% of Total)	$658,481
				Project Total	**$4,279,900**

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5.7.5 10-Year Improvement Project 5

Purpose: Provide source for the proposed White Cliffs Zone

Benefits:

- Extend the boundary of the White Cliffs zone and have enough source to deliver flow to more customers with adequate pressures

Key Modifications:

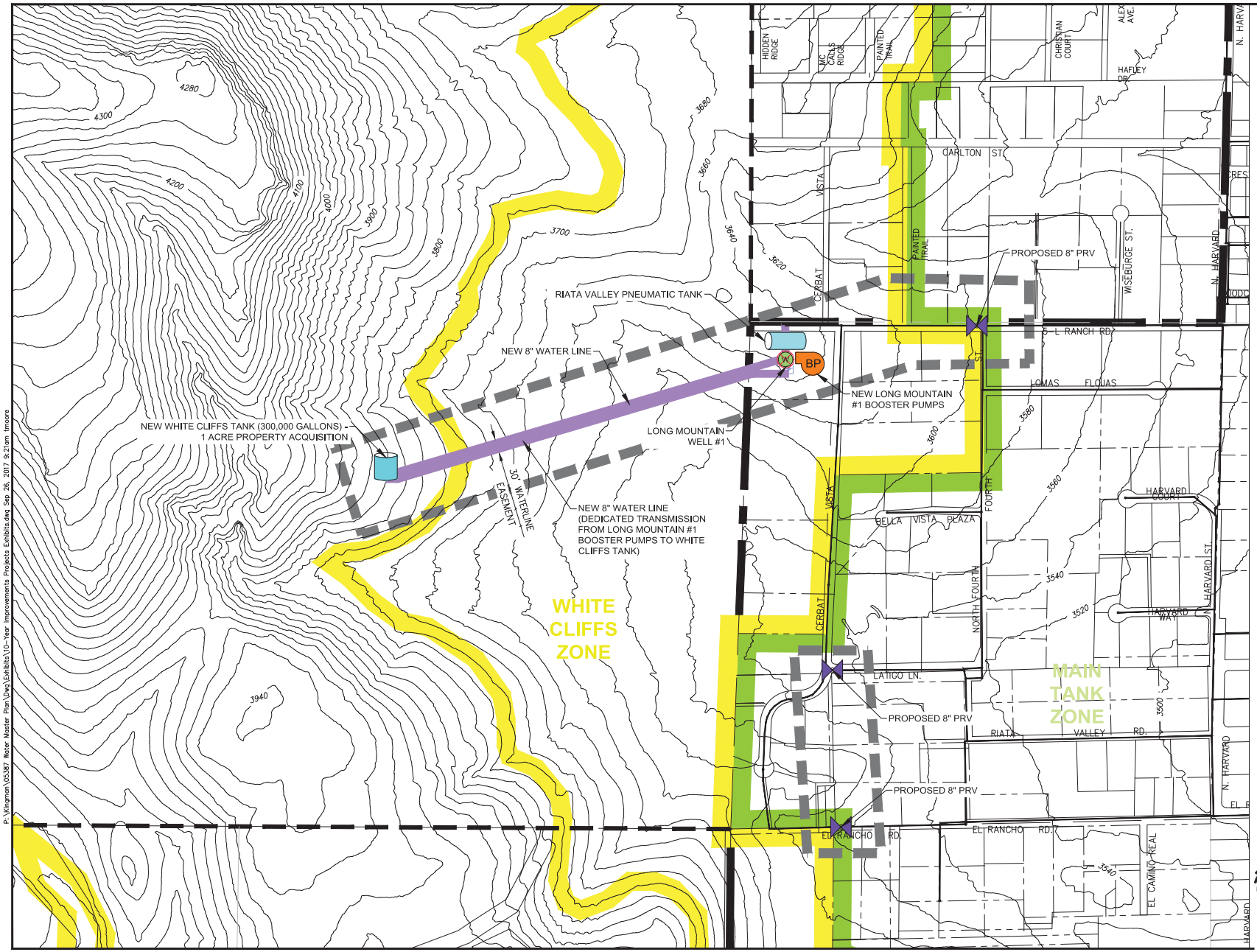
- Remove Riata Valley Pneumatic Tank
- Re-equipping of Long Mountain Well 1
- New Long Mountain 1 Booster Pumps
- New 8” Transmission Main
- New 300,000 gallon White Cliffs Tank
- New 8” Distribution Main
- 3 new 8” PRV’s to separate Main Tank and White Cliffs zones

This improvement project is located within the White Cliffs Zone on the far west side of the City. The improvement project includes the re-equipping of Long Mountain Well 1, new booster pumps and an 8” dedicated transmission main to convey water from the well to the new 300,000 gallon White Cliffs Tank. The improvement project also includes an 8” main to convey water from the White Cliffs Tank to the distribution system. Long Mountain 1 Well has been out of service for a significant amount of time; therefore, the improvement project includes cost for re-drilling the well. The proposed tank is a more efficient and effective replacement for the Riata Valley Pneumatic tank and has an HGL of 3816 to provide flow to areas within the City that the Main Tank Zone cannot supply due to insufficient pressures. Finally, the improvement project includes three (3) 8” PRV’s to separate the Main Tank and White Cliffs zones. See **Exhibit 5.5 – 10-Year Improvements Project 5** for more information.

Estimated Total Project Cost: $4,173,600

See **Cost Estimate 5.5 – 10-Year Improvements Project 5** for cost breakdown.

EXHIBIT 5.5 - 10-YEAR IMPROVEMENTS PROJECT 5



CITY OF KINGMAN
WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 5

SUNRISE ENGINEERING

2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.5 - 10-Year Improvements Project 5
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	4,754	LF	$125	$594,250
2	12" Water Line and Surface Restoration	0	LF	$100	$0
3	16" Water Line and Surface Restoration	0	LF	$125	$0
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	10	EA	$2,500	$24,000
6	8" PRV Station	3	EA	$50,000	$150,000
7	12" PRV Station	0	EA	$75,000	$0
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	1	EA	$250,000	$250,000
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	300,000	GAL	$1	$300,000
12	Well Drilling	1	EA	$350,000	$350,000
13	Well Equipping	1	EA	$750,000	$750,000
14	Site Property Acquisition	1	AC	$50,000	$50,000
15	Waterline Easement Acquisition	2	AC	$50,000	$100,000
				Construction Subtotal	**$2,568,250**
				Traffic Control (5% of Total)	$128,413
				Construction Administration (5% of Total)	$128,413
				Mobilization (15% of Total)	$385,238
				Construction Total	**$3,210,313**
				Final Engineering and Permitting (10% of Total)	$321,031
				Contingency (20% of Total)	$642,127
				Project Total	**$4,173,600**

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5.7.6 10-Year Improvement Project 6

Purpose: Replace the Castlerock Booster Station

Benefits:

- Modernize the outdated equipment within the booster pump station
- Save on pump/energy costs to operate the booster pump station
- Deliver water to specific zones at flow and pressure needed

Key Modifications:

- Replace the existing booster pumps and building with a new facility
- Create pressure zone boosting capabilities
- Match flow and pressure needs with new variable frequency drives
- Update SCADA and electrical systems

This improvement project is located at the northwest corner of Castlerock Road and Gordon Drive. The Castlerock Booster Pump Station is one of the most critical infrastructure components within the City's water system. The existing booster pump station should be replaced with a new facility because the existing building and some of the components are nearing the end of their design life. Some of the booster pump station equipment has been recently replaced and/or upgraded. If deemed possible at the time of the project design and construction, some of the newer equipment may be salvaged and reused. Currently, the station pumps water at a pressure equal to the hydraulic grade of the Main Tank Pressure Zone. Water required for lower zones, near the station, are pressure reduced via pressure reducing valves, which is very energy inefficient. A new station would be equipped with variable frequency drive (VFD) pumps dedicated to each pressure zone so that flow and pressure could be delivered where needed in the system, without requiring pressure-reducing valves. In addition, the new station would include updates to the City's SCADA system for controlling the pumps. The new facility would be constructed adjacent to the existing station so that flow to the system could be maintained until the new facility is operational. See **Exhibit 5.6 – 10-Year Improvements Project 6** for more information.

Estimated Total Project Cost: $9,360,300

See **Cost Estimate 5.6 – 10-Year Improvements Project 6** for cost breakdown.

NORTH

SCALE
0 60' 120'
HORIZ: 1" = 60'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 6

SUNRISE ENGINEERING

2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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EXHIBIT 5.6 - 10-YEAR IMPROVEMENTS PROJECT 6

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2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.6 - 10-Year Improvements Project 6
New Castle Rock Booster Station
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	Site Piping and Improvements	1	EA	$1,000,000	$1,000,000
2	12" Water Line and Surface Restoration	3,000	LF	$100	$300,000
3	Water Valve, Box and Cover	6	EA	$2,500	$15,000
4	Pump Station Building	1	EA	$1,500,000	$1,500,000
5	Building Piping and Appurtenances	1	EA	$750,000	$750,000
6	Electrical Work	1	EA	$750,000	$750,000
7	SCADA Improvements	1	EA	$250,000	$250,000
8	Booster Pumps with VFD's	1	EA	$750,000	$750,000
9	Building Equipment (interior piping, mechanical, valving, ect.)	1	EA	$1,000,000	$1,000,000
				Construction Subtotal	**$6,315,000**
				Construction Administration (5% of Total)	$315,750
				Mobilization (15% of Total)	$947,250
				Construction Total	**$7,578,000**
				Final Engineering and Permitting (10% of Total)	$757,800
				Contingency (20% of Total)	$1,515,752
				Project Total	**$9,851,700**

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5.7.7 10-Year Improvement Project 7

Purpose: Provide source for the proposed Bull Mountain Zone

Benefits:

- Provide flow to the new Bull Mountain zone and have enough source to deliver flow to more customers with adequate pressures

Key Modifications:

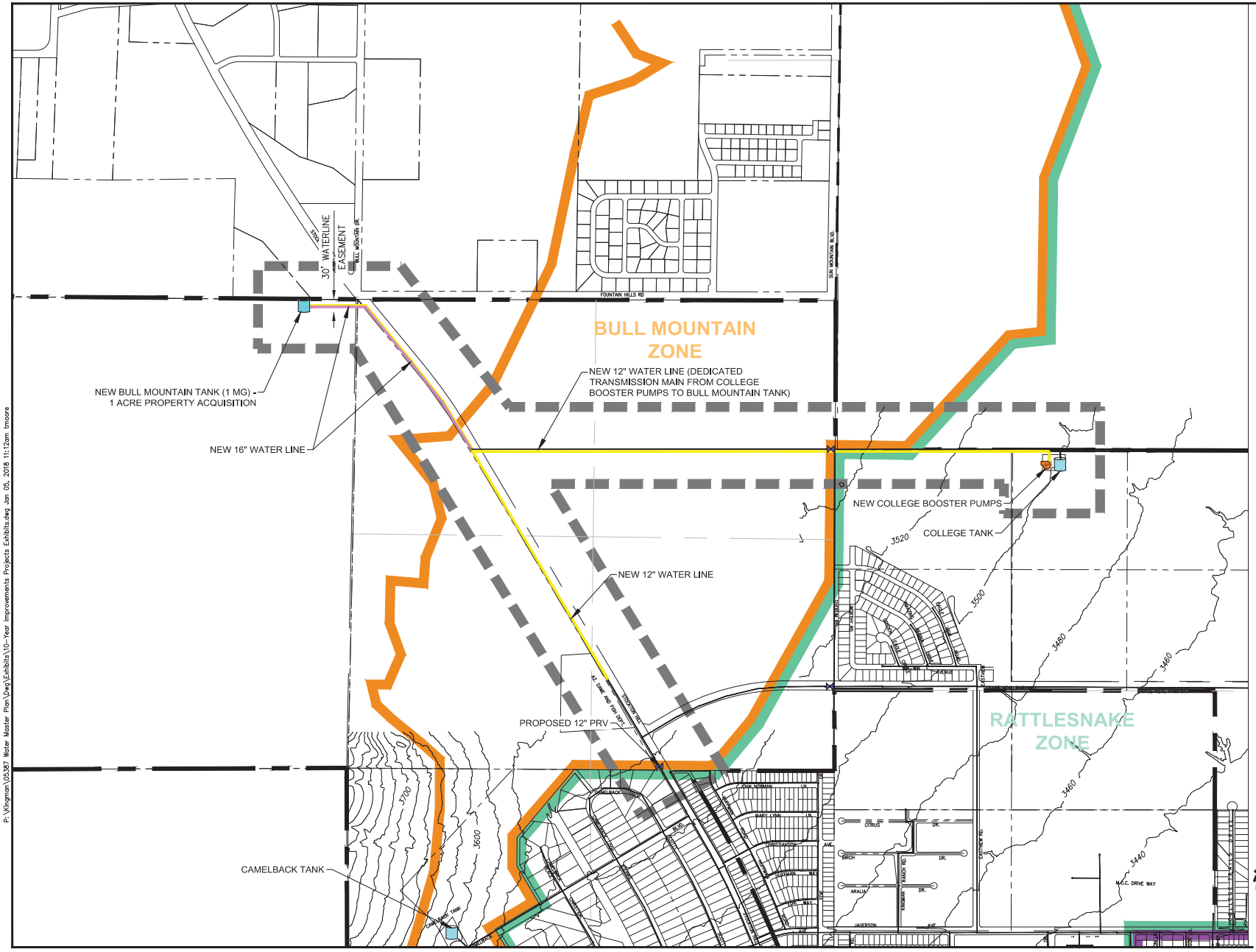
- New College Booster Pumps
- New 12” Transmission Main
- New 1,000,000 gallon White Cliffs Tank
- New 16” & 12” Distribution Mains
- 1 new 12” PRV to separate Rattlesnake and Bull Mountain zones

This improvement project is located within the Bull Mountain Zone on the far northwest side of the City. The improvement project includes new booster pumps at the college tank site, a 12” dedicated transmission main to convey water from the new booster pumps to the new 1,000,000 gallon Bull Mountain Tank. The improvement project also includes a 16” distribution main from the Bull Mountain to Stockton Hill Road, and along Stockton Hill Road to the Calle Santa Fe alignment connecting to a 12” main along Stockton Hill Road from the Calle Santa Fe alignment to the existing 12” water line stub near Grace Neal Parkway. The proposed tank has an HGL of 3740 to provide flow to areas within the City that the College and Rattlesnake Zones cannot supply due to insufficient pressures. Finally, the improvement project includes one (1) 12” PRV on Stockton Hill Road at the southern pressure zone boundary to separate the Rattlesnake and Bull Mountain zones. See **Exhibit 5.7 – 10-Year Improvements Project 7** for more information.

Estimated Total Project Cost: $4,907,000

See **Cost Estimate 5.7 – 10-Year Improvements Project 7** for cost breakdown.

EXHIBIT 5.7 - 10-YEAR IMPROVEMENTS PROJECT 7



NORTH

SCALE
0 1000' 2000'
HORIZ: 1" = 1000'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 7

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.7 - 10-Year Improvements Project 7
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	0	LF	$55	$0
2	12" Water Line and Surface Restoration	12,053	LF	$100	$1,205,300
3	16" Water Line and Surface Restoration	2,630	LF	$125	$328,750
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	29	EA	$2,500	$73,500
6	8" PRV Station	0	EA	$50,000	$0
7	12" PRV Station	1	EA	$75,000	$75,000
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	1	EA	$250,000	$250,000
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	1,000,000	GAL	$1	$1,000,000
12	Well Equipping	0	EA	$750,000	$0
13	Site Property Acquisition	1	AC	$50,000	$50,000
14	Waterline Easement Acquisition	1	AC	$50,000	$50,000
				Construction Subtotal	**$3,032,550**
				Traffic Control (5% of Total)	$151,628
				Construction Administration (5% of Total)	$151,628
				Mobilization (15% of Total)	$454,883
				Construction Total	**$3,790,688**
				Final Engineering and Permitting (10% of Total)	$379,069
				Contingency (20% of Total)	$758,213
				Project Total	**$4,928,100**

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5.7.8 10-Year Improvement Project 8

Purpose: Tank Level Stabilization

Benefits:

- Help stabilize the tank level in the Foothills (Hualapai 2) Tank

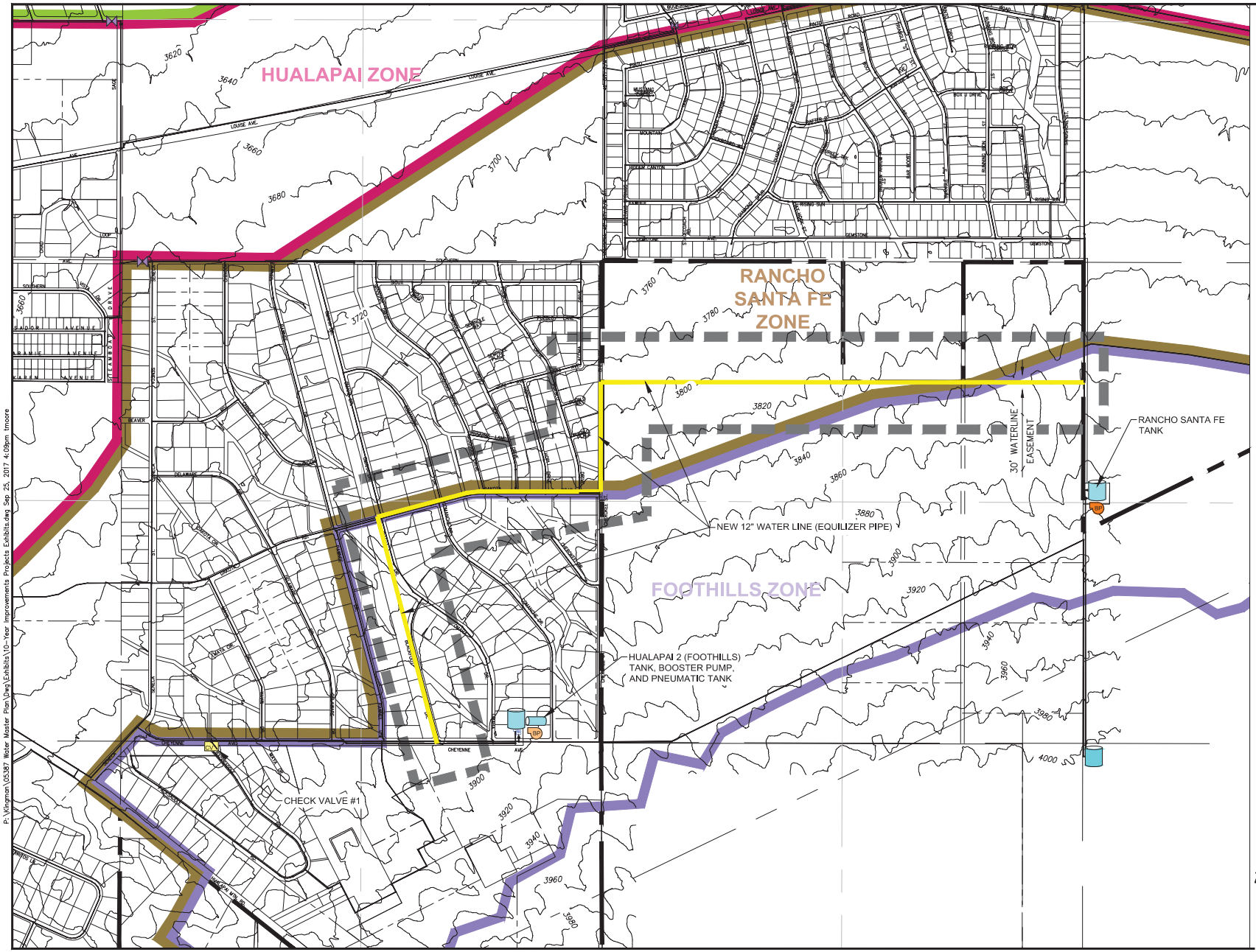
Key Modifications:

- 12” transmission main from the Rancho Santa Fe Tank to the Foothills (Hualapai 2) Tank

This improvement project is located along the upper elevation boundary of the proposed Rancho Santa Fe Zone. The improvement project is a 12” transmission main from the Rancho Santa Fe Tank to the Foothills (Hualapai 2) Tank. See **Exhibit 5.8 – 10-Year Improvements Project 8** for more information.

Estimated Total Project Cost: $2,299,900

See **Cost Estimate 5.8 – 10-Year Improvements Project 8** for cost breakdown.



NORTH

SCALE
0 1000' 2000'
HORIZ: 1" = 1000'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
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CITY OF KINGMAN
WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 8

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MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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EXHIBIT 5.8 - 10-YEAR IMPROVEMENTS PROJECT 8

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2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.8 - 10-Year Improvements Project 8
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	0	LF	$55	$0
2	12" Water Line and Surface Restoration	11,572	LF	$100	$1,157,200
3	16" Water Line and Surface Restoration	0	LF	$125	$0
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	23	EA	$2,500	$58,000
6	8" PRV Station	0	EA	$50,000	$0
7	12" PRV Station	0	EA	$75,000	$0
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	0	EA	$250,000	$0
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	0	GAL	$1	$0
12	Well Equipping	0	EA	$750,000	$0
14	Waterline Easement Acquisition	4	AC	$50,000	$200,000
				Construction Subtotal	**$1,415,200**
				Traffic Control (5% of Total)	$70,760
				Construction Administration (5% of Total)	$70,760
				Mobilization (15% of Total)	$212,280
				Construction Total	**$1,769,000**
				Final Engineering and Permitting (10% of Total)	$176,900
				Contingency (20% of Total)	$353,835
				Project Total	**$2,299,900**

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5.7.9 10-Year Improvement Project 9

Purpose: Zone-specific infrastructure improvements for imminent growth

Benefits:

- Provide zone-specific infrastructure improvements to allow for impending growth within the Hualapai Zone

Key Modifications:

- New 8” and 12” mains on key streets and section lines

This improvement project is located within the Hualapai Pressure Zone and extends from Sage Street east to El Camino Drive. The improvement project centers mainly on the installation of new infrastructure to meet demand based on growth within the Hualapai Zone. The improvement project includes a new 12” water main along Louise Avenue from Sage Street east to Mountain Trail Road as well as a new 12” water main along Prospector Street from Louise Avenue north to Airfield Avenue. The improvement project also includes a new 8” water main along Airfield Avenue, east to the I-40, southeast along I-40 to Rancho Santa Fe Parkway, a new 12” south along Rancho Santa Fe Parkway to Louise Avenue, and then a new 8” west along Louise Avenue to Diamond Spur Street to loop the subdivision. The improvement project includes a new 12” water main from Rancho Santa Fe Parkway, east along the south pressure zone boundary to El Camino Drive, and north along El Camino Drive to the northern pressure zone boundary. The improvement project includes a 12” PRV at the point where the I-40 intersects the southern pressure zone boundary to separate the Rancho Santa Fe and Hualapai zones. The project also includes a new 12” water main west along Diamond Joe Road from El Camino Drive to the western pressure zone boundary. Finally, the improvement project includes a new 12” water main west along Siesta Road from El Camino Drive to Rancho Santa Fe Parkway, and south to the I-40. See **Exhibit 5.9 – 10-Year Improvements Project 9** for more information.

Estimated Total Project Cost: $6,637,800

See **Cost Estimate 5.9 – 10-Year Improvements Project 9** for cost breakdown.

NORTH

SCALE
0 1250' 2500'
HORIZ: 1" = 1250'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
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WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 9

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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EXHIBIT 5.9 - 10-YEAR IMPROVEMENTS PROJECT 9

SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.9 - 10-Year Improvements Project 9
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	8,908	LF	$55	$489,940
2	12" Water Line and Surface Restoration	29,287	LF	$100	$2,928,700
3	16" Water Line and Surface Restoration	0	LF	$125	$0
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	76	EA	$2,500	$191,000
6	8" PRV Station	0	EA	$50,000	$0
7	12" PRV Station	1	EA	$75,000	$75,000
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	0	EA	$250,000	$0
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	0	GAL	$1	$0
12	Well Equipping	0	EA	$750,000	$0
13	Jack & Bore (I-40)	400	LF	$1,000	$400,000
				Construction Subtotal	**$4,084,640**
				Traffic Control (5% of Total)	$204,232
				Construction Administration (5% of Total)	$204,232
				Mobilization (15% of Total)	$612,696
				Construction Total	**$5,105,800**
				Final Engineering and Permitting (10% of Total)	$510,580
				Contingency (20% of Total)	$1,021,262
				Project Total	**$6,637,800**

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5.7.10 10-Year Improvement Project 10

Purpose: Zone-specific infrastructure improvements for imminent growth

Benefits:

- Provide zone-specific infrastructure improvements to allow for impending growth within the Main Tank Zone on the southeast side of the City

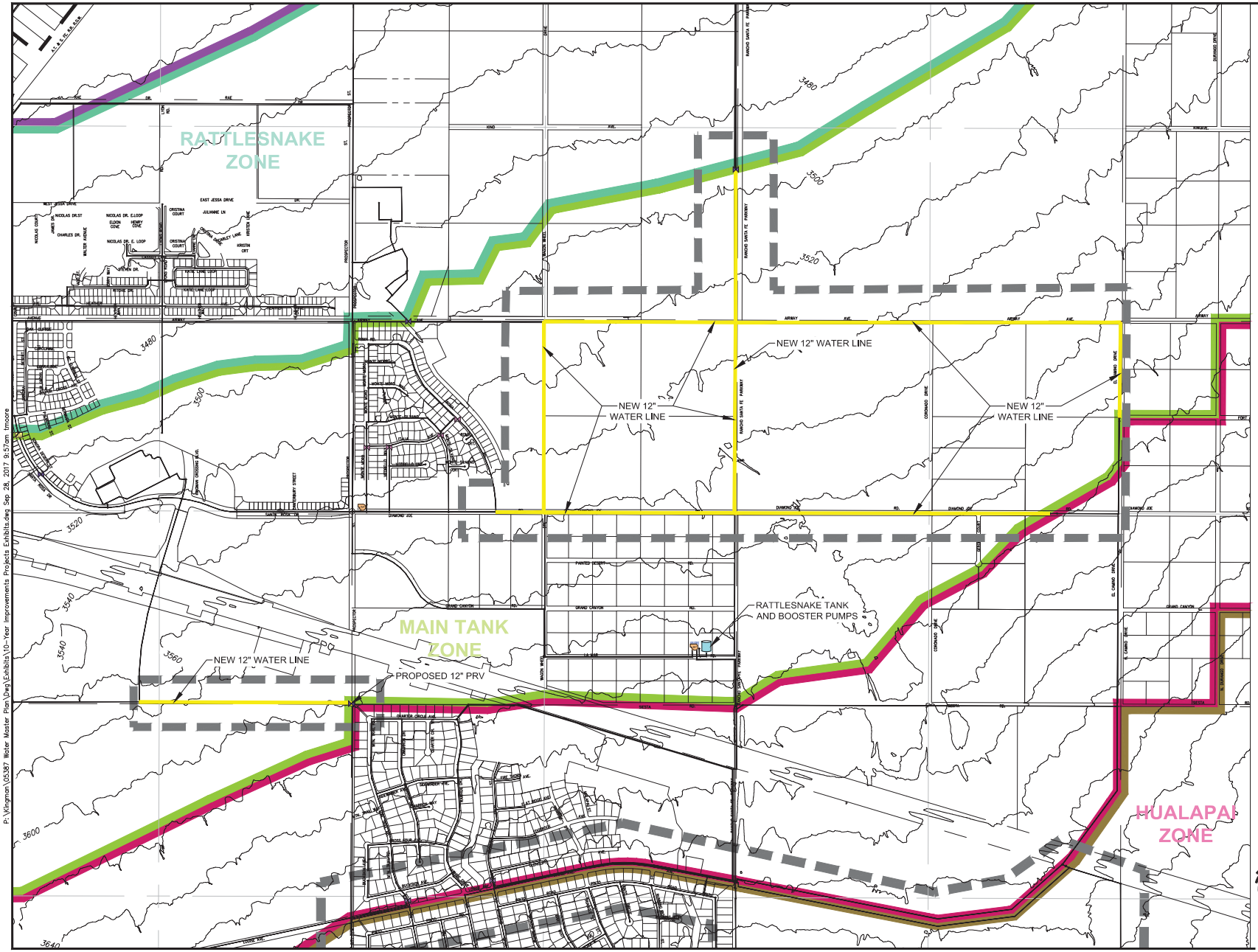
Key Modifications:

- New 12” mains on key streets and section lines
- 3 new 12” PRV’s to separate the Hualapai and Main Tank Zones

This improvement project is located within the Main Tank Zone on the southeast side of the City and spans from approximately Kingman Crossing Boulevard east to El Camino Drive. The improvement project focuses mainly on installation of new infrastructure to meet demand based on growth within the southeastern portion of the Main Tank Zone. The improvement project includes a 12” main on Airfield Avenue from the alignment of the proposed I-40 Crossing to Prospector Street as well as a 12” PRV at the intersection of Airfield and Prospector. The improvement project also includes a 12” main along Diamond Joe Road from Roma Road east to the east pressure zone boundary in addition to a 12” PRV at the zone boundary line. The project includes a 12” water main along Airway Avenue from Wagon Wheel Drive east to El Camino Drive and south along El Camino Drive to the southern pressure zone boundary along with a 12” PRV at the zone boundary line. Lastly, the improvement project includes a 12” water main along Wagon Wheel Drive north from Diamond Joe Road to Airway Avenue as well as a 12” water main along Rancho Santa Fe Parkway from Diamond Joe Road north to the northern pressure zone boundary. See **Exhibit 5.10 – 10-Year Improvements Project 10** for more information.

Estimated Total Project Cost: $4,986,900

See **Cost Estimate 5.10 – 10-Year Improvements Project 10** for cost breakdown.



NORTH

SCALE
0 1250' 2500'
HORIZ: 1" = 1250'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 10

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 5.10 - 10-YEAR IMPROVEMENTS PROJECT 10

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.10 - 10-Year Improvements Project 10
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	0	LF	$55	$0
2	12" Water Line and Surface Restoration	27,082	LF	$100	$2,708,200
3	16" Water Line and Surface Restoration	0	LF	$125	$0
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	54	EA	$2,500	$135,500
6	8" PRV Station	0	EA	$50,000	$0
7	12" PRV Station	3	EA	$75,000	$225,000
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	0	EA	$250,000	$0
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	0	GAL	$1	$0
12	Well Equipping	0	EA	$750,000	$0
				Construction Subtotal	**$3,068,700**
				Traffic Control (5% of Total)	$153,435
				Construction Administration (5% of Total)	$153,435
				Mobilization (15% of Total)	$460,305
				Construction Total	**$3,835,875**
				Final Engineering and Permitting (10% of Total)	$383,588
				Contingency (20% of Total)	$767,252
				Project Total	**$4,986,900**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

5.7.11 10-Year Improvement Project 11

Purpose: Zone-specific infrastructure improvements for imminent growth

Benefits:

- Provide zone-specific infrastructure improvements to allow for impending growth within the Rattlesnake Zone on the southeast side of the City

Key Modifications:

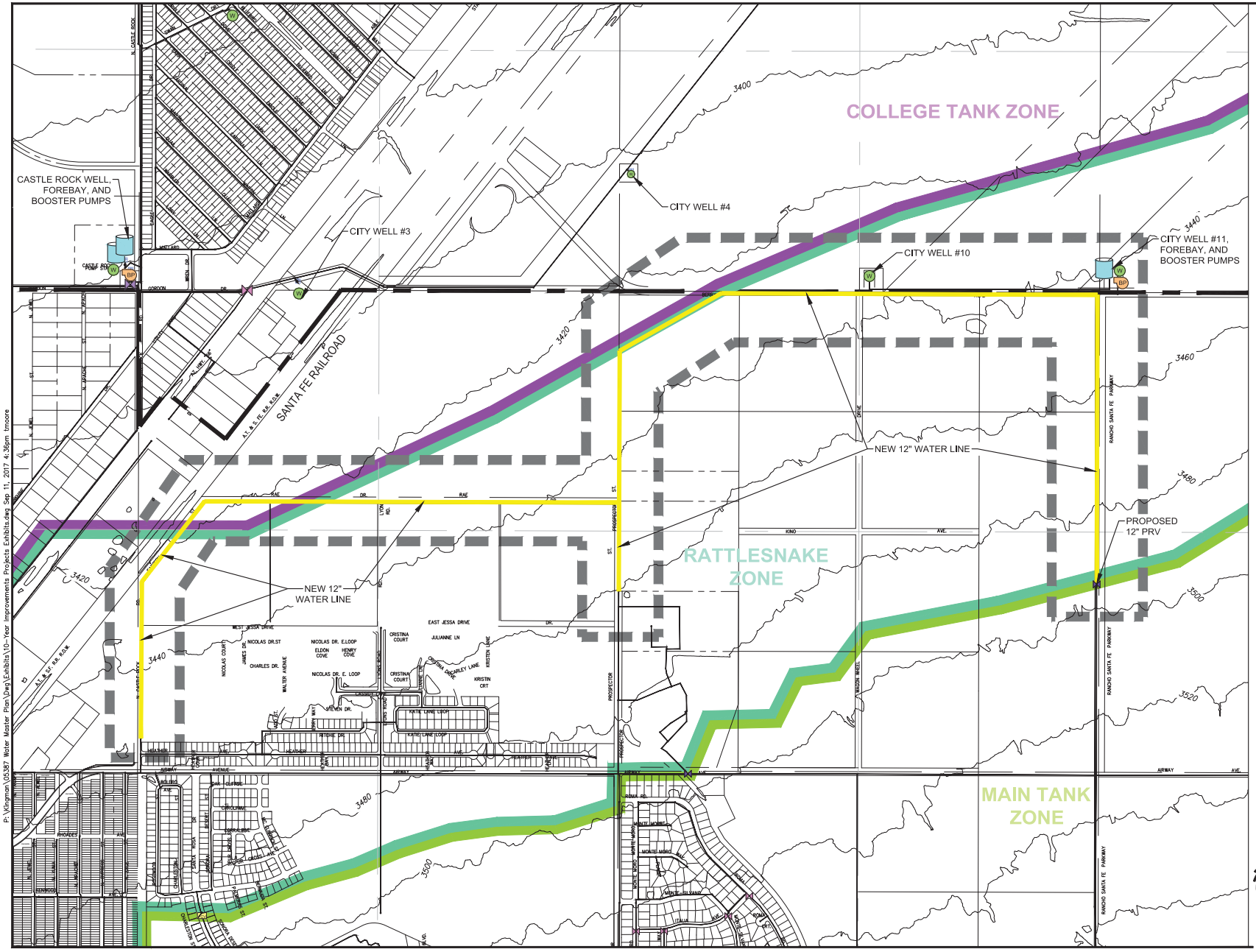
- New 12” mains on key streets and section lines
- 1 new 12” PRV to separate the Rattlesnake and Main Tank Zones

This improvement project is located within the Rattlesnake Zone on the southeast side of the City and spans from Castle Rock Road east to Rancho Santa Fe Parkway. The improvement project focuses mainly on installation of new infrastructure to meet demand based on growth within the southeastern portion of the Rattlesnake Zone. The improvement project includes a 12” PRV connecting to the 12” main on Rancho Santa Fe Parkway at the southern pressure zone boundary. The project also includes a 12” water main connecting to the PRV and running north along Rancho Santa Fe Parkway to Berry Road, west along Berry Road to Prospector Street and then south along Prospector to the existing 12” main adjacent to Desert Willow Elementary School. Finally, the improvement project includes a 12” main west along Rae Drive from Prospector Street to Eastern Street, southwest along Eastern Street to Castle Rock Road, and then south along Castle Rock Road to the existing 8” main just north of Heather Avenue. See **Exhibit 5.11 – 10-Year Improvements Project 11** for more information.

Estimated Total Project Cost: $3,302,900

See **Cost Estimate 5.11 – 10-Year Improvements Project 11** for cost breakdown.

EXHIBIT 5.11 - 10-YEAR IMPROVEMENTS PROJECT 11



NORTH

SCALE
0 1000' 2000'
HORIZ: 1" = 1000'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 11

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.11 - 10-Year Improvements Project 11
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	0	LF	$55	$0
2	12" Water Line and Surface Restoration	18,642	LF	$100	$1,864,200
3	16" Water Line and Surface Restoration	0	LF	$125	$0
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	37	EA	$2,500	$93,250
6	8" PRV Station	0	EA	$50,000	$0
7	12" PRV Station	1	EA	$75,000	$75,000
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	0	EA	$250,000	$0
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	0	GAL	$1	$0
12	Well Equipping	0	EA	$750,000	$0
				Construction Subtotal	**$2,032,450**
				Traffic Control (5% of Total)	$101,623
				Construction Administration (5% of Total)	$101,623
				Mobilization (15% of Total)	$304,868
				Construction Total	**$2,540,563**
				Final Engineering and Permitting (10% of Total)	$254,056
				Contingency (20% of Total)	$508,163
				Project Total	**$3,302,900**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

5.7.12 10-Year Improvement Project 12

Purpose: Zone-specific infrastructure improvements for imminent growth

Benefits:

- Provide zone-specific infrastructure improvements to allow for impending growth within the Bull Mountain Zone

Key Modifications:

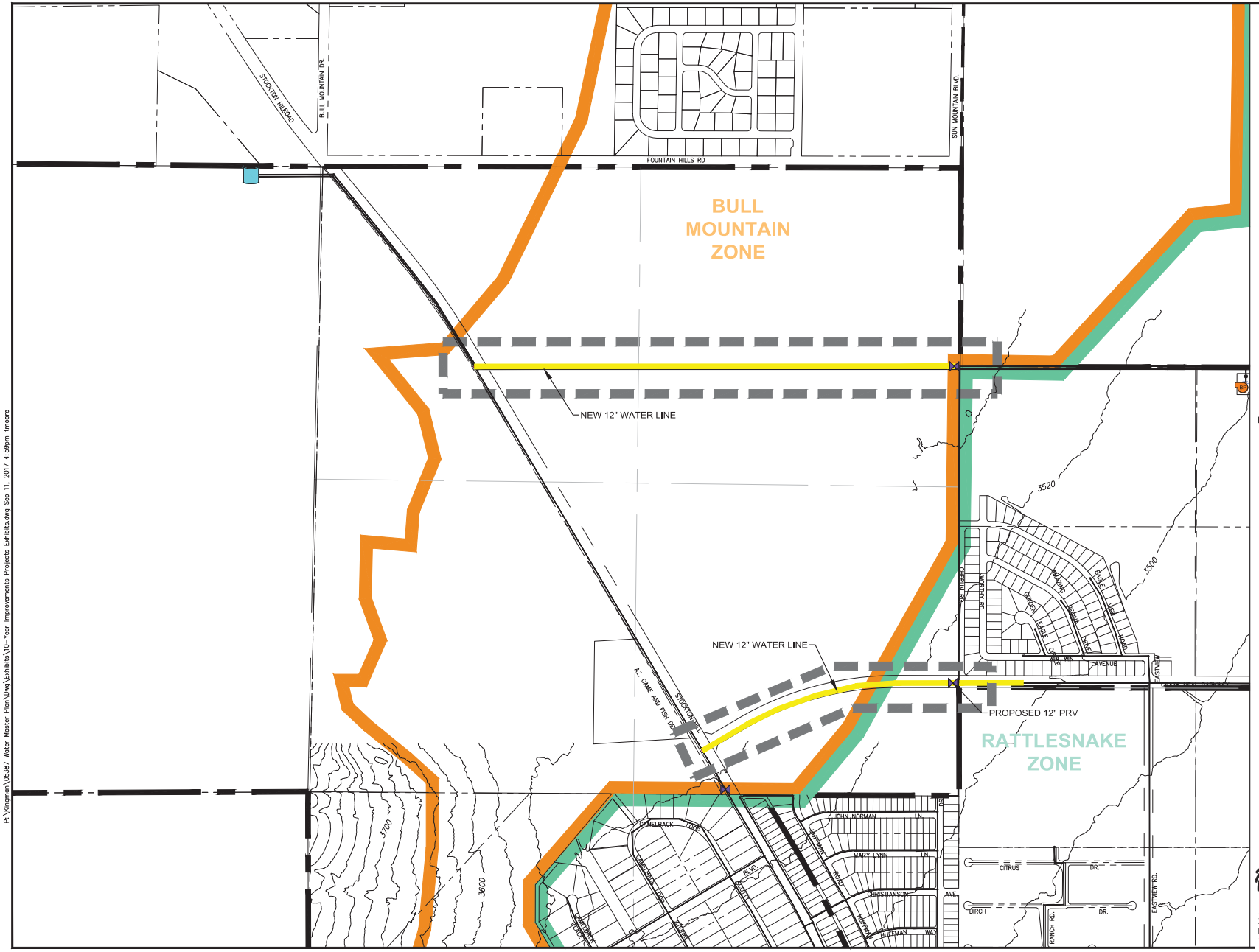
- New 12” mains on key streets and section lines
- 1 new 12” PRV to separate the College and Bull Mountain Zones

This improvement project is located within the Bull Mountain Zone and spans from approximately Stockton Hill Road east to Cherum Road. The improvement project focuses mainly on installation of new infrastructure to meet demand based on growth within the Bull Mountain Zone. The improvement project includes new 12” water mains along Calle Santa Fe and Grace Neal Parkway from Stockton Hill Road east to Cherum Road as well as a 12” PRV at Grace Neal Parkway and Cherum Road. See **Exhibit 5.12 – 10-Year Improvements Project 12** for more information.

Estimated Total Project Cost: $1,267,400

See **Cost Estimate 5.12 – 10-Year Improvements Project 12** for cost breakdown.

EXHIBIT 5.12 - 10-YEAR IMPROVEMENTS PROJECT 12



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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.12 - 10-Year Improvements Project 12
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	0	LF	$55	$0
2	12" Water Line and Surface Restoration	6,711	LF	$100	$671,100
3	16" Water Line and Surface Restoration	0	LF	$125	$0
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	14	EA	$2,500	$33,750
6	8" PRV Station	0	EA	$50,000	$0
7	12" PRV Station	1	EA	$75,000	$75,000
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	0	EA	$250,000	$0
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	0	GAL	$1	$0
12	Well Equipping	0	EA	$750,000	$0
				Construction Subtotal	**$779,850**
				Traffic Control (5% of Total)	$38,993
				Construction Administration (5% of Total)	$38,993
				Mobilization (15% of Total)	$116,978
				Construction Total	**$974,813**
				Final Engineering and Permitting (10% of Total)	$97,481
				Contingency (20% of Total)	$194,982
				Project Total	**$1,267,400**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

5.7.13 10-Year Improvement Project 13

Purpose: Zone-specific infrastructure improvements for imminent growth

Benefits:

- Provide zone-specific infrastructure improvements to allow for impending growth within the Rattlesnake Zone on the northwest side of the City

Key Modifications:

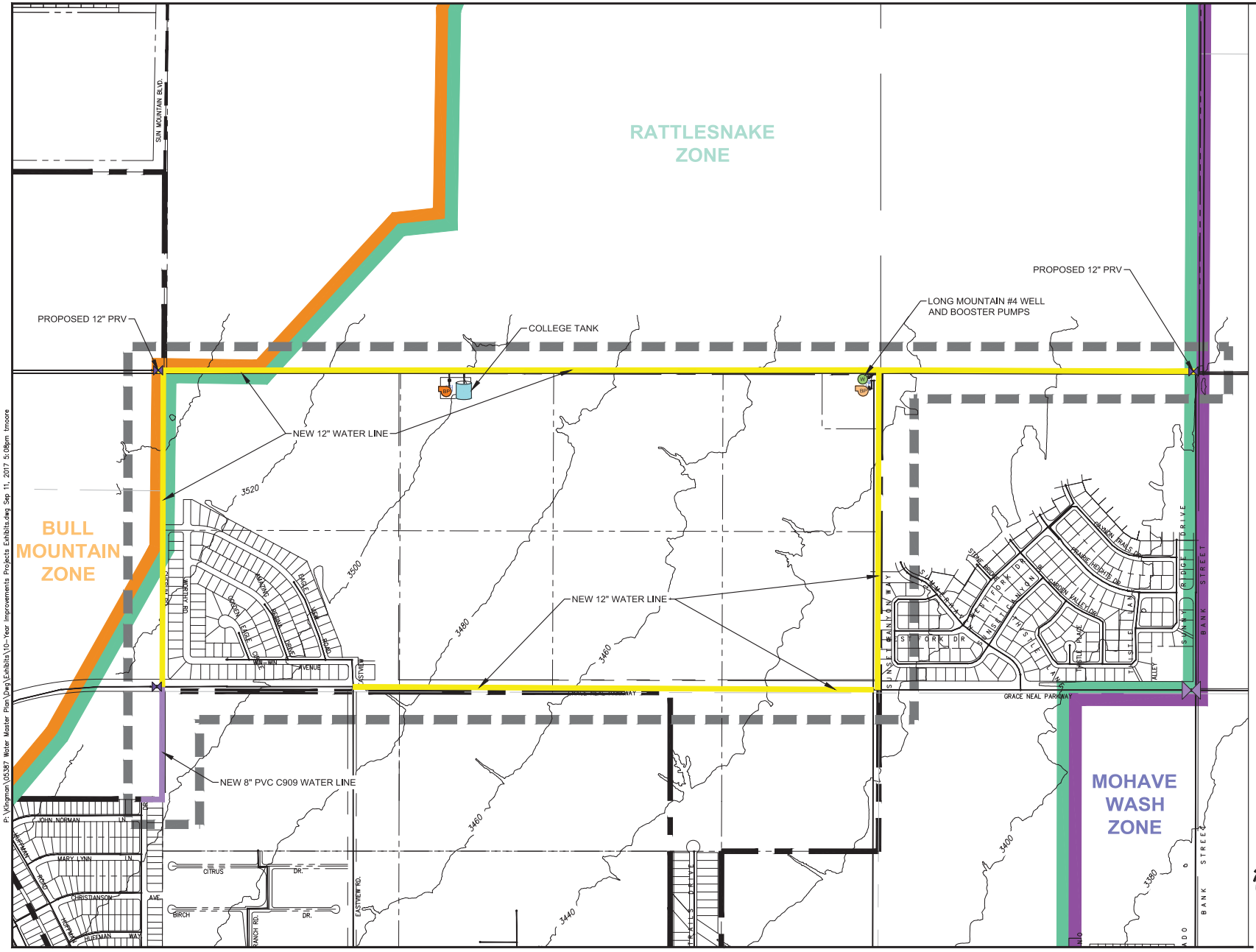
- New 8” and 12” mains on key streets and section lines
- 2 new 12” PRV’s to separate the Rattlesnake zone from the College and Bull Mountain Zones

This improvement project is located within the Rattlesnake Zone on the northwest side of the City and spans from Cherum Road east to Bank Street. The improvement project focuses mainly on installation of new infrastructure to meet demand based on growth within the northwestern portion of the Rattlesnake Zone. The improvement project includes an 8” water main from the north end of Edie Drive within the College Heights subdivision, north to Grace Neal Parkway. The project also includes a 12” main along Grace Neal Parkway from Eastview Road east to the southwest corner of the Prairie Heights subdivision. The project includes a 12” PRV at the intersection of Calle Santa Fe and Cherum Road to separate the Rattlesnake zone from the Bull Mountain Zone. The improvement project also includes a 12” main along Calle Santa Fe from Cherum Road east to Bank Street as well as a 12” PRV at the intersection of Calle Santa Fe and Bank Street to separate the College and Rattlesnake Zones. Lastly, the project includes 12” water mains along Cherum Road and along the west side of the Prairie Heights subdivision from Grace Neal Parkway north to Calle Santa Fe. See **Exhibit 5.13 – 10-Year Improvements Project 13** for more information.

Estimated Total Project Cost: $3,438,000

See **Cost Estimate 5.13 – 10-Year Improvements Project 13** for cost breakdown.

EXHIBIT 5.13 - 10-YEAR IMPROVEMENTS PROJECT 13



NORTH

SCALE
0 750' 1500'
HORIZ: 1" = 750'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 13

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.13 - 10-Year Improvements Project 13
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	1,099	LF	$55	$60,445
2	12" Water Line and Surface Restoration	18,091	LF	$100	$1,809,100
3	16" Water Line and Surface Restoration	0	LF	$125	$0
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	38	EA	$2,500	$96,000
6	8" PRV Station	0	EA	$50,000	$0
7	12" PRV Station	2	EA	$75,000	$150,000
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	0	EA	$250,000	$0
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	0	GAL	$1	$0
12	Well Equipping	0	EA	$750,000	$0
				Construction Subtotal	**$2,115,545**
				Traffic Control (5% of Total)	$105,777
				Construction Administration (5% of Total)	$105,777
				Mobilization (15% of Total)	$317,332
				Construction Total	**$2,644,431**
				Final Engineering and Permitting (10% of Total)	$264,443
				Contingency (20% of Total)	$528,939
				Project Total	**$3,438,000**

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5.7.14 10-Year Improvement Project 14

Purpose: Zone-specific infrastructure improvements for imminent growth

Benefits:

- Provide zone-specific infrastructure improvements to allow for impending growth within the College Tank Zone on the north side of the City

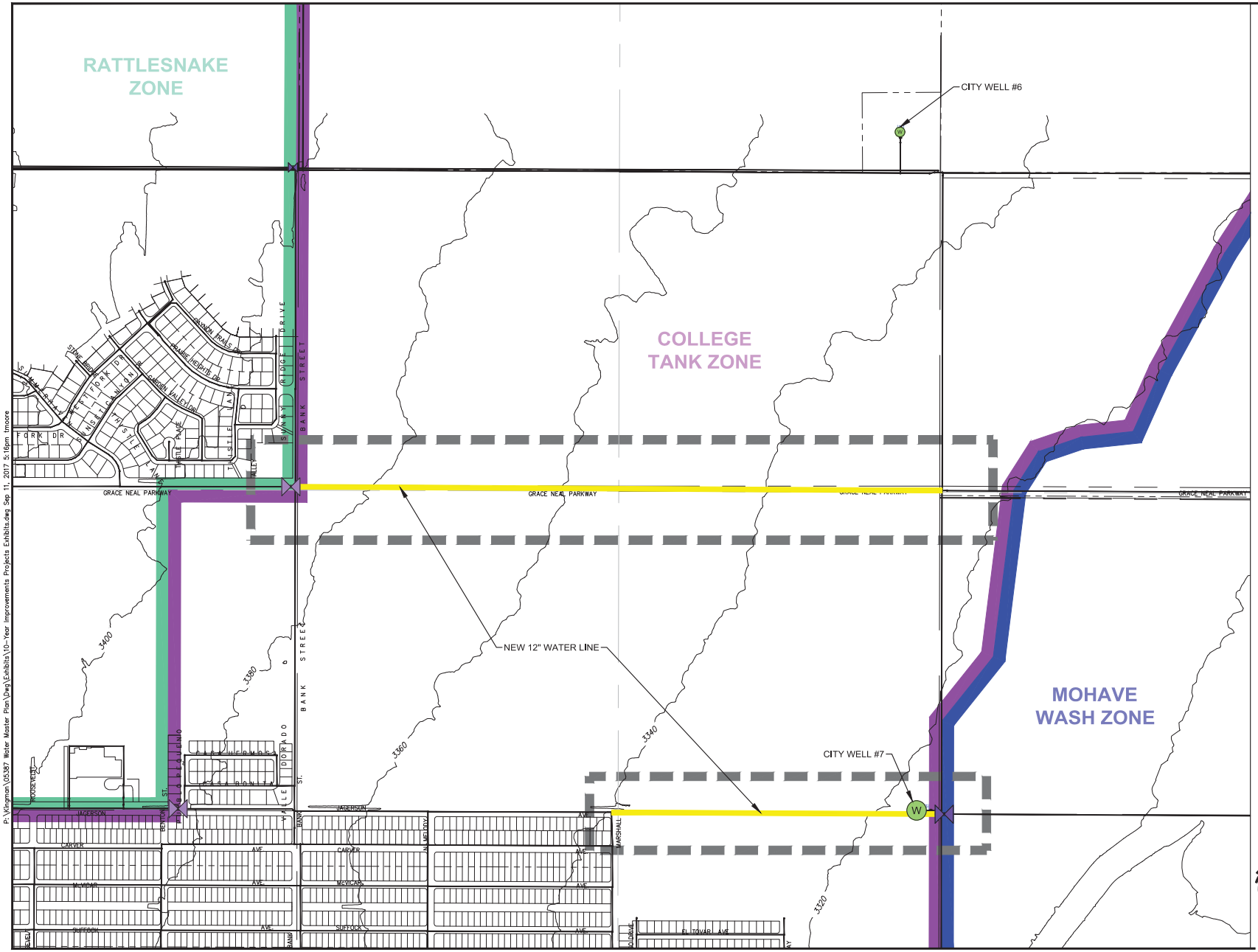
Key Modifications:

- New 12” mains on key streets and section lines
- Modify connections at Calle Santa Fe & Bank Street

This improvement project is located within the College Tank Zone on the north side of the City and spans from Bank Street east to Castle Rock Road. The improvement project focuses mainly on installation of new infrastructure to meet demand based on growth within the north portion of the College Tank Zone. The improvement project includes a 12” along Grace Neal Parkway from Bank Street east to Castle Rock Road as well as a 12” main along Jagerson Avenue from Marshall Drive east to Castle Rock Road. The project also includes a modification of the connections at the intersection of Calle Santa Fe and Bank Street to reconcile the cross-connection between transmission and distribution lines within the zone. It is important to note that there is not a PRV on Grace Neal Parkway at the College Tank and Mohave Wash Pressure Zone boundary. This is due to the fact that the existing 16” water main within Grace Neal Parkway is a dedicated transmission main that is part of the College Tank zone even though it crosses through the Mohave Wash Pressure Zone. See **Exhibit 5.14 – 10-Year Improvements Project 14** for more information.

Estimated Total Project Cost: $1,372,100

See **Cost Estimate 5.14 – 10-Year Improvements Project 14** for cost breakdown.



NORTH

SCALE
0 750' 1500'
HORIZ: 1" = 750'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
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CITY OF KINGMAN
WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 14

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 5.14 - 10-YEAR IMPROVEMENTS PROJECT 14

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SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.14 - 10-Year Improvements Project 14
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	0	LF	$55	$0
2	12" Water Line and Surface Restoration	8,040	LF	$100	$804,000
3	16" Water Line and Surface Restoration	0	LF	$125	$0
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	16	EA	$2,500	$40,250
6	8" PRV Station	0	EA	$50,000	$0
7	12" PRV Station	0	EA	$75,000	$0
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	0	EA	$250,000	$0
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	0	GAL	$1	$0
12	Well Equipping	0	EA	$750,000	$0
				Construction Subtotal	**$844,250**
				Traffic Control (5% of Total)	$42,213
				Construction Administration (5% of Total)	$42,213
				Mobilization (15% of Total)	$126,638
				Construction Total	**$1,055,313**
				Final Engineering and Permitting (10% of Total)	$105,531
				Contingency (20% of Total)	$211,084
				Project Total	**$1,372,100**

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5.7.15 10-Year Improvement Project 15

Purpose: Zone-specific infrastructure improvements for imminent growth

Benefits:

- Provide zone-specific infrastructure improvements to allow for impending growth within the Mohave Wash Zone

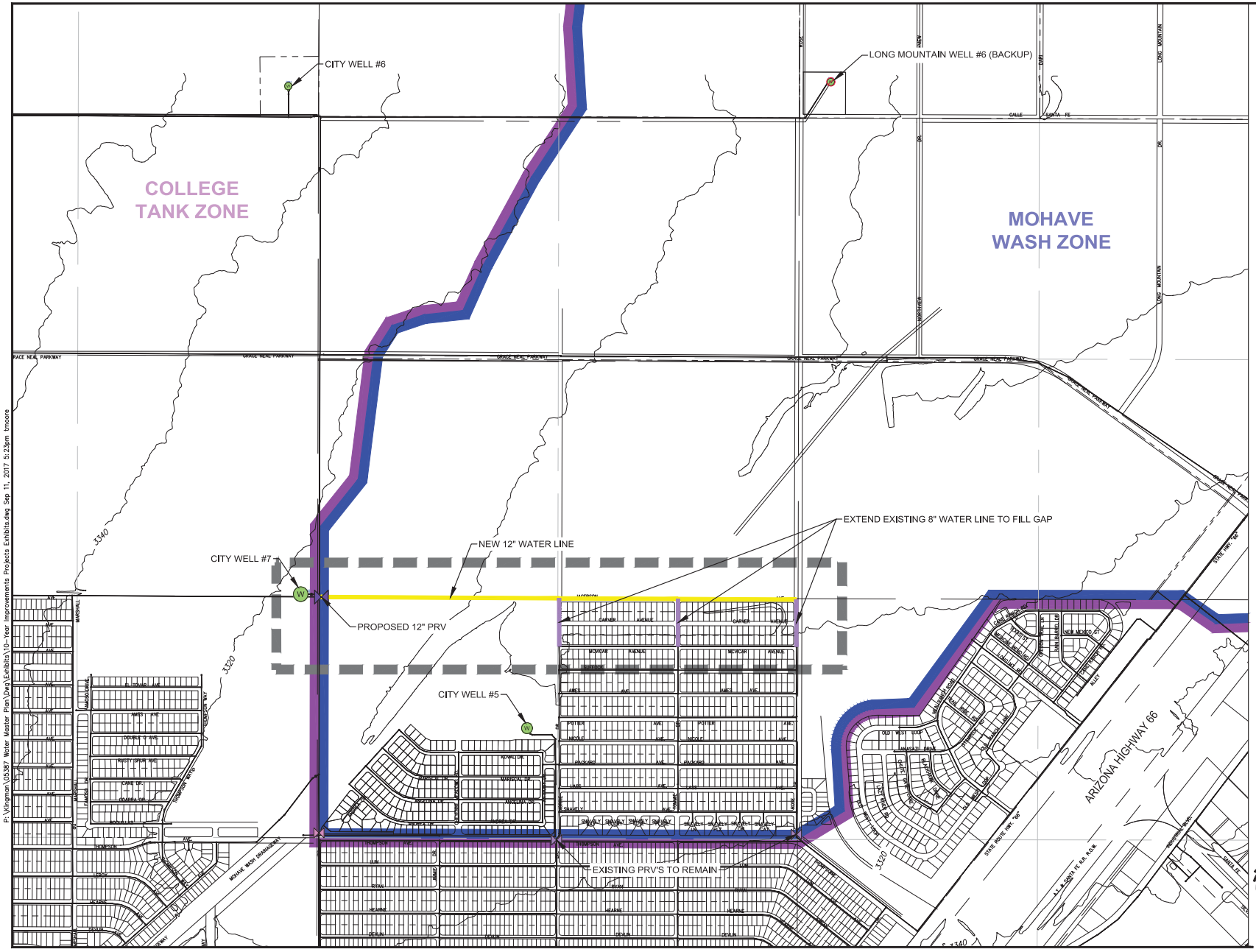
Key Modifications:

- New 8” and 12” mains on key streets
- 1 new 12” PRV to separate the Mohave Wash and College Tank zones

This improvement project is located within the Mohave Wash Zone and spans from Castle Rock Road east to Rose Drive. The improvement project focuses mainly on installation of new infrastructure to meet demand based on growth within the Mohave Wash Zone. The improvement project includes a new 12” water main along Jagerson Avenue from Castle Rock Road east to Rose Drive as well as a 12” PRV at the intersection of Jagerson and Castle Rock separating the College Tank Zone from the Mohave Wash Zone. The improvement project also includes the extension of the 8” water mains within the Chaparral Mesa subdivision along Norrie Drive, Tommie Drive, and Rose Drive to Jagerson Avenue. See **Exhibit 5.15 – 10-Year Improvements Project 15** for more information.

Estimated Total Project Cost: $1,170,000

See **Cost Estimate 5.15 – 10-Year Improvements Project 15** for cost breakdown.



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NORTH

SCALE
0 1000' 2000'
HORIZ: 1" = 1000'

LEGEND

- WATER SYSTEM LINES NOT INCLUDED IN PROJECT
- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE
- PROJECT BOUNDARY
- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
W	W	WELL
W		INACTIVE WELL
W		BACKUP WELL
		TANK
		PNEUMATIC TANK
BP	BP	BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
CV	CV	CHECK VALVE
		FIRE HYDRANT

CITY OF KINGMAN
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CITY OF KINGMAN
WATER MASTER PLAN
10-YEAR IMPROVEMENTS
PROJECT 15

SUNRISE ENGINEERING
2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

EXHIBIT 5.15 - 10-YEAR IMPROVEMENTS PROJECT 15

SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.15 - 10-Year Improvements Project 15
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	1,566	LF	$55	$86,130
2	12" Water Line and Surface Restoration	5,245	LF	$100	$524,500
3	16" Water Line and Surface Restoration	0	LF	$125	$0
4	24" Water Line and Surface Restoration	0	LF	$200	$0
5	Water Valve, Box and Cover	14	EA	$2,500	$34,250
6	8" PRV Station	0	EA	$50,000	$0
7	12" PRV Station	1	EA	$75,000	$75,000
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	0	EA	$250,000	$0
10	Booster Pump Modification	0	EA	$150,000	$0
11	Tank	0	GAL	$1	$0
12	Well Equipping	0	EA	$750,000	$0
				Construction Subtotal	**$719,880**
				Traffic Control (5% of Total)	$35,994
				Construction Administration (5% of Total)	$35,994
				Mobilization (15% of Total)	$107,982
				Construction Total	**$899,850**
				Final Engineering and Permitting (10% of Total)	$89,985
				Contingency (20% of Total)	$179,988
				Project Total	**$1,170,000**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

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Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

10-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 5.16 - 10-Year Improvements Projects Summary
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price	Total
	Construction				
1	8" Water Line and Surface Restoration	18,009	LF	$55	$990,495
2	12" Water Line and Surface Restoration	174,519	LF	$100	$17,451,900
3	16" Water Line and Surface Restoration	16,893	LF	$125	$2,111,625
4	24" Water Line and Surface Restoration	19,614	LF	$200	$3,922,800
5	Water Valve, Box and Cover	439	EA	$2,500	$1,098,000
6	8" PRV Station	5	EA	$50,000	$250,000
7	12" PRV Station	11	EA	$75,000	$825,000
8	16" PRV Station	0	EA	$100,000	$0
9	Booster Pump Station	3	EA	$250,000	$750,000
10	Booster Pump Modification	1	EA	$150,000	$150,000
11	Tank	1,800,000	GAL	$1	$1,800,000
12	Well Equipping	1	EA	$750,000	$750,000
13	Site Property Acquisition	3	AC	$50,000	$150,000
14	Waterline Easement Acquisition	13	AC	$50,000	$650,000
15	New Castle Rock Booster Pump Station	1	EA	$6,315,000	$6,315,000
				Construction Subtotal	**$37,214,820**
				Traffic Control (5% of Total)	$1,860,741
				Construction Administration (5% of Total)	$1,860,741
				Mobilization (15% of Total)	$4,634,973
				Construction Total	**$45,571,275**
				Final Engineering and Permitting (10% of Total)	$4,557,128
				Contingency (20% of Total)	$9,115,166
				Project Total	**$59,243,700**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

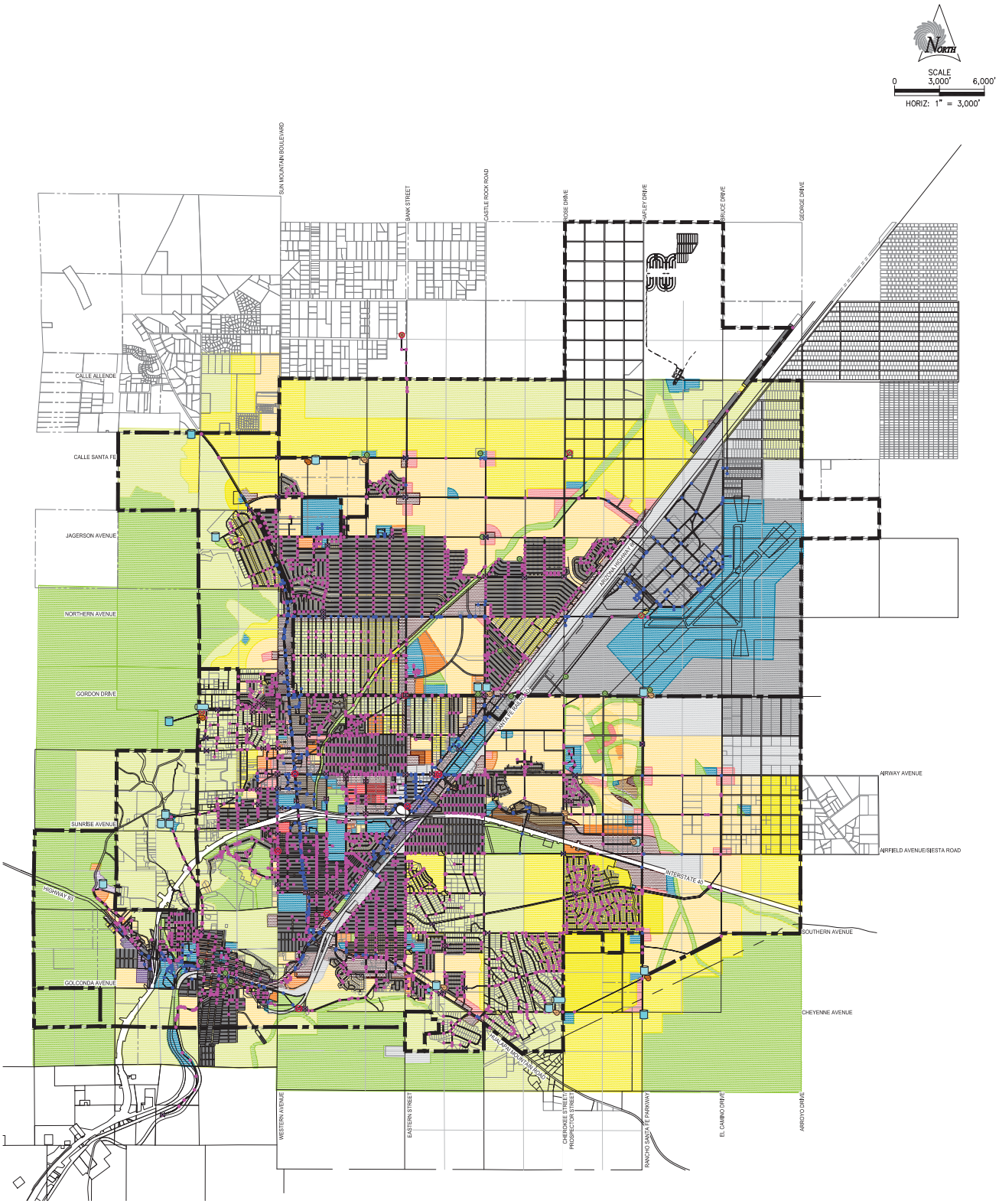
SECTION 5 FIGURES

Figure 5.1 – 10-Year Fire Flow Demands

Figure 5.2 – 10-Year Improvements Projects Overview

Figure 5.3 – 10-Year Model – Peak Hour Results

Figure 5.4 – 10-Year Model – Fire Flow Results



LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING PROPOSED

- WELL
- INACTIVE WELL
- BACKUP WELL
- TANK
- PNEUMATIC TANK
- BOOSTER PUMP
- PRESSURE REDUCING VALVE (PRV)
- INACTIVE PRV
- ZONE VALVE
- CHECK VALVE

- 1,000 GPM (RESIDENTIAL)
- 3,500 GPM (COMMERCIAL & INDUSTRIAL)

LAND USE DESIGNATION LEGEND

- RURAL DENSITY RESIDENTIAL (1 DU OR LESS/AC)
- LOW DENSITY RESIDENTIAL (1–2 DU/AC)
- MEDIUM DENSITY RESIDENTIAL (3–8 DU/AC)
- INTERMEDIATE DENSITY RESIDENTIAL (9–16 DU/AC)
- HIGH DENSITY RESIDENTIAL (17–28 DU/AC)
- NEIGHBORHOOD COMMERCIAL
- COMMUNITY COMMERCIAL
- REGIONAL COMMERCIAL
- HIGHWAY SERVICE COMMERCIAL
- LIGHT INDUSTRIAL
- MANUFACTURING INDUSTRIAL
- PUBLIC/QUASI–PUBLIC
- PARKS/OPEN SPACE

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 5.1
10-YEAR FIRE FLOW DEMANDS

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MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

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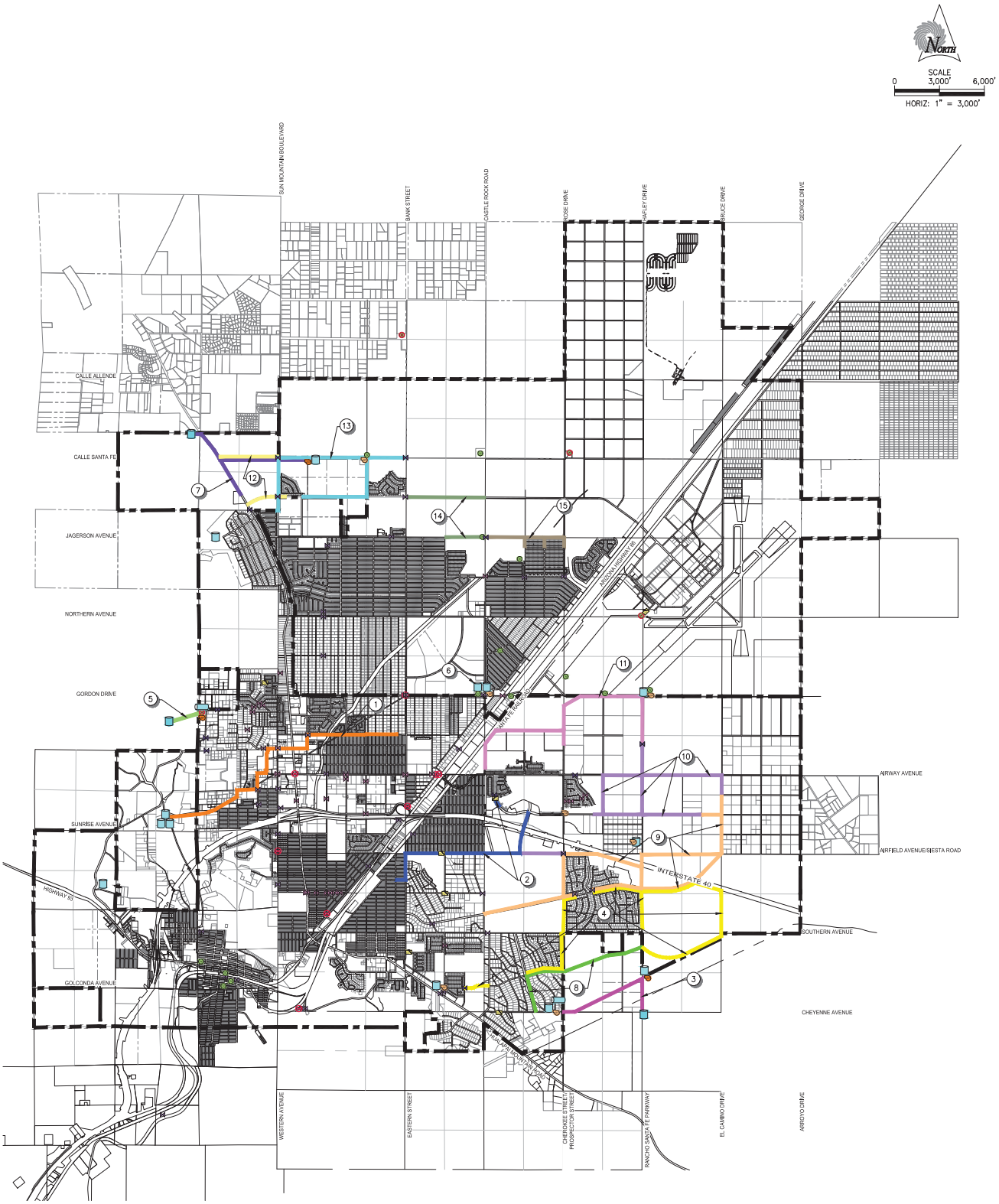

LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE
		PROJECT ID NUMBER

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 5.2
10-YEAR IMPROVEMENTS
PROJECTS OVERALL

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MESA, ARIZONA 85210
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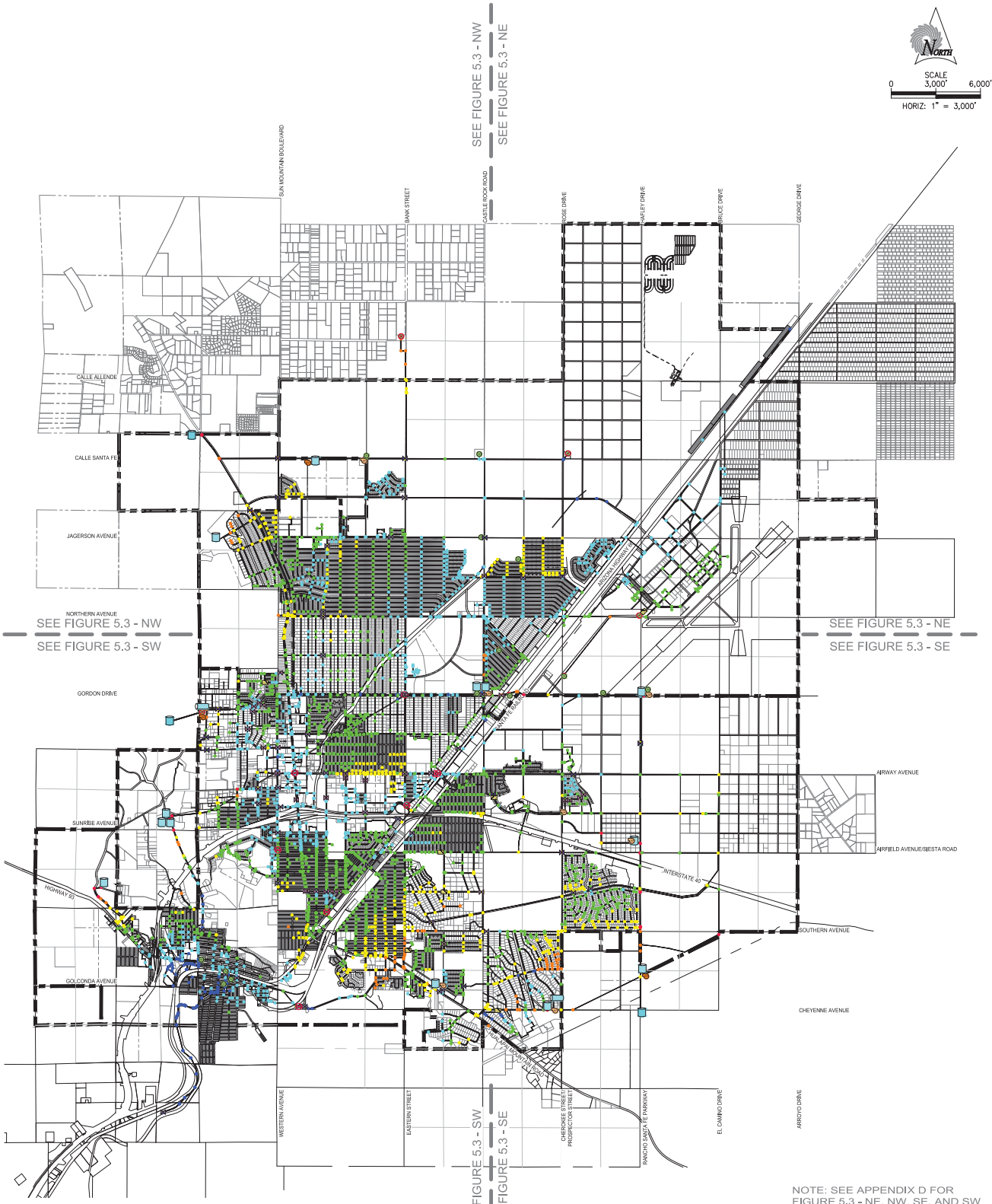

NOTE: SEE APPENDIX D FOR FIGURE 5.3 - NE, NW, SE, AND SW

LEGEND

CITY BOUNDARY	
STUDY LIMITS (WATER BOUNDARY)	
EXISTING / PROPOSED	
WELL	
INACTIVE WELL	
BACKUP WELL	
TANK	
PNEUMATIC TANK	
BOOSTER PUMP	
PRESSURE REDUCING VALVE (PRV)	
INACTIVE PRV	
ZONE VALVE	
CHECK VALVE	

< 20.00 PSI
20.00 – 40.00 PSI
40.00 – 60.00 PSI
60.00 – 80.00 PSI
80.00 – 100.00 PSI
> 100.00 PSI

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 5.3
10-YEAR MODEL
PEAK HOUR RESULTS

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MESA, ARIZONA 85210
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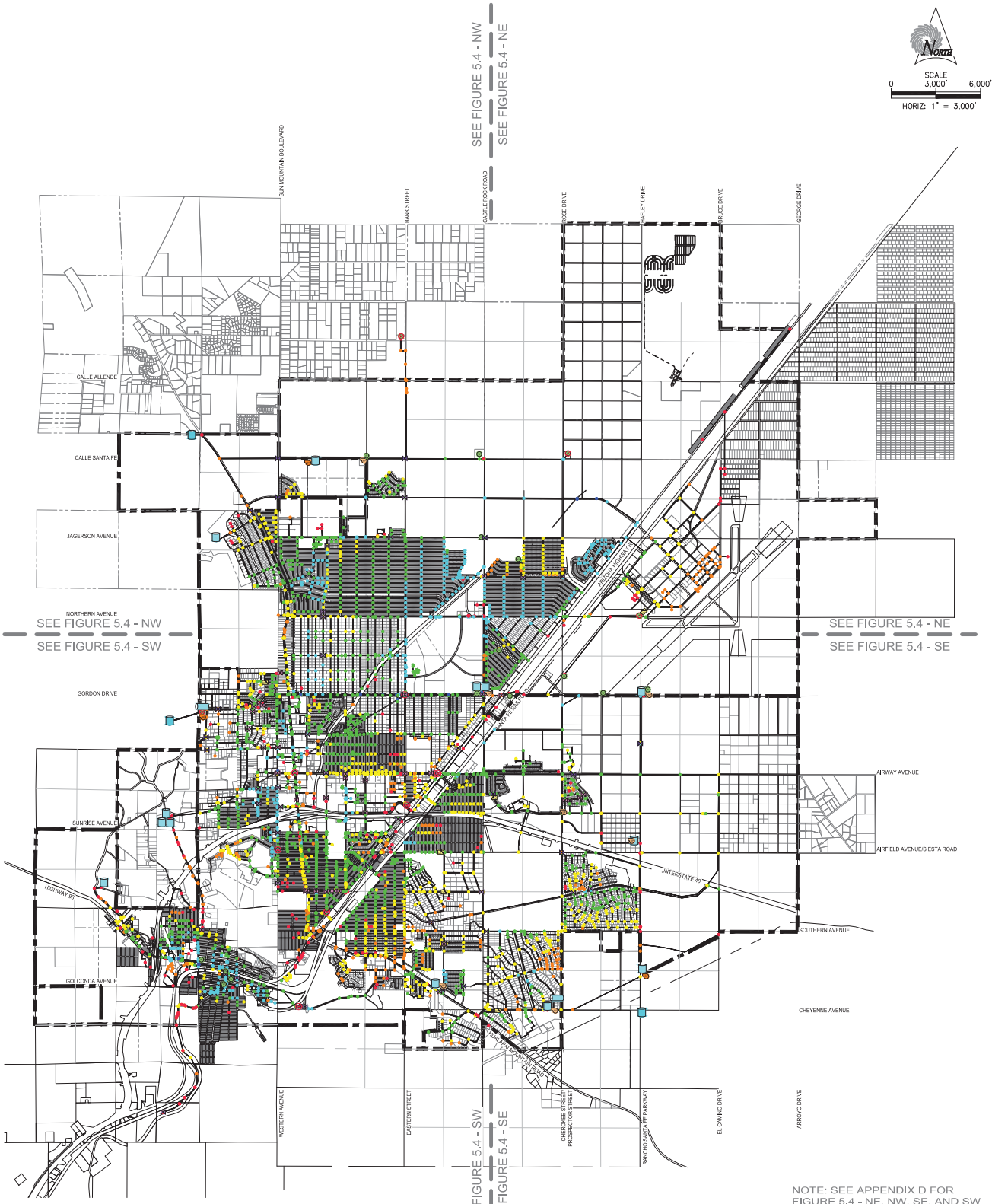

NOTE: SEE APPENDIX D FOR FIGURE 5.4 - NE, NW, SE, AND SW

LEGEND

	CITY BOUNDARY
	STUDY LIMITS (WATER BOUNDARY)
EXISTING / PROPOSED	WELL
	INACTIVE WELL
	BACKUP WELL
	TANK
	PNEUMATIC TANK
	BOOSTER PUMP
	PRESSURE REDUCING VALVE (PRV)
	INACTIVE PRV
	ZONE VALVE
	CHECK VALVE

	< 20.00 PSI
	20.00 – 40.00 PSI
	40.00 – 60.00 PSI
	60.00 – 80.00 PSI
	80.00 – 100.00 PSI
	> 100.00 PSI

CITY OF KINGMAN
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CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 5.4
10-YEAR MODEL
FIRE FLOW RESULTS

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2152 SOUTH VINEYARD, SUITE 123
MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
www.sunrise-eng.com

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6.0 30-YEAR (2047) WATER SYSTEM ANALYSIS

The proposed 30-year water system was analyzed and compared to the design criteria presented in **Section 3.0 - Design Criteria** in regards to available water system source, storage, and booster pump demands. Zonal distribution of source, storage and booster pump capacity was evaluated as to determine need and safety, in the form of redundancy, within the system and projected 30-year demands. The 30-year water distribution system was examined to provide adequate pressures on an average day, month, year as well as in fire flow conditions. An H2ONet model was created for the 30-year water system analysis. The 30-year model used the 10-year model as a foundation and was revised per the recommended improvements proposed for the 30-year water system based on the projected growth discussed in the following sections.

6.1 CONNECTIONS & POPULATION PROJECTIONS

Projected 30-year connections are determined by projecting existing connections (accounts) with an estimated growth rate of 2.5% over 30 years. Projected population is based off estimated accounts multiplied by 2.5 people per account. People per account from the City of Kingman Utility Regulations Section 7.5 is determined as 3.5. The value for people per account of 2.5 was determined by comparison with current census data and through City staff input. Projected connections and population are shown in **Table 6.1 - 30-Year Connection & Population Projections**.

Table 6.1 - 30-Year Connection & Population Projections

Year	Estimated Accounts	Estimated Population
2027	24,382	60,954
2028	24,991	62,478
2029	25,616	64,040
2030	26,256	65,641
2031	26,913	67,282
2032	27,586	68,964
2033	28,275	70,688
2034	28,982	72,456
2035	29,707	74,267
2036	30,449	76,124
2037	31,211	78,027
2038	31,991	79,977
2039	32,791	81,977
2040	33,611	84,026
2041	34,451	86,127
2042	35,312	88,280
2043	36,195	90,487
2044	37,100	92,749
2045	38,027	95,068
2046	38,978	97,445
2047	39,952	99,881

6.2 WATER DEMAND ANALYSIS

Projected water demand was calculated from projected connections multiplied by average water usage per connection. The City provided 2015 monthly consumption data for the water system for the existing demand analysis. The existing system demand analysis produced an estimated average water usage per account per day of 312 gallons per connection. In general, daily water usage decreases over time as users and technology become more water-conscious and therefore water-conservative. However; for our analysis, average water usage per account per day is assumed the same. This assumption will act as a safety-factor in our analysis. See **Table 6.2 - 30-Year Demand Projections** for the 30-year total system demand calculations.

Table 6.2 - 30-Year Demand Projections

Year	Estimated Accounts	Average Water Usage per Account per Day (gal/conn/day)	Average Day (MGD)	Maximum Day (x1.5) (MGD)	Peak Day (x2.0) (MGD)	Peak Hour (x3.0) (MGD)
2027	24,382	312	7.61	11.41	15.21	22.82
2028	24,991	312	7.80	11.70	15.59	23.39
2029	25,616	312	7.99	11.99	15.98	23.98
2030	26,256	312	8.19	12.29	16.38	24.58
2031	26,913	312	8.40	12.60	16.79	25.19
2032	27,586	312	8.61	12.91	17.21	25.82
2033	28,275	312	8.82	13.23	17.64	26.47
2034	28,982	312	9.04	13.56	18.08	27.13
2035	29,707	312	9.27	13.90	18.54	27.81
2036	30,449	312	9.50	14.25	19.00	28.50
2037	31,211	312	9.74	14.61	19.48	29.21
2038	31,991	312	9.98	14.97	19.96	29.94
2039	32,791	312	10.23	15.35	20.46	30.69
2040	33,611	312	10.49	15.73	20.97	31.46
2041	34,451	312	10.75	16.12	21.50	32.25
2042	35,312	312	11.02	16.53	22.03	33.05
2043	36,195	312	11.29	16.94	22.59	33.88
2044	37,100	312	11.58	17.36	23.15	34.73
2045	38,027	312	11.86	17.80	23.73	35.59
2046	38,978	312	12.16	18.24	24.32	36.48
2047	39,952	312	12.47	18.70	24.93	37.40

6.3 WATER SOURCE ANALYSIS

Along with population and demand projections, infrastructure requirements versus existing capacity was estimated. The minimum required water source for the system is maximum day demand plus 10 percent with the largest well out of service, as defined in **Section 3.0 - Design Criteria**. The maximum day factor is 1.5 times average day water demands. In 2047, the system is estimated to have 39,952 total average connections based on a 2.5% growth on the estimated 19,047 accounts in 2017. The required minimum source for 2047 was calculated to be 20.57 million gallons per day of source water. Following the 10-year model recommended improvements, which included the re-equipping of Long Mountain Well 1, the wells in the water system can deliver 28.05 million gallons per day of water. This total capacity does not include City Well 1 and Long Mountain Well 6, which are backup wells, as well as Bank Street Well which is an inactive well. The largest well in the system is City Well 10, which has a capacity of 4.29 million gallons per day. With City Well 10 out of service, the existing wells in the system can deliver 23.76 million gallons of water per day. The existing system delivers enough source water to meet minimum design criteria for existing demand. The activation of backup wells would increase the available source by another 3.17 million gallons. For minimum required source calculations, see **Table 6.3 – 30-Year Water Source Analysis**.

Table 6.3 – 30-Year Water Source Analysis

	Capacity (GPM)	Capacity (MGD)
Total Source	19,480	28.05
Total Available Source*	**16,500**	**23.76**
Minimum Required	14,283	20.57

**Largest Well out of Service*

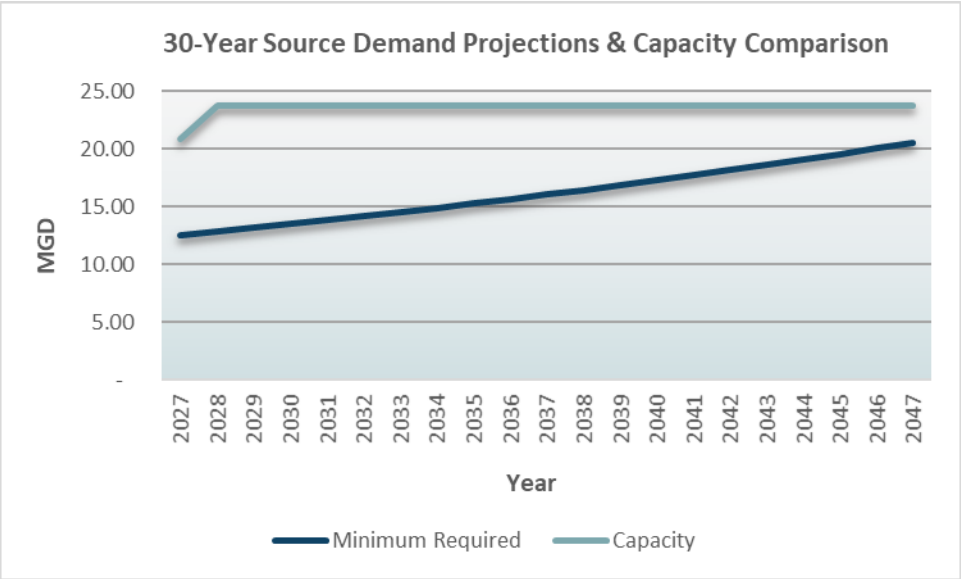
See **Table 6.4 - 30-Year Source Demand Projections & Capacity Comparison** and **Graph 6.1 - 30-Year Source Demand Projections & Capacity Comparison** for a yearly comparison of the projected minimum required source and system source capacity.

All but four (4) of the wells within the water system are located north of the City boundary. The four (4) wells within City limits are all located within the downtown area and supply the downtown zones. The re-equipping of Long Mountain Well #1, which was included in the 10-Year recommended improvement projects provides 2.88 MGD of source for the proposed White Cliff Zone. In the existing condition, the source provided to this zone was through the Main Tank Zone distribution system.

Table 6.4 - 30-Year Source Demand Projections & Capacity Comparison

Year	Minimum Required Source (MGD)	Source Capacity (MGD)	Addition (MGD)
2027	12.55	20.88	2.88
2028	12.87	23.76	
2029	13.19	23.76	
2030	13.52	23.76	
2031	13.85	23.76	
2032	14.20	23.76	
2033	14.56	23.76	
2034	14.92	23.76	
2035	15.29	23.76	
2036	15.68	23.76	
2037	16.07	23.76	
2038	16.47	23.76	
2039	16.88	23.76	
2040	17.30	23.76	
2041	17.74	23.76	
2042	18.18	23.76	
2043	18.63	23.76	
2044	19.10	23.76	
2045	19.58	23.76	
2046	20.07	23.76	
2047	20.57	23.76	

Graph 6.1 - 30-Year Source Demand Projections & Capacity Comparison



6.4 WATER STORAGE ANALYSIS

Water storage for the projected 30-year connections was checked against storage criteria as defined in **Section 3.0 - Design Criteria**. Required storage is the sum of the equalization storage, emergency storage, and fire storage. Equalization storage is 25 percent of maximum day demand. Emergency storage is 20 percent of maximum day demand. Fire storage is calculated as the volume equal to two (2) commercial fires and two (2) residential fires. Commercial fire storage is defined as 3,500 gallons per minute over a four (4) hour period per fire. The total system wide commercial fire flow storage requirement is equal to 1.68 million gallons. Residential fire storage is defined as the volume equal to 1,000 gallons per minute over a two (2) hour period per fire. The total system wide residential fire flow storage requirement is equal to 240,000 gallons. Total system wide combined residential and commercial fire flow storage is 1.92 million gallons. Adding fire flow to emergency storage and equalization storage, in 2047 the 30-year condition storage requirement is approximately 10.33 million gallons. Three additional storage tanks are proposed in the 10-year system analysis; the 300,000 gallon White Cliffs Tank, the 500,000 gallon Northridge Tank, and the 1,000,000 gallon Bull Mountain Tank. The storage tanks after the improvements recommended in the 10-year system analysis have a total capacity of 14.98 million gallons. Therefore, the system has adequate storage capacity within the system for 2047 requirements. For minimum required storage calculations see **Table 6.5 – 10-Year Water Storage Analysis**.

Table 6.5 – 10-Year Water Storage Analysis

	Capacity (gallons)	Capacity (MG)
Total Available Storage	**14,976,000**	**14.98**
Minimum Required	10,333,969	10.33

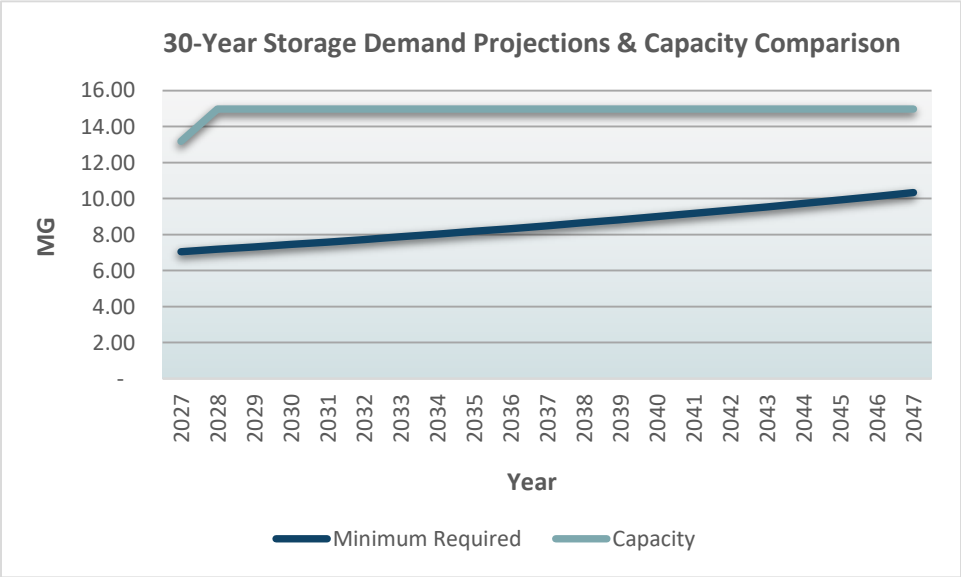
See Error! Reference source not found. and **Graph 6.2 - 30-Year Storage Demand Projections & Capacity Comparison** for a yearly comparison of the projected minimum required storage and system storage capacity.

Even though the system as a whole has nearly one and a half times the required storage, prior to the 10-year recommendations, some of the pressure zones had considerable excess storage while others were deficient, specifically the Foothills, White Cliffs, and Bull Mountain Zones. The three tanks proposed as part of the 10-Year recommended improvements addressed lack of storage within the Foothills, White Cliffs, and Bull Mountain Zones. However, some of the zones within the system are still lacking in storage redundancy, specifically, the Foothills, Rancho Santa Fe, and College Tank Zones. Having storage redundancy either within specific zones or across zones is especially important in fire flow conditions.

Table 6.6 - 30-Year Storage Demand Projections & Capacity Comparison

Year	Minimum Required Storage (MG)	Storage Capacity (MGD)	Addition (MGD)
2027	7.05	13.18	1.80
2028	7.18	14.98	
2029	7.31	14.98	
2030	7.45	14.98	
2031	7.59	14.98	
2032	7.73	14.98	
2033	7.87	14.98	
2034	8.02	14.98	
2035	8.18	14.98	
2036	8.33	14.98	
2037	8.49	14.98	
2038	8.66	14.98	
2039	8.83	14.98	
2040	9.00	14.98	
2041	9.18	14.98	
2042	9.36	14.98	
2043	9.54	14.98	
2044	9.73	14.98	
2045	9.93	14.98	
2046	10.13	14.98	
2047	10.33	14.98	

Graph 6.2 - 30-Year Storage Demand Projections & Capacity Comparison



6.5 BOOSTER PUMP ANALYSIS

Booster pumping capacity of the 30-year system was checked against booster pump criteria as defined in **Section 3.0 - Design Criteria**. Booster pumps must be able to supply peak hour demand with the largest pump out of service. Peak hour demand is 3.0 times average day demand. The booster pump capacity after the largest pump is taken out of service is the firm capacity. The firm capacity is calculated for every pump site. The firm capacity of the total system is the sum of the firm capacity for each pump site. In 2047, the projected booster pump capacity required is 37.40 million gallons per day, including the three (3) booster pump stations recommended in the 10-year system analysis; Long Mountain 1 which feeds the proposed the White Cliffs Tank, Rancho Santa Fe which feeds the proposed Northridge Tank, and College which feeds the Bull Mountain Tank. The system has a firm booster pump capacity of 37.02 million gallons per day. Therefore, the water system is just short of meeting booster pump capacity in the 30-year scenario. Starting at year 30 (2047), additional booster pump capacity may be required. For minimum required booster pump calculations, see **Table 6.7 – 30-Year Booster Pump Analysis**.

Table 6.7 – 30-Year Booster Pump Analysis

	Capacity	Firm Capacity*
Total Available Booster Capacity (GPM)	35,010	25,705
Total Available Booster Capacity (MGD)	**50.41**	**37.02**
Minimum Required (MGD)	-	37.40

**Largest Pump out of Service*

See **Table 6.8 - 30-Year Booster Pump Demand Projections & Capacity Comparison** and **Graph 6.3 - 30-Year Booster Pump Demand Projections & Capacity Comparison** for a yearly comparison of the projected minimum required booster pump capacity and system booster pump capacity.

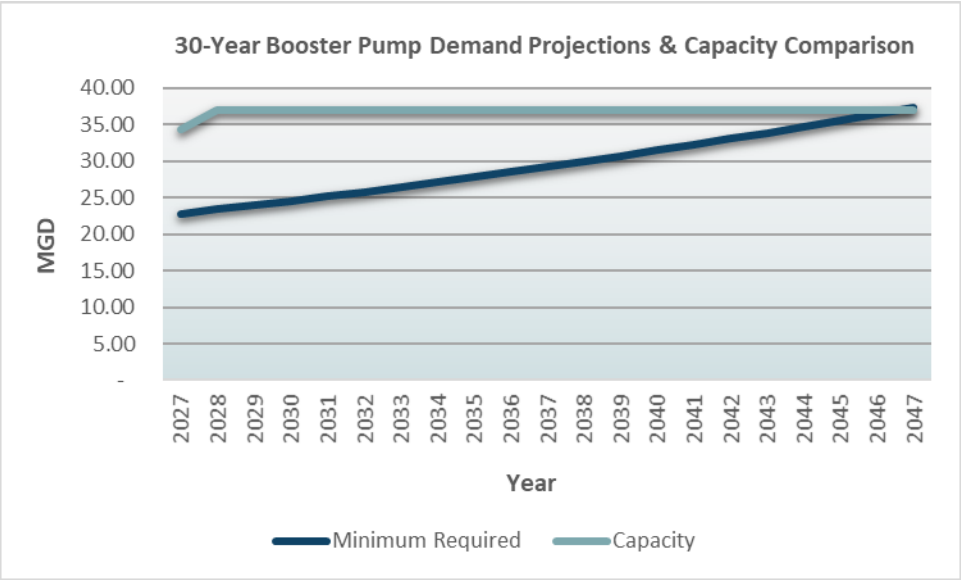
Booster pumps within the water system serve a variety of uses. The booster pumps within the existing system either feed directly to the distribution system, feed to the distribution system via PRV's, or boost to storage tanks within the system. Some booster pump stations have a combination of uses, such as the Rattlesnake Booster Station, in which two (2) of the booster pumps are dedicated to filling the Rancho Santa Fe Tank and two (2) of the booster pumps are dedicated to feeding the Rattlesnake Tank Zone.

The three booster pump stations included in the 10-Year recommended improvements feed tanks in the Foothills, White Cliffs, and Bull Mountain Zones. These tanks provide storage to zones in which there was previously a lack of storage. The booster pumps used to feed these proposed tanks contributed additional booster pump capacity to the system in zones where booster pumps were previously lacking.

Table 6.8 - 30-Year Booster Pump Demand Projections & Capacity Comparison

Year	Minimum Required Booster Pump Capacity (MGD)	Booster Pump Capacity (MGD)	Addition (MGD)
2027	22.82	34.42	2.60
2028	23.39	37.02	
2029	23.98	37.02	
2030	24.58	37.02	
2031	25.19	37.02	
2032	25.82	37.02	
2033	26.47	37.02	
2034	27.13	37.02	
2035	27.81	37.02	
2036	28.50	37.02	
2037	29.21	37.02	
2038	29.94	37.02	
2039	30.69	37.02	
2040	31.46	37.02	
2041	32.25	37.02	
2042	33.05	37.02	
2043	33.88	37.02	
2044	34.73	37.02	
2045	35.59	37.02	
2046	36.48	37.02	
2047	37.40	37.02	

Graph 6.3 - 30-Year Booster Pump Demand Projections & Capacity Comparison



6.6 DISTRIBUTION SYSTEM MODELING

A water model was constructed to simulate and analyze the projected 30-year distribution system. The projected 30-year system model uses the 10-year model as a foundation and modified for the 30-year projections and recommended improvements.

The storage tanks and wells that pump directly to the system were modeled as a constant head reservoir. Flow control valves were used on the output of the wells to limit the outflow to the actual flow rates provided by the City.

The models were run at average day, peak day, and peak hour demands scenarios. A fire flow analysis was also modeled on top of peak day flows. The model output for the demand scenarios includes the expected pressure at every node, the flow in pipes, and the reservoir flow. See **Appendix E – 30-Year Model & Junction Exhibits** for the existing model and junction exhibits of each demand scenario.

6.6.1 Pressure Zones

Given that the 30-year model was a copy of the 10-year system analysis model, the pressure zones in the model were set up as described in **Section 4.5.1 - Pressure Zones**. 30-year recommended improvements projects continue following the pressure zone realignments as described in **Section 3.9.3 - Proposed Pressure Zones**.

6.6.2 Flow Simulations

As discussed in **Section 3.9.1 - Flow Simulations**, steady state and fire flow simulations were conducted on the 30-year system. Steady state flow simulations were conducted on the system using average day, peak day, and peak hour demands.

Fire flow simulations were conducted on the system at peak day demand on nodes throughout the system (one at a time) to simulate the available fire flow at peak day demand. Model nodes were assigned a fire flow of 1,000 gallons per minute for residential fire flow demand and 3,500 gallons per minute for commercial and industrial fire flow demand. Fire flow was assigned to nodes based on existing infrastructure and the City of Kingman General Plan 2030 Projected Land Use Map. See **Figure 6.1 – 30-Year Fire Flow Demands** for a depiction of the fire flow assignments of the 30-year model.

Potential growth areas have been established with the use of the City of Kingman General Plan 2030 Figure 3-1 and City staff input. The potential growth areas determined were used as a guideline when proposing growth in the 30-year model and calculating zonal and junction demand therein. Pipe sizing for 30-year recommended improvements were governed by system demands for both steady state and fire flow scenarios.

6.7 IMPROVEMENT RECOMMENDATIONS & COST ESTIMATES

Based on the analysis performed as described in the previous sections, proposed improvement recommendations (storage tanks, booster pumps, PRV's, line extensions, line size increases, wells, etc.) have been developed to address the growth needs within the Existing water system boundary. Cost estimates for these improvements have been developed to serve as a guide for the construction of water system infrastructure as development occurs in the City. Proposed improvements projects within the 30-year analysis are not numbered as they are improvements solely based on need as dictated by growth within the City. Therefore, the order of these projects may change according to the development within potential growth areas.

The 30-year model was set-up very similarly to the 10-year system analysis model. The model was loaded with the system demands by separating demands according to the existing pressure zones. Then each zone's demand was divided amongst the nodes in that zone. The model consists of the distribution network of pipes, nodes, reservoirs, and flow valves per zone. In the model, the reservoirs provide an endless supply of water at a hydraulic grade line. The hydraulic grade lines in the model were set to equal the head provided by each specific well, tank, or booster pump.

The junction demand was allocated a little differently in the 30-year model than in any other model of the system. The model demand input for each junction is identified as flow in gallons per minute. For modeling purposes, a junction is considered the same as a node. As in the previous models, the total number of connections was determined for each zone and a zonal water demand was calculated by adding up the number of connections and multiplying that value by the average water usage per connection design criteria (312 gallons per connection per day). For the 30-year model; however, the "New Demand" was separated from the total demand. The new demand is the demand that was added to the system between the 10-year and 30-year models (years 2027-2047). In zones where no additional junctions are proposed for the 30-year model recommendations, the total demand is divided by the number of junctions in the zone. Alternatively, in zones where additional junctions are proposed in the 30-year model recommendations, the "New Demand" is divided by the number of "New Nodes" to determine the flow per new junction. Then, the remaining demand ("Total Demand" minus "New Demand") is divided by the number of existing nodes in the zone (the same number of junctions in the 10-year model) to determine the flow per existing junction. Once obtained, the flow per junction was entered into the model database. See **Table 6.9 – 30-Year Demand Calculations** and **Appendix E – 30-Year Model & Junction Exhibits** for model junction demands used.

Table 6.9 – 30-Year Demand Calculations

Zone	Number of Connections (2017)	Number of Connections (2027)	Number of Connections (2047)	Number of NEW Connections (2027-2047)	Total Demand (MGD)	Total Demand (GPM)	Percentage of Total	NEW Demand (MGD)	NEW Demand (GPM)	Number of EXISTING Nodes	Flow per EXISTING Junction (gpm)	Number of NEW Nodes	Flow per NEW Junction (gpm)
Foothills Zone	109	140	229	89	0.07	50	1%	0.03	19	58	0.9	0	-
Rancho Santa Fe Zone	777	995	1,630	635	0.51	353	4%	0.20	138	258	0.8	10	13.8
Hualapai Zone	789	1,010	1,655	645	0.52	359	4%	0.20	140	172	1.3	5	27.9
White Cliffs Zone	5	6	10	4	0.00	2	0%	0.00	1	7	0.2	3	0.3
Bull Mountain Zone	9	12	19	7	0.01	4	0%	0.00	2	10	0.2	2	0.8
Downtown 1 Zone	177	227	371	145	0.12	80	1%	0.05	31	64	1.3	0	-
Downtown 2 Zone	767	982	1,609	627	0.50	349	4%	0.20	136	306	1.1	0	-
Main Tank Zone	3,725	4,768	7,813	3,045	2.44	1,693	19%	0.95	660	1,021	1.0	17	38.8
Camel Ricca Snake Zone	4,677	5,987	9,810	3,823	3.06	2,126	24%	1.19	828	1,152	1.1	8	103.5
College Tank Zone	7,908	10,123	16,588	6,465	5.18	3,594	41%	2.02	1,401	1,032	2.1	15	93.4
Mohave Wash Zone	522	668	1,095	427	0.34	237	3%	0.13	92	50	2.9	20	4.6
Total	**19,465**	**24,917**	**40,829**	**15,912**	**12.74**	**8,846**	**100%**	**4.96**	**3,448**	**4,130**	**-**	**79**	**-**

Generally, flow per junction demand is considered the same across all areas of a zone even though high density subdivisions and low density large lot parcels typically experience different water usage rates. The model accounts for the difference in density by placing more junctions in areas of higher density and fewer junctions in areas of lower density. This naturally occurs as high density areas typically have more street and water line intersections that require nodes. For example, a high density subdivision will typically have more short blocks with nodes at each intersection which equates to a higher density of nodes in the project. Versus a low density development that may have one long half-mile street with two (2) nodes on each end that serve several lots. The only exception to this is the difference in new versus existing junction demand as discussed above.

The recommended improvements for the 30-year system include proposed booster pump stations, tanks, main water lines, well re-equipping, and pressure reducing valve stations. Proposed water lines within improvement projects, of which the main focus is to provide zone-specific infrastructure improvements for imminent growth, are assumed along the simplest alignments. These alignments may be subject to change according to development. Moreover, some of the proposed improvement projects show parallel mains along pressure zone boundaries. Parallel mains may not be necessary depending upon development; however, the intent of showing parallel mains is to emphasize the importance of keeping the pressure zones separated. Additionally, the cost of development of parallel mains is generally less than the construction and maintenance costs of a single main with PRV's on either side of the pressure zone boundary.

The existing City Well 1 will be re-equipped (activated) as part of the 30-year recommended improvements, which will act as a redundant source along with City Wells 4, 10, and 11 on the southeast quadrant of the City. There are no new wells proposed as part of the 30-year recommended improvements. Two of the proposed booster pump stations and storage tanks are intended to provide redundant source for zones within the system which were previously lacking, specifically the College Tank and Rancho Santa Fe Zones. Main Tank East is provided as additional storage on the east side of Route 66 in the Main Tank Zone. These improvements should be used to govern expansion and growth within the City. These recommendations should be reanalyzed as growth patterns change. See **Figure 6.2 – 30-Year Improvements Projects Overview** for recommended improvement to the system.

The total estimates cost for the 30-year recommended improvements is $58,745,800. See **Cost Estimate 6.1 – 30-Year Improvements Project Summary** for the proposed cost of the 30-year recommended improvements. It is important to note that these costs are very rough estimates and have been based on current (2017) unit prices, which should be adjusted on an annual basis.

As discussed in **Section 3.9.1 - Flow Simulations**, steady state and fire flow results are provided in this report for reference. See **Figure 6.3 – 30-Year Model – Peak Hour Results** for the steady state analysis results and **Figure 6.4 – 30-Year Model – Fire Flow Results** for the fire flow analysis results of the existing model. See **Appendix E – 30-Year Model & Junction Exhibits** for the existing model and junction exhibits of each demand scenario.

The City's proposed distribution network contains pipe sizes from 2-inch to 24-inch in diameter. Most of the piping within the system is 8-inch and larger. The proposed water system's infrastructure will be able to provide water to elevations of approximately 3200 to 3940. The proposed water system, which is divided into 11 pressure zones by PRV's and zone valves is depicted in **Figure 6.5 – Proposed System Schematic**.

An exhibit has been created as a quick-reference guide for the proposed water main sizing on the main streets within the City. This depicts the ultimate (30-year) water main size within the streets. See **Figure 6.6 – Proposed System Major Street Water Mains** for the proposed sizing of water mains in main streets within the City.

SUNRISE ENGINEERING, INC.
2152 S. Vineyard, Suite 123
Mesa, Arizona 85210
Tel: (480) 768-8600 Fax: (480) 768-8609

30-Year Improvements Preliminary Opinion of Probable Cost *

Cost Estimate: 6.1 - 30-Year Improvements Projects Summary
Owner: City of Kingman
Prepared By: CRC & TJM

Date
1/5/2018

No.	Item Description	Total	Unit	Unit Price**	Total
	Construction				
1	8" Water Line and Surface Restoration	23,034	LF	$55	$1,266,870
2	12" Water Line and Surface Restoration	216,051	LF	$100	$21,605,100
3	16" Water Line and Surface Restoration	47,087	LF	$125	$5,885,875
4	Water Valve, Box and Cover	572	EA	$2,500	$1,431,000
5	8" PRV Station	2	EA	$50,000	$100,000
6	12" PRV Station	11	EA	$75,000	$825,000
7	16" PRV Station	4	EA	$100,000	$400,000
8	Booster Pump Station	2	EA	$250,000	$500,000
9	Tank	4,000,000	GAL	$1	$4,000,000
10	Well Drilling	1	EA	$250,000	$250,000
11	Well Equipping	2	EA	$750,000	$1,500,000
12	Site Property Acquisition	3	AC	$50,000	$150,000
				Construction Subtotal	**$37,913,845**
				Traffic Control (5% of Total)	$1,895,692
				Construction Administration (5% of Total)	$1,895,692
				Mobilization (15% of Total)	$5,687,077
				Construction Total	**$47,392,306**
				Final Engineering and Permitting (10% of Total)	$4,739,231
				Contingency (20% of Total)	$9,479,409
				Project Total	**$61,611,100**

*In providing opinions of probable construction cost the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as the accuracy if such opinions compared to bid or actual costs.

**Unit prices are based on current (2017) estimated costs and should be adjusted on an annual basis.

SECTION 6 FIGURES

Figure 6.1 – 30-Year Fire Flow Demands

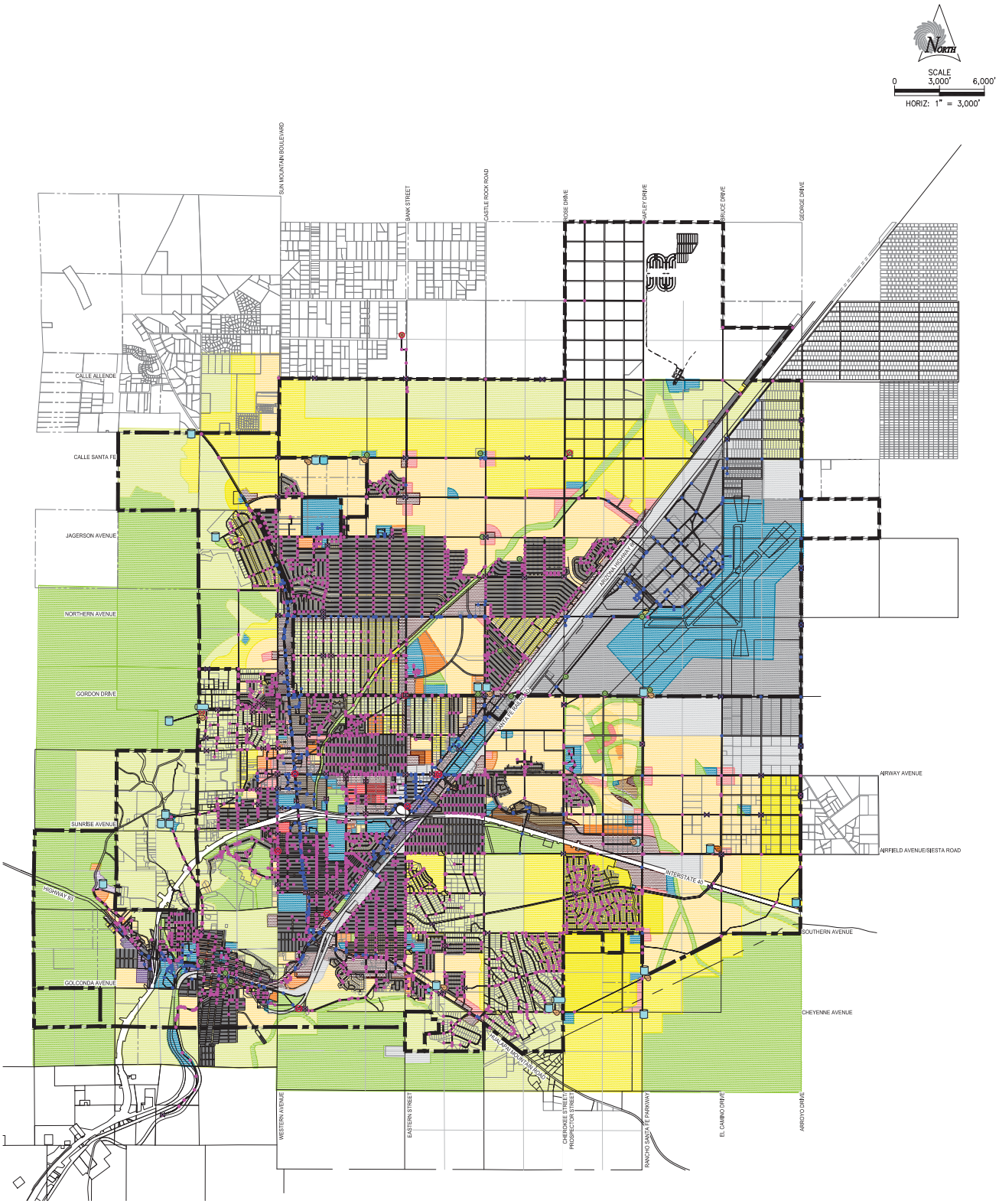
Figure 6.2 – 30-Year Improvements Projects Overview

Figure 6.3 – 30-Year Model – Peak Hour Results

Figure 6.4 – 30-Year Model – Fire Flow Results

Figure 6.5 – Proposed System Schematic

Figure 6.6 – Proposed System Major Street Water Mains



LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING PROPOSED

- WELL
- INACTIVE WELL
- BACKUP WELL
- TANK
- PNEUMATIC TANK
- BOOSTER PUMP
- PRESSURE REDUCING VALVE (PRV)
- INACTIVE PRV
- ZONE VALVE
- CHECK VALVE

- 1,000 GPM (RESIDENTIAL)
- 3,500 GPM (COMMERCIAL & INDUSTRIAL)

LAND USE DESIGNATION LEGEND

- RURAL DENSITY RESIDENTIAL (1 DU OR LESS/AC)
- LOW DENSITY RESIDENTIAL (1–2 DU/AC)
- MEDIUM DENSITY RESIDENTIAL (3–8 DU/AC)
- INTERMEDIATE DENSITY RESIDENTIAL (9–16 DU/AC)
- HIGH DENSITY RESIDENTIAL (17–28 DU/AC)
- NEIGHBORHOOD COMMERCIAL
- COMMUNITY COMMERCIAL
- REGIONAL COMMERCIAL
- HIGHWAY SERVICE COMMERCIAL
- LIGHT INDUSTRIAL
- MANUFACTURING INDUSTRIAL
- PUBLIC/QUASI–PUBLIC
- PARKS/OPEN SPACE

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 6.1
30-YEAR
FIRE FLOW DEMANDS

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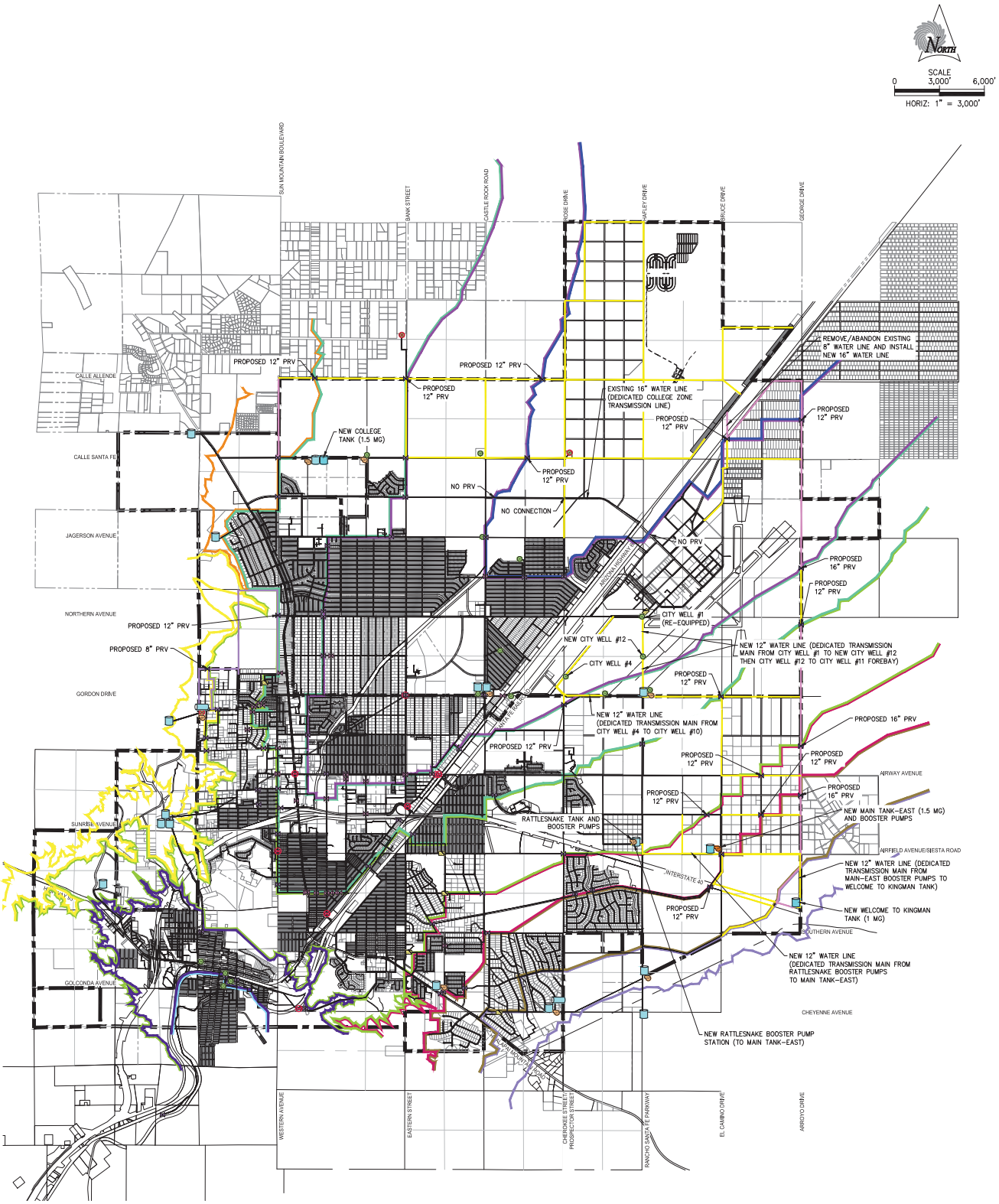

LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE

- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE

PRESSURE ZONE LEGEND

- FOOTHILLS ZONE
- RANCHO SANTA FE ZONE
- HUALAPAI ZONE
- WHITE CLIFFS ZONE
- BULL MOUNTAIN ZONE
- DOWNTOWN ZONE 1
- DOWNTOWN ZONE 2
- MAIN TANK ZONE
- RATTLESNAKE ZONE
- COLLEGE TANK ZONE
- MOHAVE WASH ZONE
- AREA NOT LIKELY TO BE DEVELOPED (PER WWMP)

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 6.2
30-YEAR IMPROVEMENTS
PROJECTS OVERVIEW

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MESA, ARIZONA 85210
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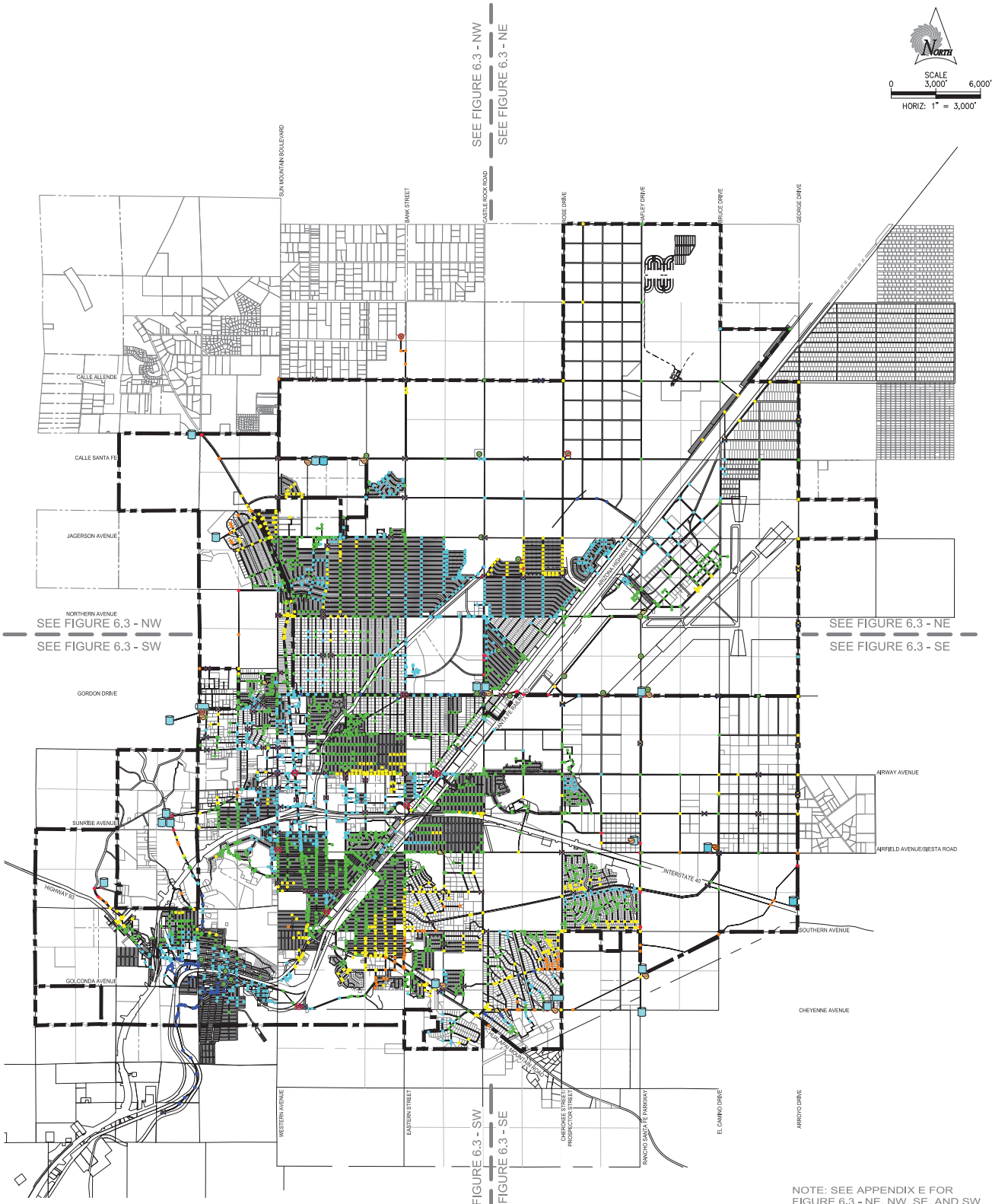

NOTE: SEE APPENDIX E FOR FIGURE 6.3 - NE, NW, SE, AND SW

LEGEND

CITY BOUNDARY	
STUDY LIMITS (WATER BOUNDARY)	
EXISTING / PROPOSED	
WELL	
INACTIVE WELL	
BACKUP WELL	
TANK	
PNEUMATIC TANK	
BOOSTER PUMP	
PRESSURE REDUCING VALVE (PRV)	
INACTIVE PRV	
ZONE VALVE	
CHECK VALVE	

< 20.00 PSI
20.00 – 40.00 PSI
40.00 – 60.00 PSI
60.00 – 80.00 PSI
80.00 – 100.00 PSI
> 100.00 PSI

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 6.3
30-YEAR MODEL
PEAK HOUR RESULTS

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MESA, ARIZONA 85210
TEL 480.768.8600 · FAX 480.768.8609
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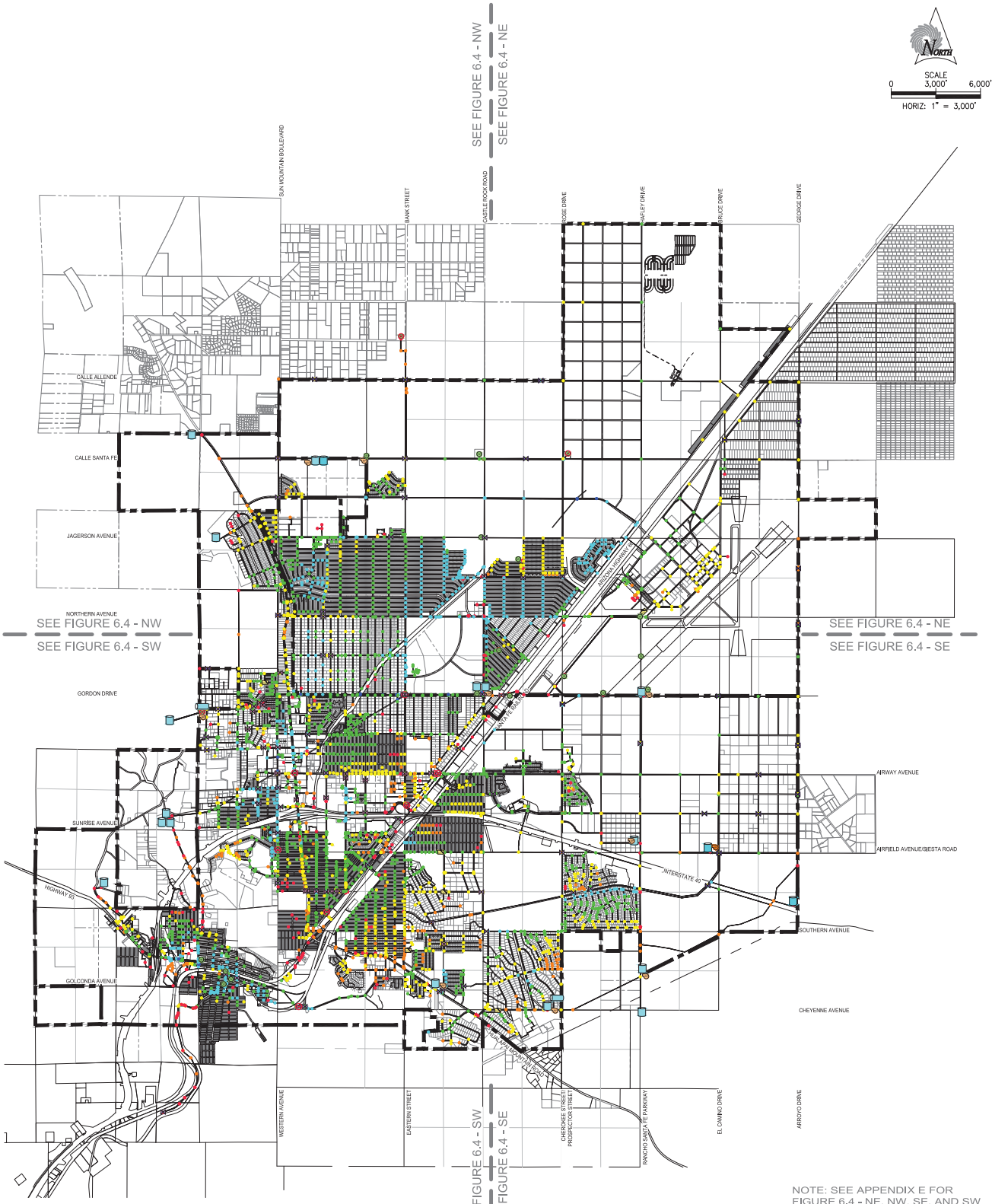

NOTE: SEE APPENDIX E FOR FIGURE 6.4 - NE, NW, SE, AND SW

LEGEND

	CITY BOUNDARY
	STUDY LIMITS (WATER BOUNDARY)
EXISTING / PROPOSED	WELL
	INACTIVE WELL
	BACKUP WELL
	TANK
	PNEUMATIC TANK
	BOOSTER PUMP
	PRESSURE REDUCING VALVE (PRV)
	INACTIVE PRV
	ZONE VALVE
	CHECK VALVE

- < 20.00 PSI
- 20.00 – 40.00 PSI
- 40.00 – 60.00 PSI
- 60.00 – 80.00 PSI
- 80.00 – 100.00 PSI
- > 100.00 PSI

CITY OF KINGMAN
FOUNDED 1882

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 6.4
30-YEAR MODEL
FIRE FLOW RESULTS

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MESA, ARIZONA 85210
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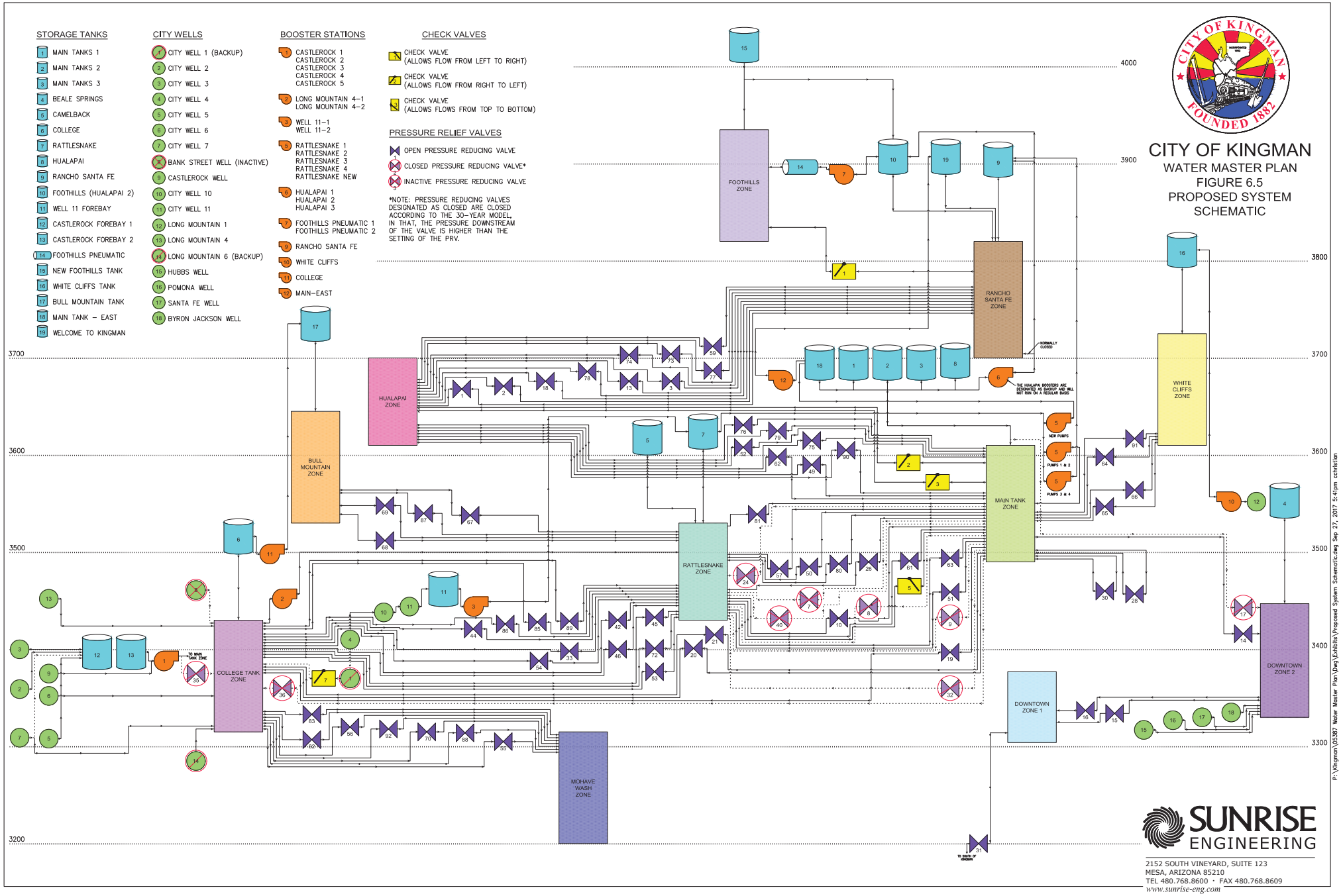
STORAGE TANKS
1 MAIN TANKS 1
2 MAIN TANKS 2
3 MAIN TANKS 3
4 BEALE SPRINGS
5 CAMELBACK
6 COLLEGE
7 RATTLESNAKE
8 HUALAPAI
9 RANCHO SANTA FE
10 FOOTHILLS (HUALAPAI 2)
11 WELL 11 FOREBAY
12 CASTLEROCK FOREBAY 1
13 CASTLEROCK FOREBAY 2
14 FOOTHILLS PNEUMATIC
15 NEW FOOTHILLS TANK
16 WHITE CLIFFS TANK
17 BULL MOUNTAIN TANK
18 MAIN TANK – EAST
19 WELCOME TO KINGMAN
CITY WELLS
1 CITY WELL 1 (BACKUP)
2 CITY WELL 2
3 CITY WELL 3
4 CITY WELL 4
5 CITY WELL 5
6 CITY WELL 6
7 CITY WELL 7
8 BANK STREET WELL (INACTIVE)
9 CASTLEROCK WELL
10 CITY WELL 10
11 CITY WELL 11
12 LONG MOUNTAIN 1
13 LONG MOUNTAIN 4
14 LONG MOUNTAIN 6 (BACKUP)
15 HUBBS WELL
16 POMONA WELL
17 SANTA FE WELL
18 BYRON JACKSON WELL
BOOSTER STATIONS
1 CASTLEROCK 1
CASTLEROCK 2
CASTLEROCK 3
CASTLEROCK 4
CASTLEROCK 5
2 LONG MOUNTAIN 4–1
LONG MOUNTAIN 4–2
3 WELL 11–1
WELL 11–2
5 RATTLESNAKE 1
RATTLESNAKE 2
RATTLESNAKE 3
RATTLESNAKE 4
RATTLESNAKE NEW
6 HUALAPAI 1
HUALAPAI 2
HUALAPAI 3
7 FOOTHILLS PNEUMATIC 1
FOOTHILLS PNEUMATIC 2
9 RANCHO SANTA FE
10 WHITE CLIFFS
11 COLLEGE
12 MAIN–EAST
CHECK VALVES
CHECK VALVE (ALLOWS FLOW FROM LEFT TO RIGHT)
CHECK VALVE (ALLOWS FLOW FROM RIGHT TO LEFT)
CHECK VALVE (ALLOWS FLOWS FROM TOP TO BOTTOM)
PRESSURE RELIEF VALVES
OPEN PRESSURE REDUCING VALVE
CLOSED PRESSURE REDUCING VALVE*
INACTIVE PRESSURE REDUCING VALVE
*NOTE: PRESSURE REDUCING VALVES DESIGNATED AS CLOSED ARE CLOSED ACCORDING TO THE 30–YEAR MODEL, IN THAT, THE PRESSURE DOWNSTREAM OF THE VALVE IS HIGHER THAN THE SETTING OF THE PRV.
CITY OF KINGMAN
FOUNDED 1882
CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 6.5
PROPOSED SYSTEM SCHEMATIC
4000
3900
3800
3700
3600
3500
3400
3300
3200
FOOTHILLS ZONE
RANCHO SANTA FE ZONE
NORMALLY CLOSED
THE HUALAPAI BOOSTERS ARE DESIGNATED AS BACKUP AND WILL NOT RUN ON A REGULAR BASIS
WHITE CLIFFS ZONE
HUALAPAI ZONE
BULL MOUNTAIN ZONE
MAIN TANK ZONE
NEW PUMPS
PUMPS 1 & 2
PUMPS 3 & 4
RATTLESNAKE ZONE
COLLEGE TANK ZONE
TO MAIN TANK ZONE
DOWNTOWN ZONE 1
DOWNTOWN ZONE 2
MOHAVE WASH ZONE
TO SOUTH OF KINGMAN
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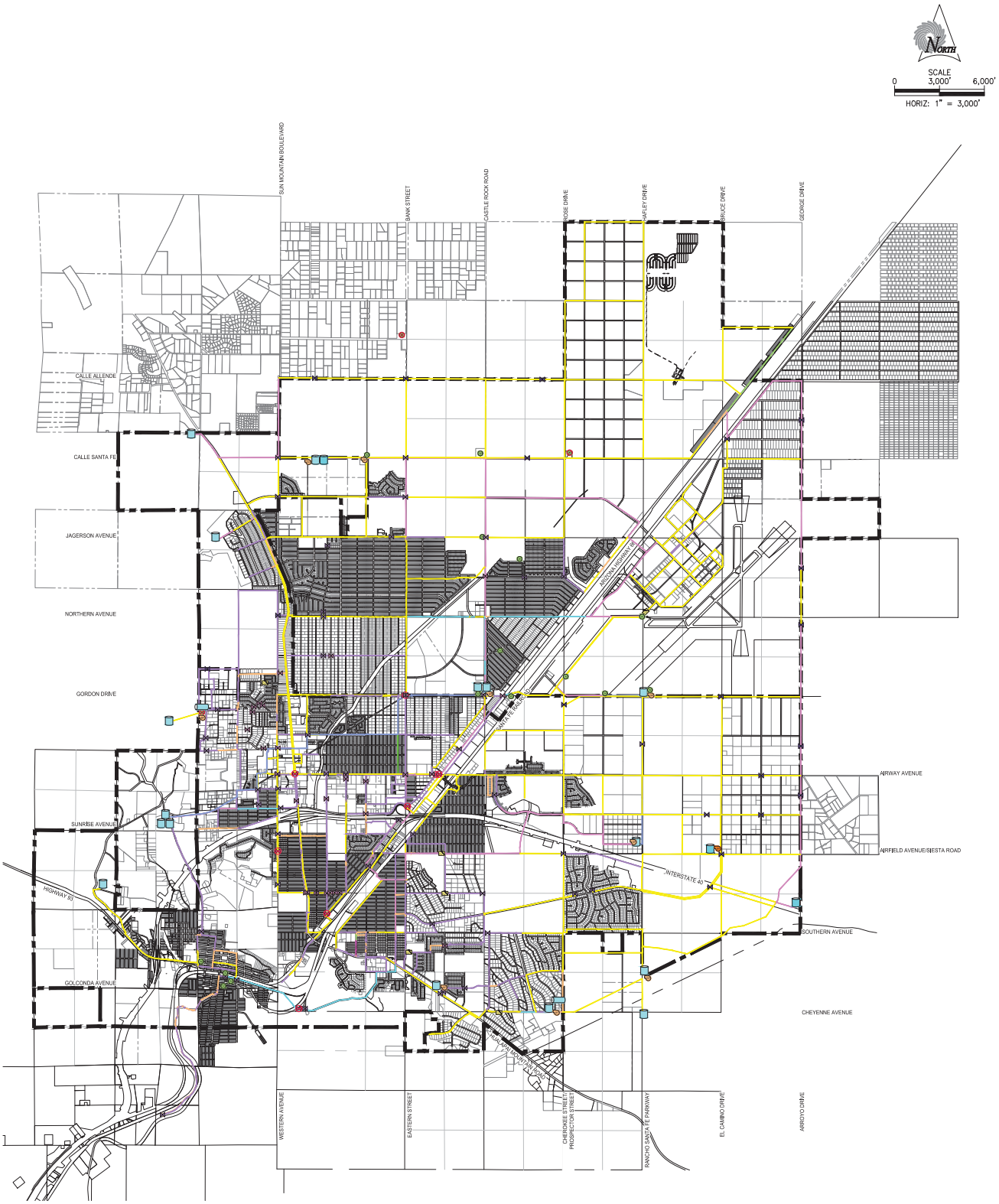

LEGEND

- CITY BOUNDARY
- STUDY LIMITS (WATER BOUNDARY)

EXISTING	PROPOSED	
		WELL
		INACTIVE WELL
		BACKUP WELL
		TANK
		PNEUMATIC TANK
		BOOSTER PUMP
		PRESSURE REDUCING VALVE (PRV)
		INACTIVE PRV
		ZONE VALVE
		CHECK VALVE

- 2" WATER PIPE
- 3" WATER PIPE
- 4" WATER PIPE
- 6" WATER PIPE
- 8" WATER PIPE
- 10" WATER PIPE
- 12" WATER PIPE
- 14" WATER PIPE
- 16" WATER PIPE
- 18" WATER PIPE
- 20" WATER PIPE
- 24" WATER PIPE

CITY OF KINGMAN
WATER MASTER PLAN
FIGURE 6.6
PROPOSED SYSTEM MAJOR STREET
WATER MAIN SIZING

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MESA, ARIZONA 85210
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7.0 CONCLUSION

The City of Kingman contracted with Sunrise Engineering, Inc. to analyze and model the existing water system and create a Water System Master Plan from the results. This Water Master Plan evaluated the existing water system, developed existing (2017), 10-year, and 30-year water model scenarios as well as the proposed improvements recommended for each scenario. The Water System Master Plan was created as a follow-up to the *Water System Master Plan* completed by C5 Engineering, Inc. in May of 2005.

An inventory of the existing water system was performed to determine its capacity of wells, storage tanks, and booster pumps. The City provided data for the existing water system and maps of the distribution system for the basis of the existing model, as well as historical usage data for water system demand calculations. Projections for population, source, storage, and booster pump demands were calculated, per established design criteria, for each scenario and compared to capacities based on recommended improvements to the water system. Four water models were created using the Innovyze software H_2ONET Analyzer as part of the analysis of the City of Kingman water system; the existing model (without improvements), the existing model (with improvements), the 10-year, and the 30-year model. Steady state and fire flow simulations were conducted on the water system for each scenario.

The existing system was evaluated and found to not be lacking in source, storage, or booster pump capacity, but in the location and efficiency of such infrastructure. The existing water distribution system had large areas that were deficient in fire flow pressures. Existing pressure zones were redefined to aide in maximizing the efficiency of the system. A prioritized list of proposed improvement recommendations, coupled with cost estimates for each, were developed to address deficiencies, lack of redundancy, as well as expected growth within the existing water system boundary. The total estimated cost for existing improvements proposed was $57,136,500.

The proposed 10-year water system was analyzed and compared to the design criteria in regards to available water system source, storage, and booster pump demands. Projected demand for source, storage, and booster pump capacity was based on projected connections throughout the system and it was determined that the proposed system has sufficient capacity of each. However, even with the existing system improvements, it was concluded that the location of the infrastructure within the system was not optimum, such that the capacity of source, storage, and booster pumps were unevenly distributed between pressure zones. A list of proposed improvement recommendations, coupled with cost estimates for each, were developed to address deficiencies, lack of redundancy, as well as expected development within the proposed growth areas of the 10-year system. The total estimated cost for 10-year system improvements proposed was $61,870,300.

Similar to the 10-year water system, the proposed 30-year water system was analyzed and compared to the design criteria in regards to available water system source, storage, and booster pump demands. Projected demand for source, storage, and booster pump capacity was based on projected connections throughout the system and it was again determined that the proposed system has sufficient capacity of each. However, additional infrastructure was proposed for long-term sustained growth within the water system. Proposed recommendation for the 30-year system were solely based on need as dictated by growth within the City. The total estimated cost for 30-year recommended improvements was $58,745,800.

8.0 REFERENCES

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