PINE-STRAWBERRY WATER IMPROVEMENT DISTRICT

PRELIMINARY ENGINEERING REPORT FOR WATER DISTRIBUTION SYSTEM IMPROVEMENTS

April 2019

125 S. AVONDALE BOULEVARD
SUITE 115
AVONDALE, ARIZONA 85323
623. 547.4661

PINE-STRAWBERRY WATER IMPROVEMENT DISTRICT
PRELIMINARY ENGINEERING REPORT FOR
WATER DISTRIBUTION SYSTEM IMPROVEMENTS

TABLE OF CONTENTS

CHAPTER 3 – NEED FOR PROJECT

CHAPTER 6 – PROPOSED PROJECT (RECOMMENDED ALTERNATIVE)

CHAPTER 7 – CONCLUSIONS AND RECOMMENDATIONS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

PROJECT PLANNING

1.1 INTRODUCTION

This chapter presents a general geographic and historical description of the project area under consideration. The description includes scale maps and photographs of the area and the existing service areas, including legal and natural boundaries and a topographical map of the Pine-Strawberry Water Improvement District ("PSWID" or "District") service area. This chapter also presents maps and narrative descriptions of the environmental and water resources present in the planning area that affect the design of the project. Finally, this chapter outlines PSWID's proposed approach to engage the community in the project planning process.

The PSWID is a non-transient community water system in the northwest region of Gila County, Arizona and provides potable water service to the unincorporated communities of Pine and Strawberry. Today's system was developed gradually beginning in the 1960s as development of the area accelerated. The various stand-alone water systems were operated for many years as private water companies and cooperatives before the PSWID was created.

The system encompasses approximately 10.1 square miles of service area. The system operates under the authority of the Arizona Department of Environmental Quality (ADEQ) as system number AZ0404034 and is classified as a Grade 2 Water Distribution System. The system also operates under the Arizona Department of Water Resources (ADWR) as Community Water System number 91-000135.0000. The District was formed by Gila County on June 2, 1996 by County resolution number 96-6-12 and recorded as document number 96-011964. The District is a public water system governed by an elected seven-member Board of Directors and began operating the water system on October 1, 2009.

The District provides water that is supplied exclusively by groundwater pumped from the District's wells drawn from the Lower Verde watershed. In 2017, PSWID produced 319.92 acre-feet (104.2 million gallons) of water to serve its 3,148 service connections. The water is produced, stored, and delivered through a complex network of 23 wells and 9 water sharing agreements, 1.311 million gallons of water in 22 storage tanks, 24 booster stations, and more than 58 miles of water mains.

The majority of residential units in Pine and Strawberry are seasonal and not occupied throughout the year. Consequently, the demand for water in the Pine and Strawberry communities is very seasonal, with the months of June through September representing the highest demand months of the year. It is interesting to note that the average demand for the month of August is less than that of September, indicating that some of the population leaves the area in August and returns in September.

The District, by virtue of being a water provider in northern Gila County, has rights to the surface water that is developed by the C.C. Cragin Dam and Reservoir, formerly known as Blue Ridge Reservoir. The Town of Payson is in the final stages of building a system to move the C.C. Cragin Reservoir water to its location and utilize it in the Town's water system. As a part of the planning for the Payson project, some feasibility analysis of the use of the remaining 500 acre-feet per year of this surface water source by the District and other water providers was completed in 2006 and is discussed in detail in section 1.6.1 of this report.

1.2 LOCATION AND GENERAL DESCRIPTION

The District's service area and the communities of Pine and Strawberry are located along Highway 87 (Arizona 260) approximately 16 miles northwest of the Town of Payson. A map showing the general location of the PSWID is included as Figure 1.1.

1.2.1 Legal Boundaries and Service Areas Map

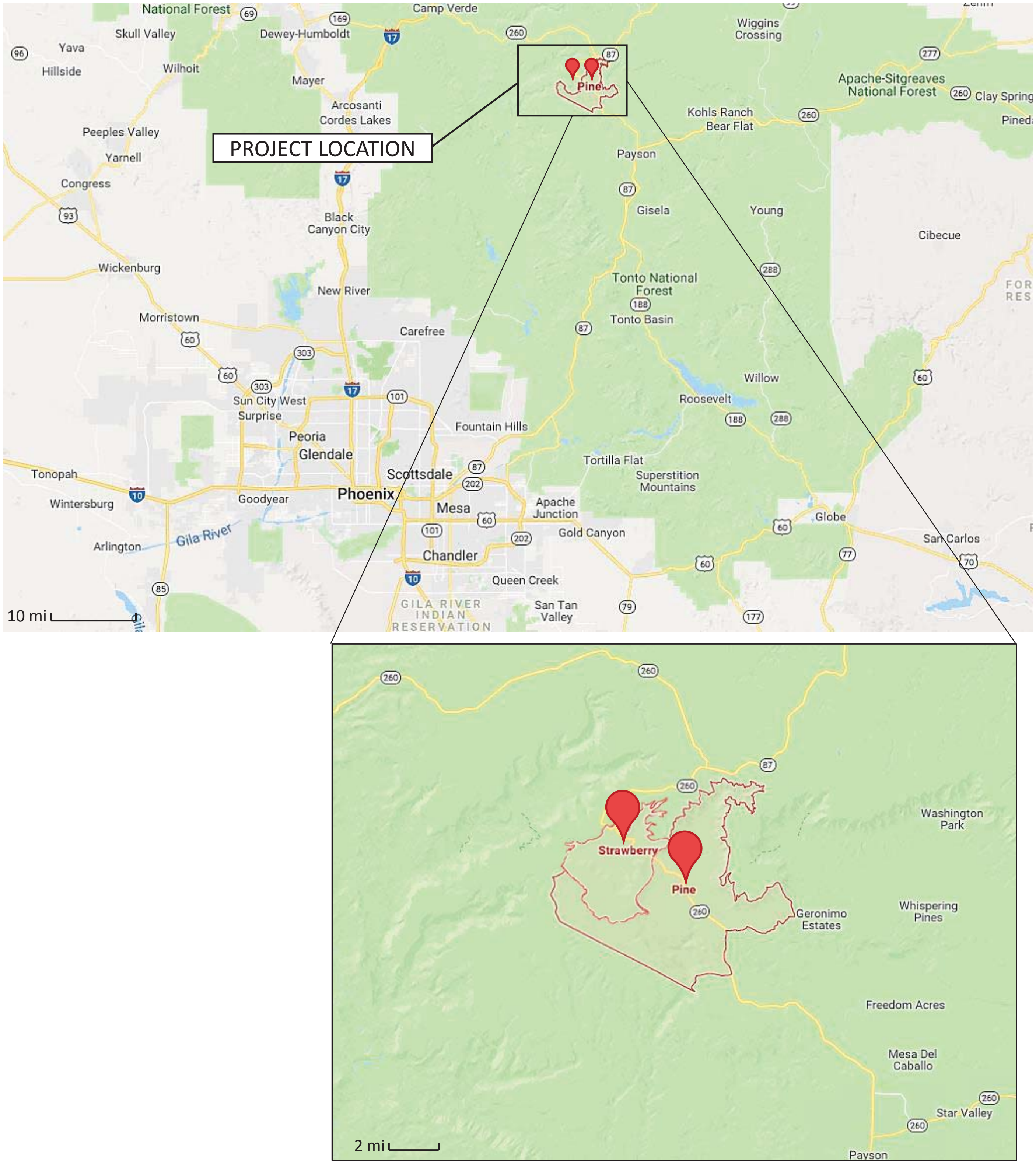
The projects under consideration by this Preliminary Engineering Report are located throughout the service area of the PSWID. Figure 1.2 shows the current service areas of PSWID, which are congregated into two main geographic areas that correspond closely with the communities of Pine and Strawberry, neither of which are incorporated municipalities. The District serves customers on private lands that are surrounded by the Tonto National Forest.

1.2.2 Service Area Topographical Map

The PSWID service area is located in the mountainous terrain below the Mogollon Rim in north-central Arizona. Thus, the topography varies greatly, ranging from 5,300 feet to 6,400 feet elevation above sea level. In addition, the system developed gradually over time with each residential subdivision building a separate, stand-alone water system with little or no redundancy, all of which were ultimately included in the current PSWID system. This gradual development combined with the wide range of elevations within the service results in a total of 27 separate pressure zones, 20 in the Strawberry system and 7 in the Pine system. Many of these pressure zones operate at similar pressures, but their physical separation due to distance and topography prevent them from being combined into larger and fewer zones. Figure 1.3 shows the topography of the service area. Figure 1.4 shows the pressure zones.

1.3 ENVIRONMENTAL RESOURCES PRESENT

It is an important goal of any infrastructure project to protect the environment within which it is developed, operated and maintained. The PSWID and its consultants and contractors must utilize good design, construction and management tools to ensure that the environment is protected for the benefit of the current and future residents of the area and those who travel to the PSWID area for recreation. While the PSWID is providing one of the most basic of human needs, good quality drinking water, it must do so in a manner that balances the needs of its customers with protection of the environment. Thus, the District must strive to achieve sustainability in its operations.



GENERAL LOCATION MAP

FIGURE 1.1

PINE STRAWBERRY WATER IMPROVEMENT DISTRICT

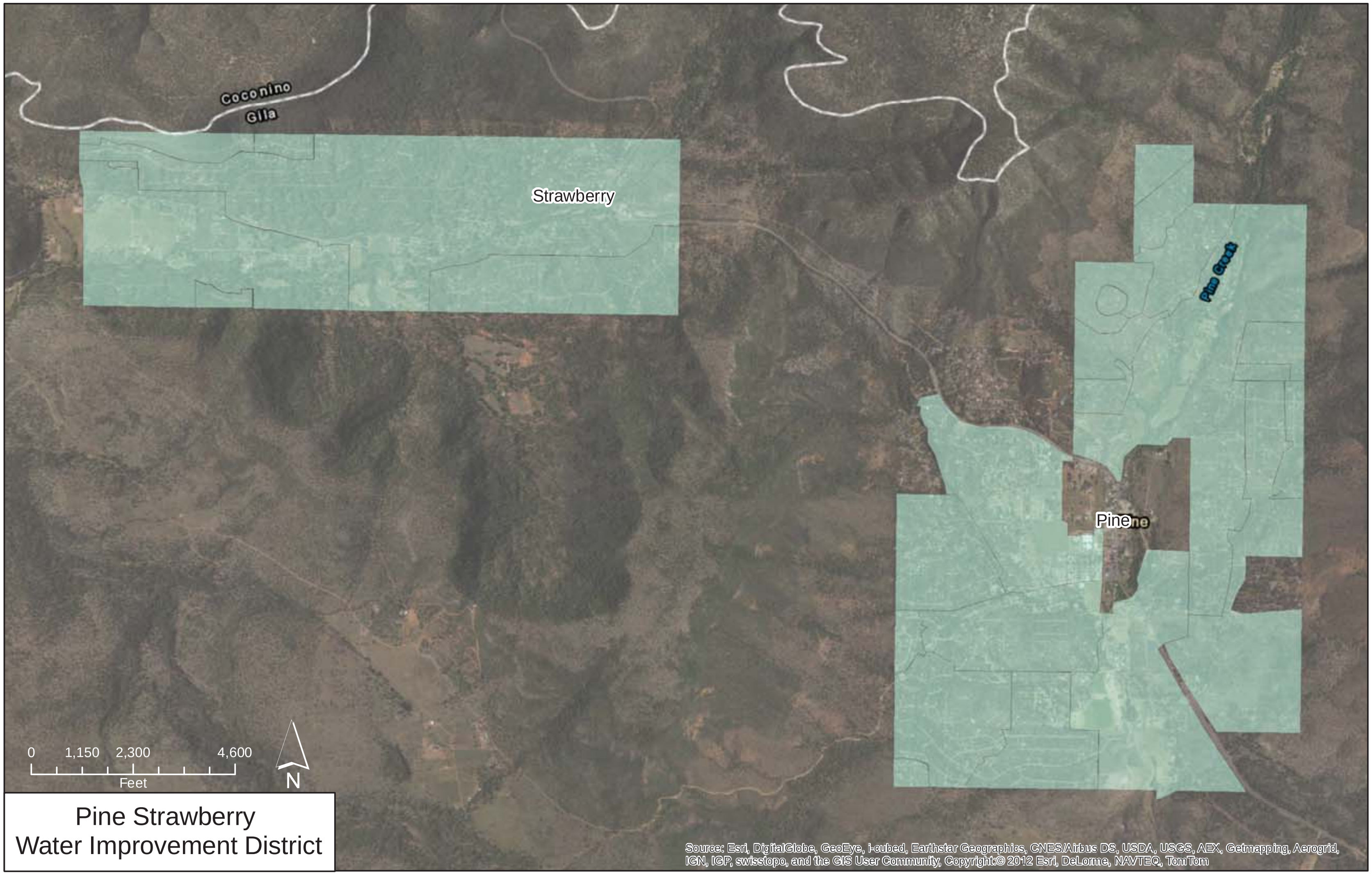
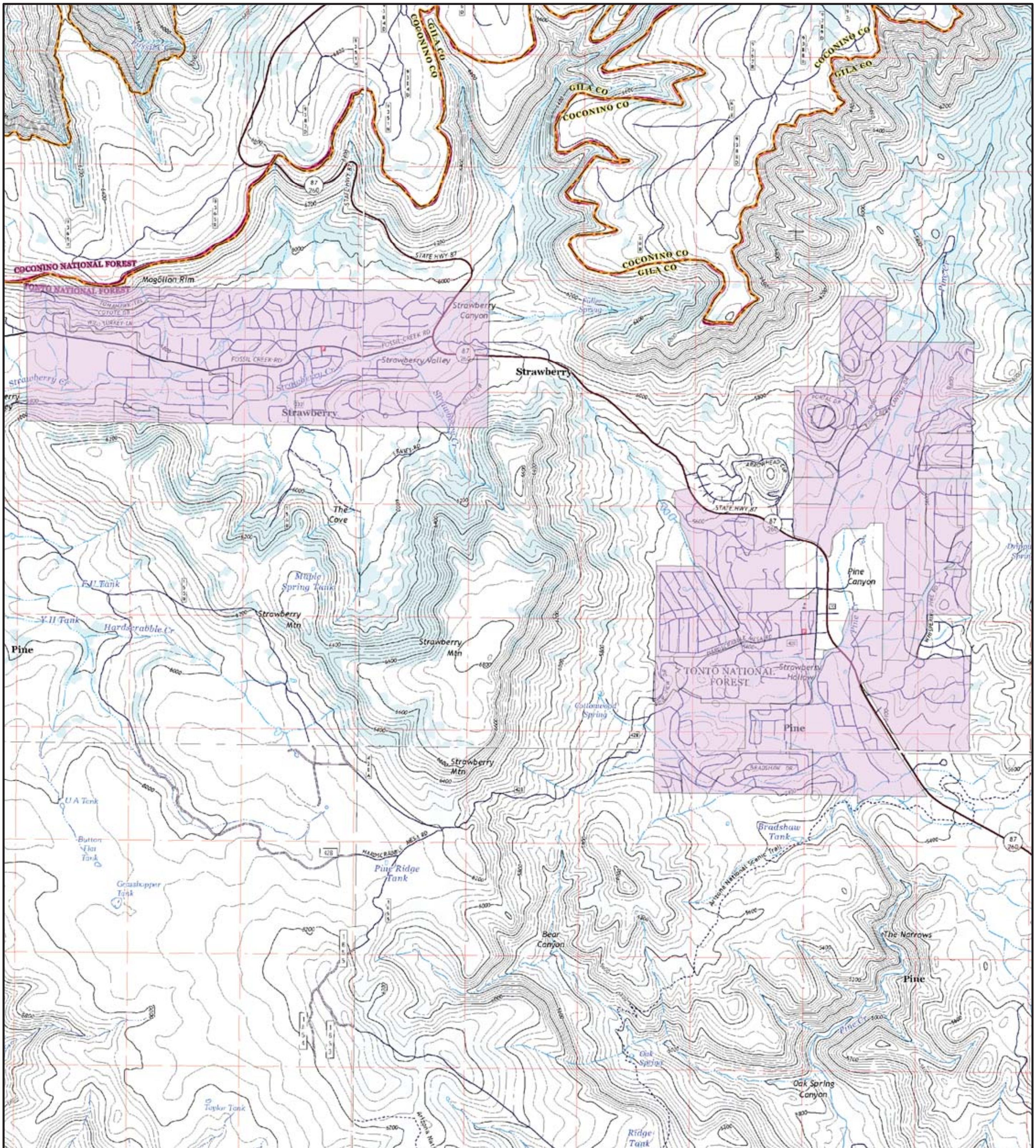


FIGURE 1.2
Service Area Map



SERVICE AREA TOPOGRAPHICAL MAP

FIGURE 1.3

N

0 1,750 3,500 7,000 Feet

PINE STRAWBERRY WATER IMPROVEMENT DISTRICT

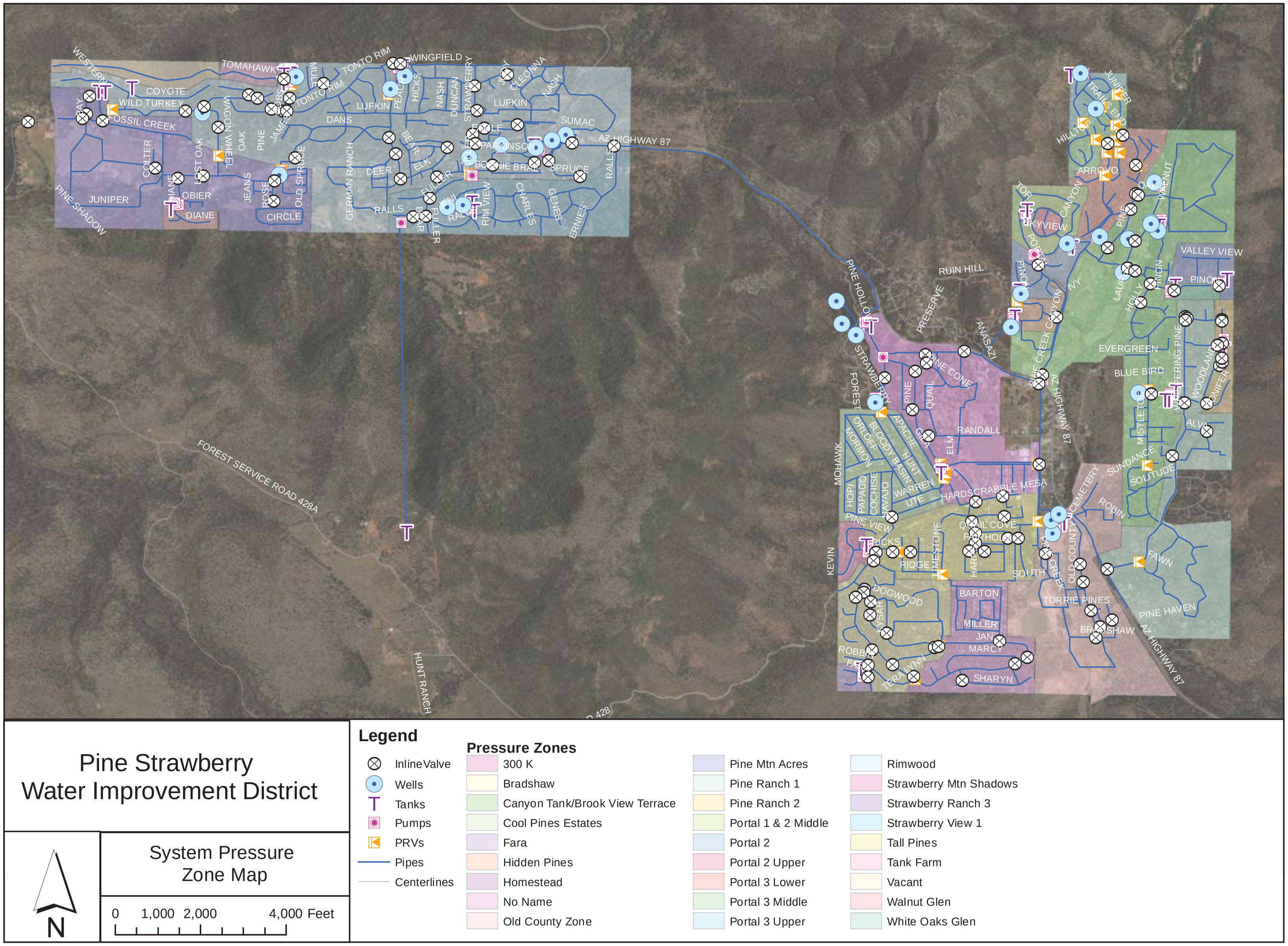


FIGURE 1.4
Pressure Zone Map

1.3.1 Environmental Resources That Affect Project Design

Native American Tribal Reservations: There are no Native American tribal reservations located within or adjacent to the boundaries of the PSWID. The closest reservations are the Tonto Apache near the Town of Payson (17 miles east of PSWID) and the Yavapai-Apache Indian Community near the Town of Camp Verde (50 miles west of PSWID).

Endangered Species: The list of Federal Threatened, Endangered, and Candidate Species that are native to the PSWID service area and the surrounding Tonto National Forest is found in Appendix A – PSWID Area Endangered Species List.

Government Land: The private land served by the PSWID is surrounded by the Tonto National Forest. Water system improvements or ancillary facilities cannot be sited on national forest lands. Any facilities designed and constructed adjacent (contiguous) to either national forest land cannot encroach, require easements, or cause any detrimental environmental effect on the land.

Recreational Areas: The Tonto National Forest completely surrounds the District's service area and contains 4,489 square miles. Due to seasonal variations and varying climate conditions, Tonto National Forest offers a multitude of recreational opportunities. Activities include hiking, camping, canyoneering, horseback riding, fishing, kayaking, motorized watercraft, jeep trails, road biking, and mountain biking. Lakes located within the Tonto National Forest include Bartlett Lake, Saguaro Lake, Canyon Lake, Apache Lake and Roosevelt Lake. Many of these lakes offer marina facilities and camping. Smaller lakes known for cool weather fishing are located above the Mogollon Rim and include Woods Canyon, Willow Springs, Bear Canyon, Knoll, Chevelon Canyon, Black Canyon, Blue Ridge, Long, and Hawley. An Arizona State Park, called Tonto Natural Bridge, is located less than eight miles east of the District on Highway 87.

Lakes and Rivers: The region surrounding the PSWID service area includes many ephemeral rivers and creeks that flow during summer rain storms and spring snowmelt. However, only two rivers in the region flow year around; the Verde River and the Salt River. Fossil Creek and the East Verde River drain much of the land within and around the District boundaries. Both of those rivers are tributary to the Verde River, which flows by the District area approximately 13 miles to the southwest. The Verde River is tributary to the Salt River and the two join at a location approximately 70 miles south of the District Boundary.

1.4 POPULATION TRENDS

1.4.1 U.S. Census and Population Data

PSWID serves the unincorporated communities of Pine and Strawberry, Arizona. These two communities are recognized as Census-Designated Places ("CDPs") by the United States Census Bureau for statistical purposes only. CDPs have been used in each decennial census since 1980 as the counterparts of incorporated places, such as self-governing cities, towns, and villages, for the purposes of gathering and correlating statistical data. CDPs are populated areas that generally include one officially designated but currently unincorporated small community, for which the CDP is named, plus surrounding inhabited countryside of varying dimensions and, occasionally, other, smaller unincorporated communities as well.

1.4.2 Population Projections for Project Planning Area

The Arizona Office of Economic Opportunity has the mission "To provide reliable unbiased projections of future population growth and a single state repository for current population references enabling sound planning and decision making by government and private entities." The AOEO has provided state and county population projections for the period 2015 to 2050. These projections are provided at the following website: https://population.az.gov/population-projections

These projections include 2016 to 2050 sub-county projections for CDPs, including Pine and Strawberry. For the community of Pine, the 2000 census population was 1,931 and the 2010 census population was 1,963. That population is estimated to grow to 1,997 in 2015. After 2015, the AOEO projections show that the population of Pine will slightly decline to 1,971 by 2025 and to 1,861 by 2050.

For the Strawberry CDP, the 2000 census population was 1,028 and the 2010 census population was 961. That population is estimated to grow to 978 in 2015. After 2015, the AOEO projections show that the population of Strawberry will slightly decline to 965 by 2025 and to 911 by 2050.

These population forecasts would indicate that these communities are fully built and that no future growth would occur, unless existing constraints were relaxed. These constraints could include current zoning laws, lack of private land for development, lack of community wastewater collection and treatment systems, and a bias against densification within the current community. Vacant developable parcels of land exist within both communities and it is unclear why they have not yet developed.

It is important to note that the population figures reported by the AOEO are the **permanent residents of the community**, in keeping with US Census methodologies. The Gila County Comprehensive Plan reports that **approximately 55 percent of the housing units in both Pine and Strawberry are seasonal units**. When seasonal units are occupied, there is a trend toward a higher number of persons per unit than would be present during the off-season, i.e. winter. These two factors help to explain why the combined population of about 3,000 persons for the two communities reported by the State balloons to an estimated 8,000 persons served by PSWID during their highest demand days.

In December 2014, CH2MHill, under contract with the District, completed a Water System Master Plan ("Master Plan"). The Master Plan projected future growth in the system, but this projection was based on observed vacant land and expected land use, not population projections. Gila County's parcel GIS file, along with aerial photographs, was utilized by the Master Plan author to determine existing vacant land. The land use category from the parcel file, as well as aerial photographs, were utilized to determine overall land use and the density of each use expressed as the number of dwelling units per acre (du/acre) for residential land use for each vacant parcel. The vacant parcel and land use information were used in conjunction with a water duty factor (gallons per day per acre (gpd/acre)) to develop future demand. This analysis determined that the build-out conditions for the system will add an average demand of 72,000 gallons per day (gpd) or 50 gallons per minute (gpm). The Master Plan reported the average day demand during the years 2010 to 2013 to be 131 gpm. (The District's records indicate that the average day water production during that period was 196 gpm. In calendar year 2017, the District's average water production rate was 130 gpm. Through August of 2018, the District's average water production rate was 141 gpm.)[1] The growth projected by the Master Plan represents a 38 percent increase in water demand due to build-out of the service area. The Master Plan did not predict when build-out would occur.

1.5 COMMUNITY ENGAGEMENT

District Management is concerned about engaging the community in this process for planning and financing improvements to the system, and has developed a plan to inform its customers and the public in general about the need for system improvements, desired service levels, and financing and revenue strategies for those projects.

Outreach: The District held a public information meetings in January and February of 2018, in an open house format, to provide an opportunity for customers and other members of the public to learn more about the specific system improvement projects.

Notification: The District's website and the Payson Roundup newspaper were used to provide notifications to the public of the January and February public meetings, and to house an overview presentation to provide information on the proposed system improvements and financing plan. Other outreach efforts include planned and unplanned water outages, and daily interaction with customers during meter reads.

1.6 WATER RESOURCES

1.6.1 Existing Water Resources Portfolio

Groundwater: All of the water supplied to the District's customers comes from groundwater wells. PSWID owns 23 water production wells (15 in Pine; 8 in Strawberry) with various production capacities. The operational status of these wells is described in Chapter 2. In addition, nine water production wells owned by other private entities (five in Pine; four in Strawberry) pump directly into the PSWID water distribution system or storage facilities. The water from these other wells is provided under what are commonly referred to as Water Sharing Agreements (WSA). Considering only District-owned assets, Pine has 334.5 gpm of existing production capability, and Strawberry has 65 gpm. Production capacities of WSAs include 106.5 gpm in Pine and 67.7 gpm in Strawberry. Under Arizona

[1] The Master Plan's demand figure is based on an analysis of billing data, while the District's production data is based on well production figures. The difference between the two figures is system loss.

groundwater statutes, the District has the legal right to pump as much groundwater as is needed to serve its customers, subject to conservation and other legal requirements.

Surface Water: The District may have the right to utilize some of the surface water in the C.C. Cragin (formerly Blue Ridge) reservoir pursuant to the 2004 Arizona Water Settlements Act (Public Law 108-451 - December 10, 2004). A financial feasibility study of providing water from the reservoir to nearby communities was conducted for Gila County by Tetra Tech, Inc. in December 2007, and is the source of much of the following information.

The C.C. Cragin Reservoir is located near Clint's Well, on the Mogollon Rim in Coconino County, about 25 miles north of Payson (32 highway miles from Pine). The reservoir has a storage capacity of 15,000 acre-feet, and is physically located within the Coconino National Forest. As a part of the Arizona Water Settlement Act, the Salt River Project (SRP) acquired the C.C. Cragin Reservoir and water transfer system from Phelps Dodge Corporation in February 2005. Ownership of the reservoir was transferred as of 2007 to the Bureau of Reclamation, with the SRP operating the reservoir under the provisions of the Salt River Federal Project. As a part of the acquisition agreement, a portion of the water is to be delivered to the Gila River Indian Community in accordance with the Comprehensive Gila River Settlement.[2]

In addition, the agreement also set aside 3,500 acre-feet of water per year to be used to improve water supplies in northern Gila County. Of this amount, 3,000 acre-feet has been designated for use by the Town of Payson; the remaining 500 acre-feet are planned to serve other communities in northern Gila County. (The PSWID currently pumps about 300 acre-feet per year of groundwater.) Surface water from the reservoir is currently conveyed from the pump station located near the reservoir through an existing pipeline to the headwaters of the East Verde River near Washington Park where the existing electrical generator is located. A new 18-inch diameter pipeline is proposed to transfer water from Washington Park to the Payson area.[3]

Tetra Tech's feasibility study utilized cost-estimating methodology and unit costs from a study titled *Town of Payson, Blue Ridge Reservoir Water Supply Pipeline and Treatment Plant,* (Pipeline Study) prepared by Black & Veatch in 2006. The Pipeline Study report discusses proposed pipelines from the Blue Ridge Reservoir to the Town of Payson and the community of Pine, as well as proposed surface water treatment for both areas (Black & Veatch, 2006). Tetra Tech's study identified more than 15 rural communities, not including Pine or Strawberry, that are located near the proposed pipeline or near the Town of Payson that may be able to utilize the water. With its existing operational structure and financing capability, the PSWID is in the best position to take advantage of the available water supply from the C.C. Cragin Reservoir.

---

[2] Tetra Tech, Inc., *Blue Ridge (C.C. Cragin) Reservoir Drinking Water Source Financial Feasibility Study*, (Gila County, Arizona, 2007), 1.
[3] Ibid., 1.

The Pipeline Study includes a discussion of a proposed 14.7-mile raw water pipeline extension from the Washington Park generator to Payson, as well as a micro-filtration-type treatment plant for this water source. A second proposed pipeline trunk off the main Payson line to serve the community of Pine is evaluated in the report, along with plans for a corresponding micro-filtration (membrane) type water treatment plant. The initial length of the raw water main will be sized to deliver a combined design flow of 4.5 million gallons per day (mgd) (considering 0.6 mgd for the Pine Extension and 3.9 mgd for the remaining length for Payson). The optimum pipe diameter for the Payson raw water main was originally determined to be 16-inches; ductile iron pipe (DIP) was determined to be the best choice for pipe material. However, according to the Town of Payson, 18-inch diameter DIP has been purchased for the pipeline. The proposed Pine Extension consists of an eight-inch DIP pipeline that is 15.2 miles long, with three intermediate booster pump stations (Black & Veatch, 2006).[4]

The proposed Payson raw water pipeline runs in a south-southwesterly direction, beginning at the Washington Park generator and mainly following the Houston Mesa Road to the proposed water treatment plant near Mesa Del Caballo, a community about three miles north of Payson. The proposed Pine extension (previously determined to not be feasible due to excessive cost) begins at Station 183+00 of the Payson raw water pipeline alignment at the intersection of Forest Road (FR) 32 and FR 64 (Control Road). The proposed pipeline runs west along Forest Route (FR) 64 to the intersection of State Route 87, then northwesterly along State Route 87 to the proposed Pine treatment plant (Black & Veatch, 2006).[5]

The Town of Payson website includes information about the proposed C.C. Cragin reservoir pipeline and water treatment project. Numerous elements of the project have been completed beginning in 2011 with purchase of the pipe. The schedule included on the Town's website appears to indicate that all elements of the project will be completed in 2018.

The proposed water treatment plants for the Town of Payson and community of Pine involve microfiltration treatment followed by disinfection. At both areas, an on-site finished water reservoir and pump station are proposed to be constructed for treated water storage and distribution (Black & Veatch, 2006). Using Year 2006 unit costs, the Pipeline Study includes estimates of probable capital and operation/maintenance costs for the Pine pipeline and water treatment plant, as shown in the following table.[6]

---

[4] Ibid., 3.
[5] Ibid., 4.
[6] Ibid., 4.

Proposed Pine Raw Water Main and Treatment Plant

Item	Cost
Raw water main	$15,185,000
Water treatment plant	$1,670,000
Total capital cost	**$16,855,000**
Amortized Cost per Year (20 year period)	$1,590,993
Operation & maintenance ($/year)	$162,262
Total annual cost	**$1,753,255**
Cost per 1,000 gallons ($/kgal)	**$10.76**
Table Source: Black & Veatch, 2006	

It is not known if the District participated in the Pipeline Study with the Town of Payson or has taken any actions to acquire the rights to any of the C.C. Cragin Reservoir water. Because the District should be planning for long-term water supplies (i.e. 100 years), it is recommended that the District revisit the 2006 Black & Veatch Pipeline Study, update the information and feasibility analysis of that study, and consider making use of some of the C.C. Cragin Reservoir water.

1.6.2 Emergency Sources of Water

The District has the ability to transfer water between Pine and Strawberry through an eight-inch interconnect, which is capable of moving approximately 144,000 gallons in either direction per day. The pipeline is known as the Magnolia Pipeline. PSWID also has an interconnection in the Strawberry Hollow development, which is capable of supplementing water into the Pine service area at about 50 gpm or 72,000 gpd. In addition, the Mag-Ralls intertie pipeline was installed in March 2018 to provide district operators more flexibility in moving water from Pine to Strawberry and vice versa. To enhance reliability of the system, variable frequency pump drives have been installed at the MR 2 well, the SH 3 Well and booster pumps, and the K2 booster pumps.

1.6.3 Seasonal Operations

During winter months, water consumption drops off significantly due to seasonal residents leaving the area. Due to the decrease in demand, some facilities can be turned off to reduce power consumption during the off season, as well as allow water tables to recover over a longer period of time. This also provides time for maintenance activities. Detailed information pertaining to seasonal operations is contained in the PSWID operation manual document maintained by the District.

1.6.4 Water Resources Summary

The Master Plan analyzed the system demands and supplies and provided a comparison by service area under existing and build-out scenarios. These comparisons are shown in Figures 1.5 and 1.6. Demands are represented by the colored vertical bars, and the total supply is shown as a horizontal line on the graphs. Pine has adequate water supply today and at build-out to meet both the Average Day Demand ("ADD") and the Maximum Day Demand ("MDD"). Strawberry has adequate supplies to meet ADD under existing and build-out demand scenarios and existing MDD if WSA wells are included. However, Strawberry does not have enough supply, even when considering use of WSA wells to meet MDD at build-out. Water systems should have enough supply to meet maximum day conditions to allow for storage tanks to refill during high demand months. PSWID has the flexibility to transfer water from Pine to Strawberry to make up for this shortfall using District-owned wells under existing conditions, but there is not enough supply available in Pine to continue this practice into the future without the use of WSA wells, or developing other sources of water such as the C.C. Cragin Reservoir water or new wells.

Figure 1.5

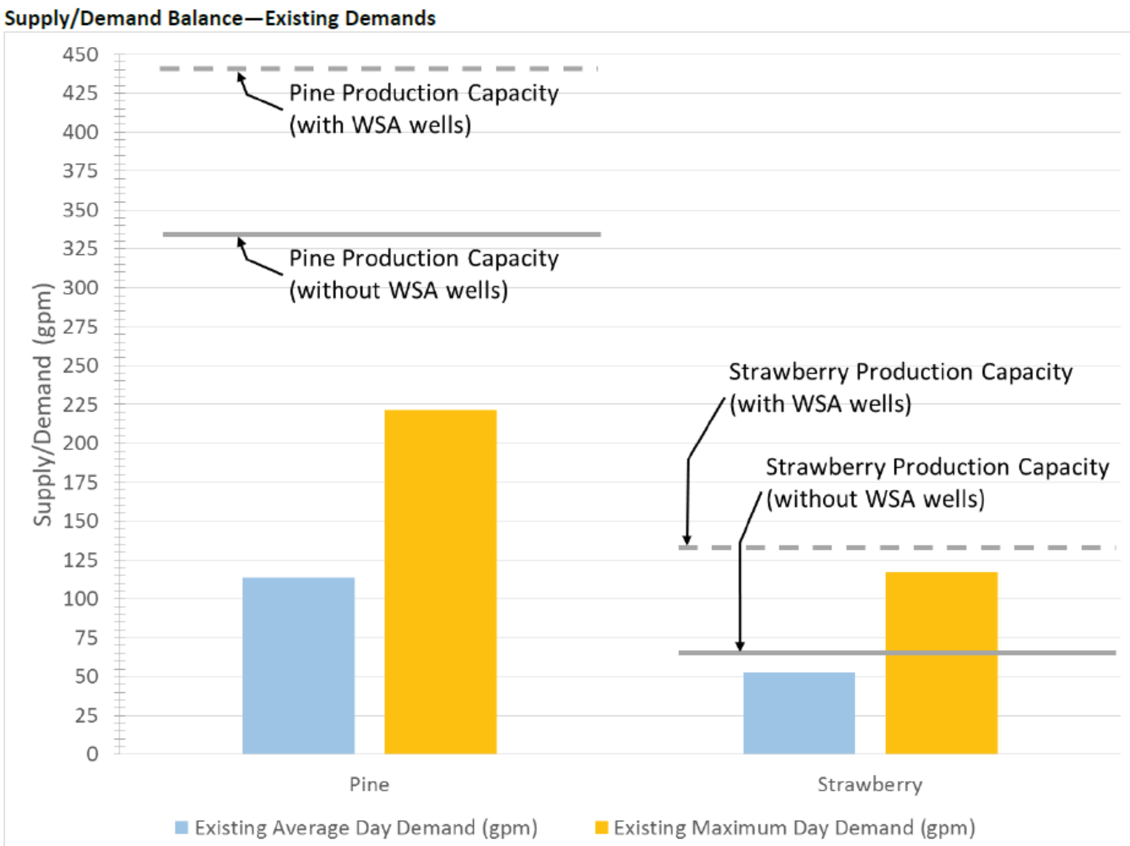
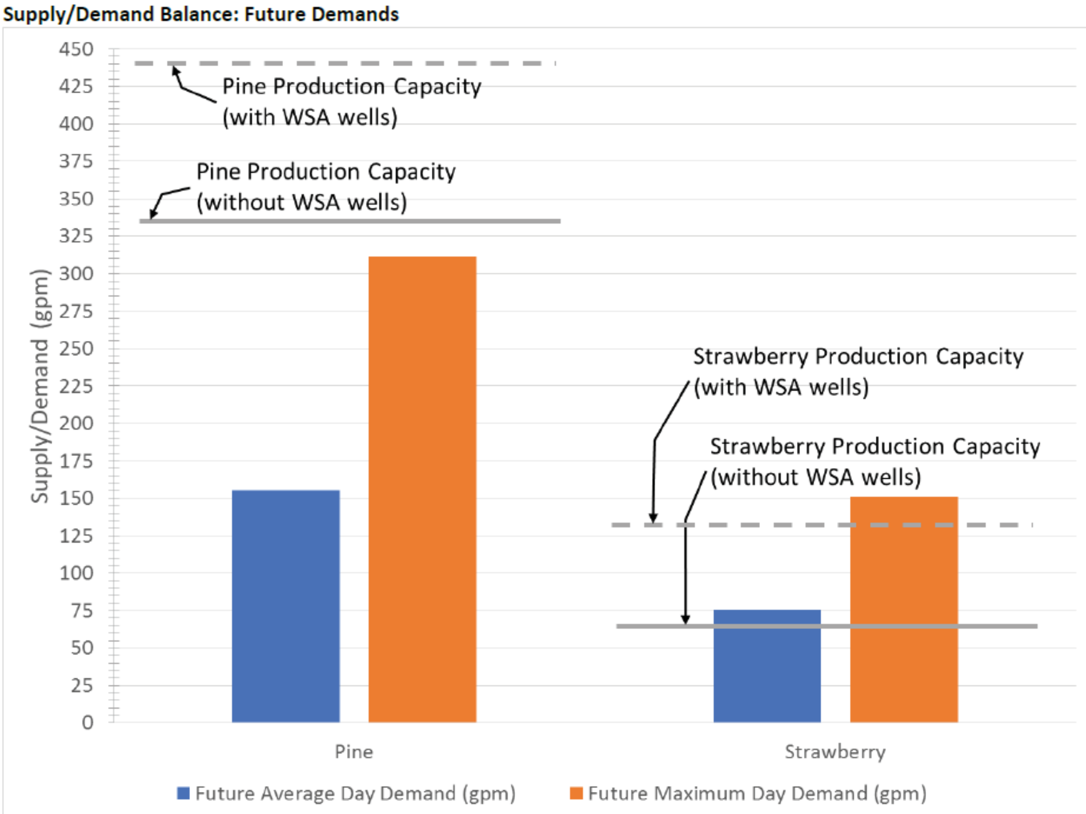


Figure 1.6

Supply/Demand Balance: Future Demands



1.7 WATER DEMANDS

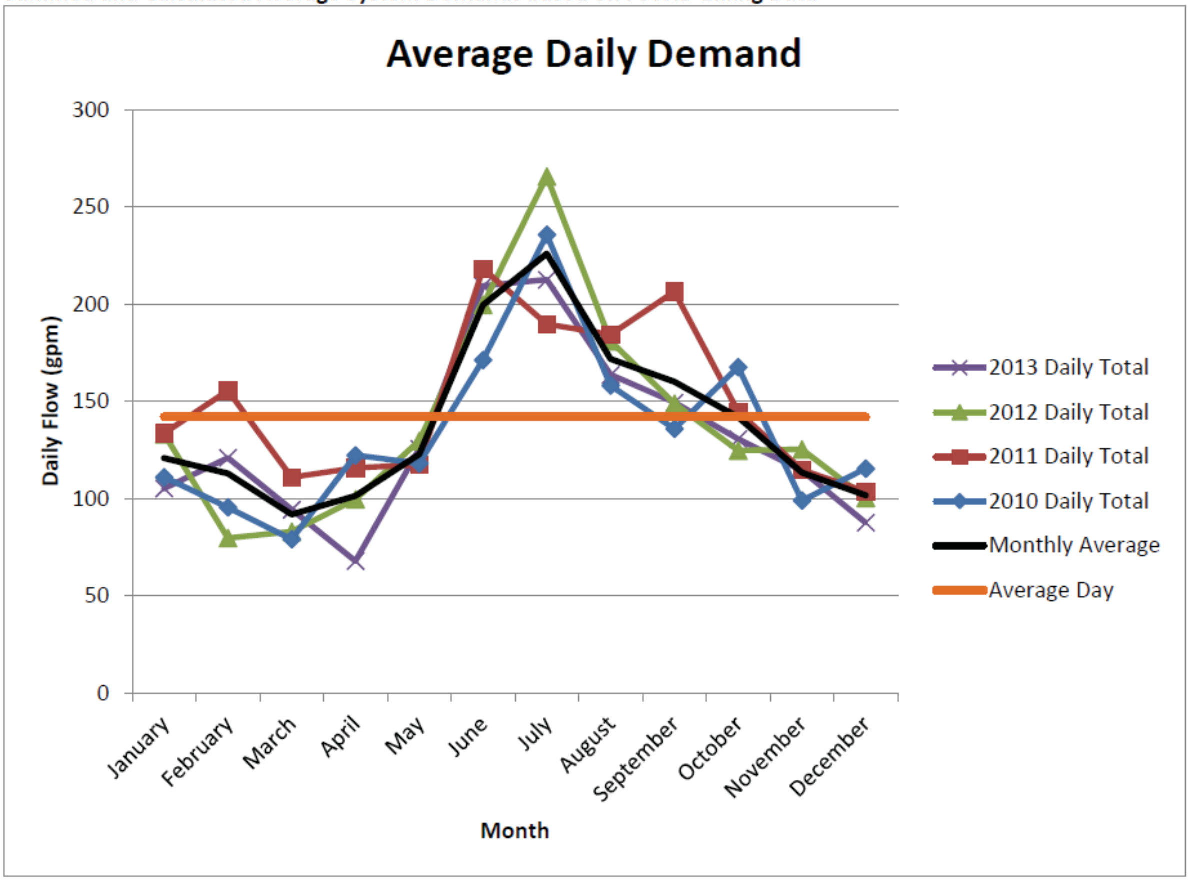
1.7.1 Existing Demands

The 2013 Master Plan analyzed the then-current demands within the PSWID systems. Historical performance of the District's distribution system, along with information gathered from nearby water systems, were used to develop existing system demands, water duty factors, and peaking factors. Future system demands were developed based on the build-out land use analysis and water duty factors.

Water billing data from PSWID customers was collected and analyzed for the years 2010 to 2013 to determine water consumption trends in Pine and Strawberry. The average daily flow for each year was calculated. Using average flows over the four years, a monthly average demand and Average Day Demand (ADD) were calculated. Figure 1.7 shows the total daily demand for each of the four years for PSWID customers, as well as the monthly average demand, and the ADD.

Figure 1.7

Summed and Calculated Average System Demands based on PSWID Billing Data



The monthly average demand matches closely with the daily total demand from 2013. Therefore, 2013 was chosen as the basis for demand calculation. Billing data from the month of October 2013 was used for the ADD and was calculated to be approximately 131 gallons per minute (gpm).

1.7.2 Unaccounted for Water

The demand summed from the billing data does not contain unaccounted for water, which is significant in both the Pine and Strawberry service areas, as shown in Table 1.1. This information was developed as a part of the Master Plan. The District reported that the overall system lost and unaccounted for water amounted to 13.3 percent of the water produced during the month of April 2018. Compared to the data in Table 1.1, it appears that the District has made great strides in reducing lost and unaccounted for water. However, the public water system industry’s rule of thumb is less than 10 percent lost and unaccounted for water. Thus, the District should continue to strive to reduce losses.

Table 1.1 – Percent Loss Per Month in 2013

Service Area	January	February	March	April	May	June	July	August	September	October	November	December	2013 Total
Pine	58%	33%	57%	59%	46%	34%	20%	26%	42%	47%	34%	41%	37%
Strawberry	36%	30%	8%	50%	30%	17%	3%	51%	0%	10%	31%	25%	12%
Total System	52%	32%	45%	56%	41%	28%	12%	9%	31%	34%	33%	36%	29%

Note: Information pertaining to water loss was provided and calculated by PSWID
Source: 2014 Master Plan by CH2MHill

One of the contributing factors of the high water loss is likely the use of acrylonitrile butadiene styrene (ABS) pipe. ABS pipe is typically used for drain, waste, and vent piping applications, not for pressurized distribution system piping. Other contributing factors are the age and condition of the system. Over time, as existing pipelines are replaced with polyvinyl chloride (PVC) or other appropriate pipe materials, and as proactive maintenance of the distribution system is enhanced, it is expected that system losses will decrease.

1.7.3 Peaking Factors

To determine the Maximum Day Demand, the Master Plan utilized billing data from the month of July 2013, because no real-time data were available to develop a MDD condition. The average of use during the peak month of July was calculated to be approximately 213 gpm, which is the average daily use of the maximum month. Based on this information, the MDD peaking factor, compared to ADD, was calculated to be approximately 1.6. The Master Plan recommended using a MDD peaking factor of 2 is based on discussions with District Staff, data from surrounding communities, and industry standards. For determination of the Peak Hour Demand (“PHD”) peaking factor, the same lack of real-time data prevented a calculation based on actual hourly flow data. Therefore, a PHD factor of 3 (PHD to ADD) was recommended, based on the peaking factors of surrounding communities and industry standards.

These factors were then applied to the Average Day Demand to calculate reasonable and conservative demands for the entire combined system as shown in Table 1.2.

Table 1.2 – Average Day Demand, Maximum Day Demand, and Peak Hour Demand - Daily Totals and Recommended Peaking Factors

Existing Demand Scenario	Base Month	Daily Total (gpm)	Recommended Peaking Factor
Average Day Demand (ADD)	October 2013	167	-
Maximum Day Demand (MDD)	July 2013	334	2
Peak Hour Demand (PHD)	N/A	501	3

Source: 2014 Master Plan by CH2MHill

EXISTING FACILITIES

2.1 INTRODUCTION

An overview of the District's existing water distribution system includes the following categories:

- Source water (wells)
- Treatment (disinfection)
- Booster Pumping
- Storage
- Transmission and distribution piping, and appurtenances.

The objective of this chapter of the Preliminary Engineering Report (PER) is to describe the primary PSWID system facilities, provide locations of the main facilities, give a brief history, and describe existing conditions. Most of the District's water facilities are aged, obsolete, failing, and are at or beyond their useful life. The information presented in this chapter is derived from site evaluations and inspections, the CH2MHill 2013 Master Plan, record drawings, and reports provided by the District staff.

2.2 EXISTING FACILITIES OVERVIEW

The PSWID inherited numerous private water systems when it was formed in 1996. These systems were installed by owners and developers of private land within the Pine and Strawberry communities over a period of many years. Since the area was settled by pioneers in 1879, Pine and Strawberry have become fast-growing communities of year-round and seasonal residents and businesses.

PSWID owns 23 water production wells (15 in Pine; 8 in Strawberry) with various production capacities. In addition, nine water production wells owned by other private parties (five in Pine; four in Strawberry) pump directly into the PSWID water distribution system or storage facilities through Water Sharing Agreements (WSA).

The groundwater is not treated, except to add chlorine to maintain a residual disinfection level in the distribution system. The chlorine is added at certain water wells through liquid chlorine solution chlorinators. The systems include a total of 22 storage tanks with a total of 1.311 million gallons of storage, 24 booster stations, and more than 58 miles of water mains.

2.3 EXISTING FACILITIES MAP

Figures 2.1 and 2.2 show the existing District facilities.

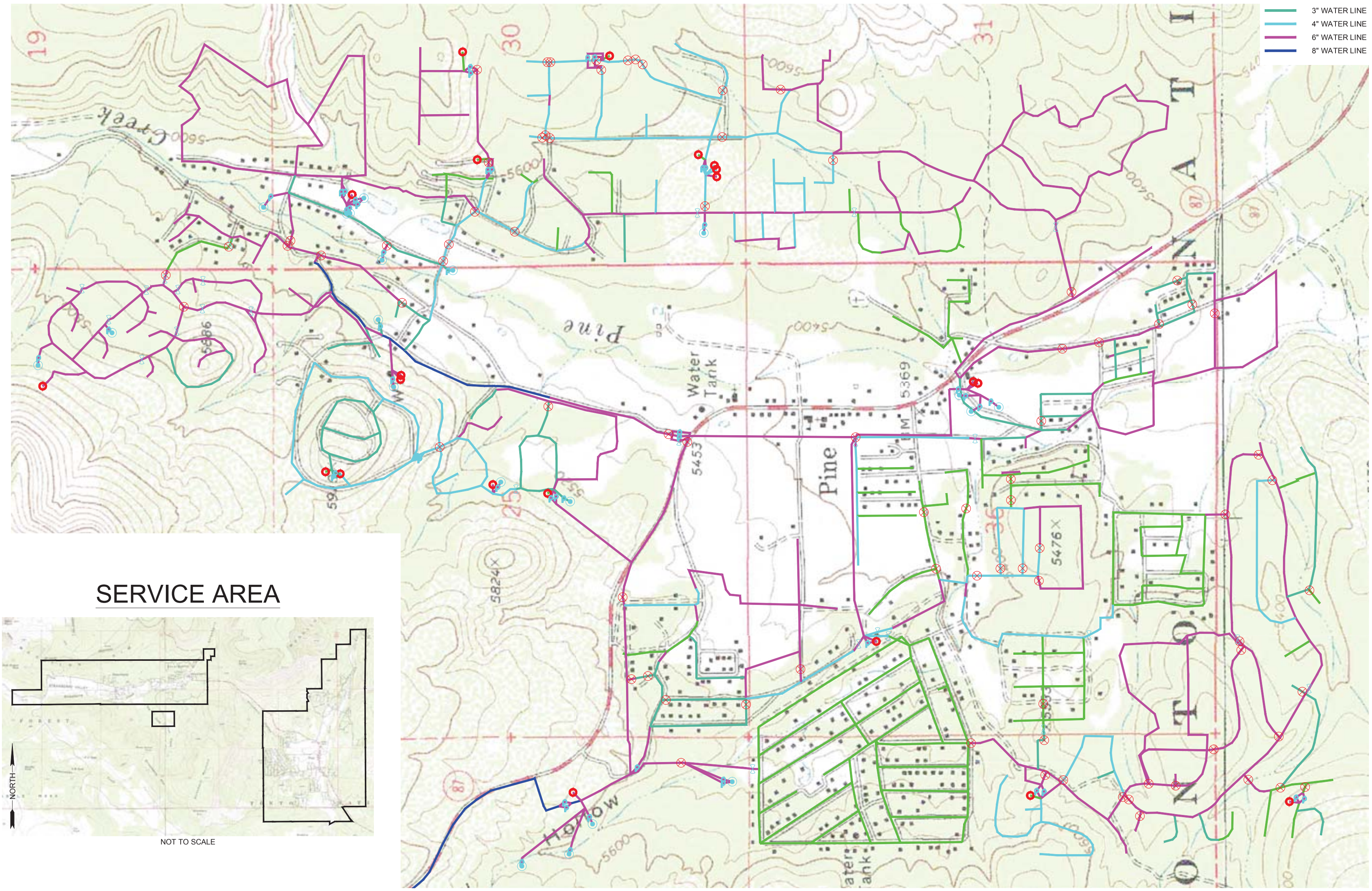
PINE E□ISTING WATER SYSTEM

A PORTION OF SECTIONS 20 THRU 29, 35, AND 36, TOWNSHIP 12 NORTH, RANGE 8 EAST AND A PORTION OF SECTIONS 19, 30, AND 31, TOWNSHIP 12 NORTH, RANGE 9 EAST AND A PORTION OF SECTIONS 19 AND 20, TOWNSHIP 11.5 NORTH, RANGE 9 EAST OF THE GILA AND SALT RIVER BASE AND MERIDIAN, MARICOPA COUNTY, ARIZONA

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

LEGEND

- TANK
- WELL
- PRV
- PUMP
- VALVE
- < 2" WATER LINE
- 3" WATER LINE
- 4" WATER LINE
- 6" WATER LINE
- 8" WATER LINE



SERVICE AREA

NOT TO SCALE

EPS GROUP
125 S. Avondale Blvd., Suite 115
Avondale, AZ 85323
T:623.547.4661 | F:623.547.4662
www.epsgroupinc.com

PINE STRAWBERRY WATER IMPROVEMENT DISTRICT
WATER SYSTEM - PROPOSED PROJECTS
PINE AND STRAWBERRY, ARIZONA

PINE EXISTING WATER SYSTEM

REVISIONS:

DESIGNER: EPS
DRAWN BY: EPS

NOT FOR CONSTRUCTION

JOB NO. 16-058
08-18-2017
SHEET NO. 2 OF 2

FIGURE 2.1

STRAWBERRY E□ISTING WATER SYSTEM

A PORTION OF SECTIONS 20 THRU 29, 35, AND 36, TOWNSHIP 12 NORTH, RANGE 8 EAST
AND A PORTION OF SECTIONS 19, 30, AND 31, TOWNSHIP 12 NORTH, RANGE 9 EAST AND A
PORTION OF SECTIONS 19 AND 20, TOWNSHIP 11.5 NORTH, RANGE 9 EAST OF THE GILA
AND SALT RIVER BASE AND MERIDIAN, MARICOPA COUNTY, ARIZONA

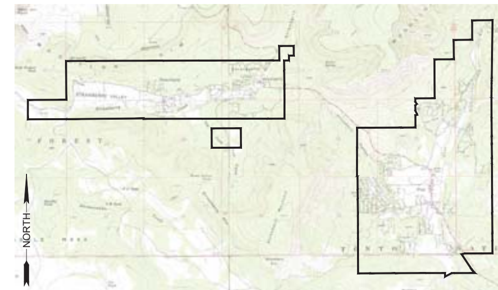
LEGEND

- TANK
- WELL
- PRV
- PUMP
- VALVE
- < 2" WATER LINE
- 3" WATER LINE
- 4" WATER LINE
- 6" WATER LINE
- 8" WATER LINE

NORTH

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

SERVICE AREA



NOT TO SCALE

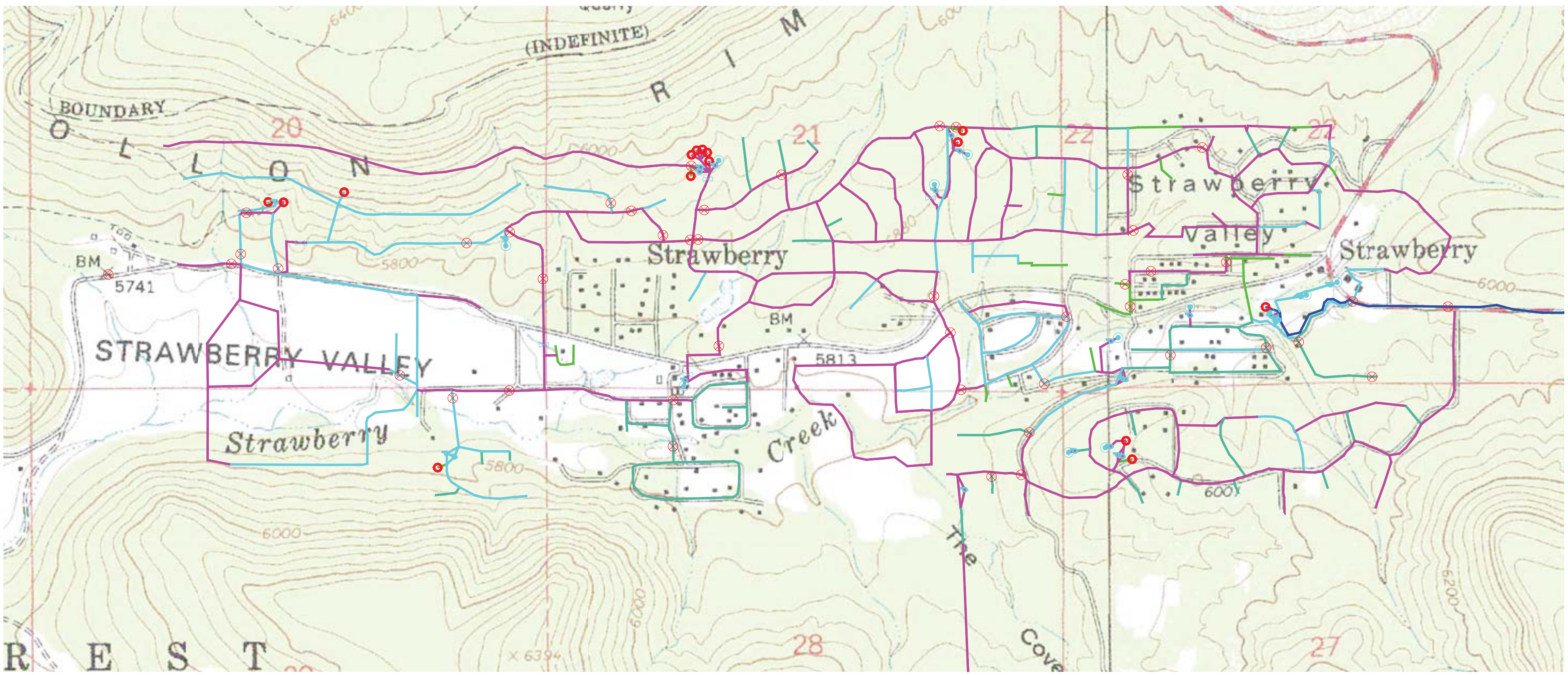


FIGURE 2.2

EPS GROUP
125 S. Avondale Blvd., Suite 115
Avondale, AZ 85323
T:623.547.4661 | F:623.547.4662
www.epsgroupinc.com

PINE STRAWBERRY WATER IMPROVEMENT DISTRICT
WATER SYSTEM - PROPOSED PROJECTS
PINE AND STRAWBERRY, ARIZONA

STRAWBERRY EXISTING WATER SYSTEM

REVISIONS:

CALL 811 OR CLICK ARIZONA811.COM

DESIGNER: EPS
DRAWN BY: EPS

NOT FOR CONSTRUCTION

JOB NO. 16-058
08-18-2017
SHEET NO. 1 OF 2

2.4 SCHEMATIC PROCESS LAYOUT OF EXISTING FACILITIES

Figure 2.7 provides a schematic diagram of the existing Pine water system. Figure 2.8 provides a schematic diagram of the existing Strawberry water system.

2.5 EXISTING FACILITIES HISTORY

The existing PSWID facilities were generally constructed over the last several decades as the private lands in the Pine and Strawberry communities were developed. Individual, stand-alone water systems based on small groundwater wells were installed by owners and developers as each area developed. There was little or no effort made toward consolidating the systems into larger, more efficient operations until the District was formed. Even now, it is very difficult to consolidate the systems due to the terrain and the differing pressures under which each of the original systems operate. This is the reason why the District still has 27 different pressure zones within the service area.

The PSWID owns 17 Active water production wells (14 in Pine; 3 in Strawberry) at various production capacities. The PSWID also employs 8 water production wells owned by other private entities (4 in Pine; 4 in Strawberry) that pump directly into the PSWID water distribution system or storage facilities.

The PSWID has 22 storage tanks with a total of 1.331 MG of storage. The Pine service area has a total of 11 storage tanks with a storage volume of 1,037,000 gallons (78 percent of total). The Strawberry service area has a total of 11 tanks with a storage volume of 294,000 gallons (22 percent).

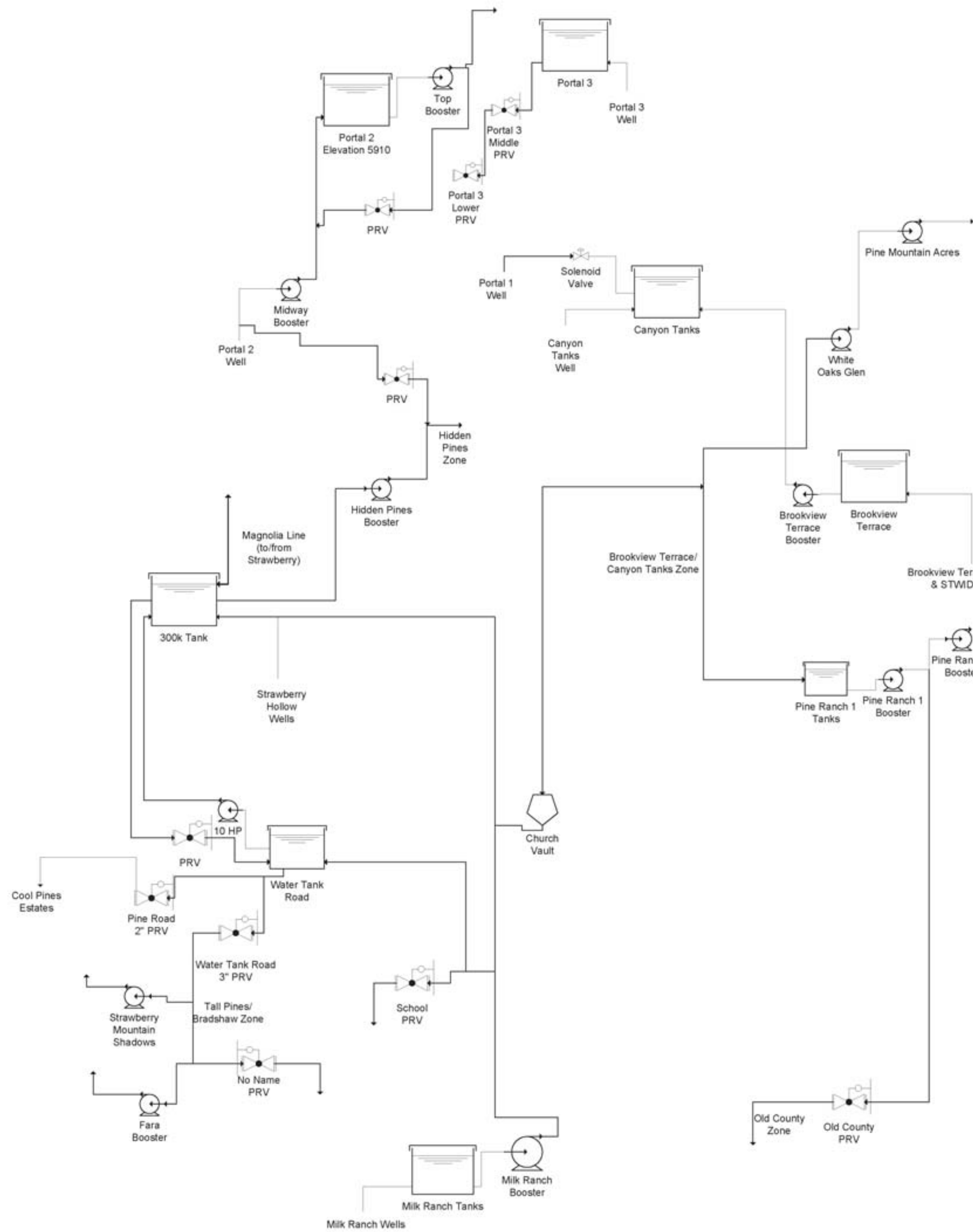
The PSWID has approximately 357,600 linear feet of water mains (67.7 miles). The water mains range in size from 2-inch to 8-inch and 78 percent of the water mains are sized 4-inch or smaller.

In 2008, the consulting firm of CVL prepared an assessment of the District's existing infrastructure. The result of that assessment for each major category of the District's facilities is reflected in the following paragraphs.

2.5.1 Source Water History

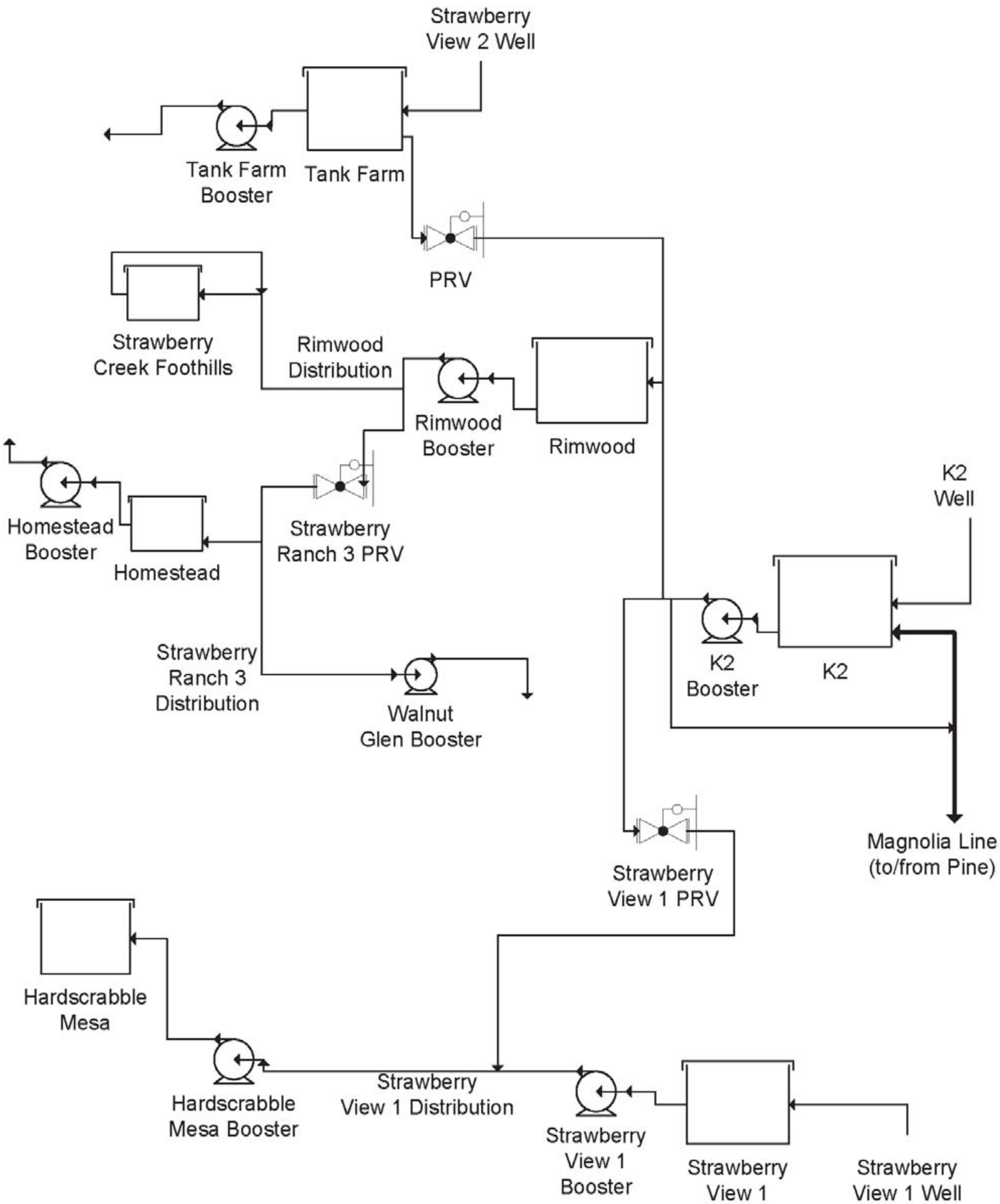
Tables 2.1 and 2.2 list the existing wells for the Pine and Strawberry systems, respectively. This information is from the 2014 Master Plan.

FIGURE 2.7
System Schematic—Pine



Source: 2014 CH2MHill Water System Master Plan

FIGURE 2.8
System Schematic—Strawberry



Source: 2014 CH2MHill Water System Master Plan

Table 2.1 – Well Production - Pine

Location Name	Well Production (gpm)	Notes
Pine Crest Lot 25	N/A	Offline – dry hole
Portal 1 TR A	16.5	
Portal 2 Lot 73	14.5	
Portal 3 TR A next to Lot 61	23.0	
Canyon Shadows	N/A	Offline – dry hole
STWID #1	24.0	WSA
Brookview Terrace 4	15.5	WSA
Bloom	30.0	WSA
Gordon	40.0	WSA
STWID #2	7.0	WSA

Source: 2014 Master Plan by CH2MHill

Table 2.2 – Well Production - Strawberry

Location Name	Well Production (gpm)	Notes
Strawberry View 1 Lot 59	28.0	
Strawberry Ranch 5 TR C	11.0	
Strawberry View 3 Lot 226	26.0	
K2	N/A	Not in Service
Rimwood	N/A	Offline – dry shallow hole
Strawberry View 3	N/A	Offline – dry shallow hole
Strawberry Creek Foothills	N/A	Offline – dry shallow hole
Strawberry Ranch 2	N/A	Offline – dry shallow hole
Gordon Strawberry	9.2	WSA
McKnight	23.5	WSA
Johnson 1	22.0	WSA
Johnson 2	13.0	WSA

Source: 2014 Master Plan by CH2MHill

2.5.2 Source Water Component Failures

The inability of a well to produce its nominal capacity of water could be due to many reasons, including pump failures, casing failures, lowering groundwater table, and problems with pump controls. In the case of PSWID, six of the wells listed above have suffered from lowering groundwater levels and have been taken out of production. Some of the wells produce excessive amounts of sand, which can damage pump impellers and casings, as well as create deposits in the waterlines. Pump and control failures are temporary problems and can be resolved with replacement and maintenance. Problems with the well casings have not been reported, although some of the wells are approaching 40 to 50 years of age. The Master Plan did not identify other problems or failures of District wells such as poor water quality.

The 2008 CVL assessment indicated that the District's wells had, on the average, reached about 93 percent of their expected life. In 2017, District staff performed an updated condition assessment and determined that the wells had reached 123 to 140 percent of their expected life. That assessment also found that 42 percent of the wells will need upgrades and repairs within one year. Based on the 2008 CVL assessment, replacing 42 percent of the District's wells would cost nearly $400,000. Well replacements would have be completed strategically to minimize the effect of the lost production on the ability of the system to serve customer demands. Thus, well replacements will require a number of years to accomplish.

2.5.3 Source Water Violations

The 2014 Master Plan provides additional information with respect to violations:

> *"CH2M HILL requested that the District provide any information related to water quality compliance reporting for the previous 3 years of system operation. A review of the information, including PSWID's Consumer Confidence Reports (CCRs) and sanitary surveys from 2010 to 2013, indicates that PSWID has been in compliance with all federal and state drinking water standards during this period."*

The current District Manager is not aware of any previous or current source water violations.

2.5.4 Source Water Condition

The wells owned by the District are capable of meeting the demands of the system throughout the year and the District is fortunate that the water quality produced by the wells meets or exceeds the Primary Drinking Water Standards and no treatment is needed. The District chooses to chlorinate the water prior to distribution as a precaution.

The Milk Ranch Well wells produce excessive amounts of sand, which can usually be managed at the wellhead. The 2014 Master Plan identified the need for additional well capacity for the Strawberry system as it approaches build-out.

2.5.4.1 Suitability of Source Water for Continued Use

While the District's wells currently meet the demands of the system, the average age of the wells is about 40 years. The advanced age of the wells increases the likelihood that the wells may begin to experience major failures of the casings. Routine maintenance and replacement of components from time to time will be required to keep the wells in good operating condition. However, a major casing failure will require the well to be replaced, which is a costly and time consuming project.

2.5.4.2 Adequacy of Well Site Facilities

The PSWID well sites are small and not well secured. Most of the well sites have several deficiencies that require remediation, rehabilitation, and replacement for them to remain viable water production sources for the District in the future.

2.5.4.3 Capacity of Well Field

Of the 23 wells owned by the District, only 17 are active (14 in Pine and 3 in Strawberry). The District also employs 8 wells through Water Sharing Agreements (4 in Pine and 4 in Strawberry). These 25 wells have adequate capacity to supply the demands of the systems for the foreseeable future. The District should monitor the static water levels in the wells from year to year to determine if any long-term trends in groundwater levels can be discerned. In addition, as part of a drought contingency plan the District will explore the opportunity to install wells into a deeper, more stable aquifer.

2.5.4.4 Compliance of Well Sites with Federal, State, and Local Laws

The water produced by the District's wells meets or exceeds all Primary Drinking Water Standards and there are no unresolved Notices of Violation from the Arizona Department Environmental Quality. However, the District is working to resolve numerous deficiencies and compliance issues that do not rise to the level of an ADEQ violation, but are needed to provide efficient and secure water services as well as safe working conditions for the District's employees.

2.5.4.5 Well Site Energy Analysis

The District obtained a State grant with which to conduct an energy evaluation for all of well facilities. Improvements have been made to include VFDs on these wells.

The operation of this system is controlled at the local well and tank sites. No central communication system is in place for the system. A system that can be remotely controlled and operate will operate more efficiently and economically. Energy can also be conserved by reducing the trips operators must make to check the operation of these facilities.

2.6 TREATMENT HISTORY

The only treatment of the water supply that the District is required to perform is disinfection before the water is introduced into the distribution system. The District provides disinfection by adding chlorine to the water at the well sites using liquid chlorine solution chlorinators.

These machines are reliable and the District has spare units that can be easily installed to replace a failed chlorinator within a short period of time. This approach to disinfection has worked well for the District and should continue to provide reliable chlorination for the foreseeable future. There are no known violations related to disinfection or other treatment requirements.

2.7 BOOSTER PUMPING HISTORY

Tables 2.3 and 2.4 list the existing booster stations for the Pine and Strawberry systems, respectively. This information is from the 2014 Master Plan.

Table 2.3 – Pine Booster Stations

Pine Service Area Zone/Group of Zones	Asset Name	Booster Pump Horsepower	VFD?	Hydro Tank (gallons)
Brookview Terrace/Canyon Tank	Brookview Terrace Booster Station (2 pumps)	5 and 7.5	No	None
	Pine Ranch Booster (2 pumps)	5		
	Church Vault Booster	5		
Portal 2 Upper	Portal 2 Tank Booster (Top)	5	No	2,000
Portal 1 & 2 Middle	Midway Booster	3	No	119
300K	Milk Ranch Booster (2 pumps)	15	Yes	86
	Magnolia Line Booster (2 pumps)	15	Yes	
Pine Ranch 1	Pine Ranch 1 Booster	5	Yes	119
Pine Ranch 2	Pine Ranch 2 Booster (1 pump)	5	No	1,000
Hidden Pines	Hidden Pines Booster	3	No	None
Pine Mountain Acres	Pine Mountain Acres Booster (2 pumps)	5	Yes	119
White Oaks Glen	White Oaks Glen Booster (2 pumps)	5	Yes	119
Fara	Strawberry Mountain Shadows 2 Booster (2 pumps)	5	Yes	None
Strawberry Mountain Shadows	Strawberry Mountain Shadows Booster (2 pumps)	5	No	2,000

Table 2.4 – Strawberry Booster Stations

Strawberry Service Area Zone/Group of Zones	Asset Name	Booster Pump Horsepower	VFD?	Hydro Tank (gallons)
K2	K2 Booster (2 pumps)	7.5	Yes	3,000

	Magnolia Line Booster (2 pumps)	15	Yes	
Strawberry View 1	SV1-K2-SR5 Inter-tie Booster (2 pumps)	7.5	Yes	
	Strawberry View 1 Booster (1 pump)	5	Yes	
Tank Farm	Tank Farm Booster	5	Yes	2,000
Rimwood	Rimwood Booster (2 pumps)	5	Yes	10,000
Homestead	Homestead Booster (1 pump)	5	Yes	
Strawberry Ridge Estates	Strawberry Ridge Estates Booster	Not in Service – reserved for future development	Yes	
Hardscrabble Mesa	Hardscrabble Mesa Booster (1 pump)	3	No	
Walnut Glen	Walnut Glen Booster	5	Yes	

Most of these booster stations are in-line, meaning that they pump from one pressure zone to a higher pressure zone. System pressures vary widely primarily due to the mountainous terrain. According to the 2014 Master Plan, there are numerous locations within both systems where the system pressure is either below 40 psi or above 100 psi. In the latter cases, pressure regulating valves are required to be installed on the water service to each home located within the high-pressure area in order to maintain the pressure in the house at or below 80 psi. The Master Plan recommended that these low- and high-pressure areas be further evaluated.

The 2008 CVL facilities assessment indicated that the district's booster stations, on the average, reached between 63 and 138 percent of their expected life. In 2017, District staff's updated condition assessment determined that the booster stations had reached 175 to 250 percent of their expected life. District staff reported that assets which are 75 percent or more through their standard useful life should be considered for major overhaul or replacement, especially if they have not received regular preventative maintenance. Staff further concluded that 54 percent of the District's booster stations will need upgrades and repairs within the next year, including redundant pumps, SCADA, and variable frequency drive controls (VFD).

2.7.1 Pumping Component Failures

With 23 active booster stations serving 27 different pressure zones, the pumps and related facilities are critical to the daily operation of the District's systems. The PSWID operations staff is able to maintain these booster stations in operating condition despite old and obsolete equipment and harsh climate conditions. Fourteen of the booster stations are in need of equipment upgrades and new pumps, and six of those are deemed to be in critical need of new equipment and control upgrades within the next year.

2.7.2 Pumping Violations

The District currently has no violations related to the booster stations.

2.7.3 Pumping Condition

The District's booster stations are capable of meeting the demands of the system throughout the year, but much of the equipment is old and obsolete and lacks redundancy. The following booster stations have been determined to need VFDs, replacement of the existing pumps, and addition of a redundant pump with associated piping and controls. Projects under WIFA funding have been identified and are being implemented to upgrade these booster stations:

- Brookview Terrace - Tract A (2 Pumps)
- Hwy 87 & Pine Creek (Church Vault - partially built, add BPS.)
- Pine Ranch 2 - Lot 25 (1 Pump)
- Strawberry View 1 - Lot 59 (1 Pump)
- Portal 2 - Lot 178 (1 Pump)
- Strawberry Knolls 2 - Lot 138 (2 Pump)
- Hardscrabble Mesa (1 Pump)
- Portal 2 Common Area - Next to Lot 166 (1 Pump)
- Pine Mountain Acres - Lot 7 (2 Pump)
- Pine Valley Homesites - Lot 109 (2 Pump)
- Strawberry Hollow #3 (2 Pump)
- Strawberry Mountain Shadows 1 - Lot 25 (2 Pump)
- Strawberry Ranch 2 - TR D (Pumps Failed - Replace 2 Pumps)
- Strawberry Ranch 5 - TR C (1 Pump)

2.7.4 Suitability of Pumping for Continued Use

All of the District's current active booster stations are suitable for continued use, subject to rehabilitation and upgrades to improve efficiency, reduce maintenance costs and improve reliability. These upgrades include SCADA, VFDs, and hydropneumatic tanks. Also, routine maintenance and replacement of components from time to time will be required to keep the booster stations in good operating condition.

2.7.5 Adequacy of Booster Pumping Facilities

The PSWID booster stations are adequate in the sense that they provide the flows into the system that are required to meet the daily demands. However, many of the stations are equipped with old and obsolete equipment, which increases the amount of time spent on maintenance and reduces their reliability.

2.7.6 Capacity of Booster Pumping Facilities

The capacities of the booster station facilities are shown in Tables 2.3 and 2.4.

2.7.7 Compliance of Booster Pumping Facilities with Federal, State, and Local Laws

The existing District booster stations are not subject to any ADEQ Notices of Violation. It is recommended that the District conduct building and electrical code inspections of the booster stations to ensure safety and current code compliance.

2.7.8 Energy Analysis

The District obtained a State grant with which to conduct an energy evaluation for all of well facilities. Improvements have been made to include VFDs on these wells.

The operation of this system is controlled at the local well and booster sites. No central communication system is in place for the system. A system that can be remotely controlled and operate will operate more efficiently and economically. Energy can also be conserved by reducing the trips operators must make to check the operation of these facilities.

2.8 STORAGE HISTORY

The Pine area has a total of 11 storage tanks with a storage volume of 1.037 million gallons (79 percent of total). The Strawberry service area has a total of 11 tanks with a storage volume of 274,000 gallons (21 percent of total). The District has inspected all of the tanks during the period of 2012 to 2015. Copies of the inspection reports are included in Appendix B. Tables 2.5 and 2.6 list the storage tanks and their locations, along with their year of installation (if known) and the date of inspection.

Table 2.5 – Pine Storage Tanks

Pine Service Area Zone/Group of Zones	Asset Name	Storage Capacity (gallons)	Year Installed	Inspection Date
Brookview Terrace/Canyon Tank	Brookview Terrace Tank	100,000	1980	1/18/15
	Pine Ranch Tanks (2 @ 10,000)	20,000	1972	1/11/15
	Canyon Tanks (2 @ 100,000)	200,000	1960 1980	1/11/15 2/22/15
Portal 3 Upper	Portal 3 Tank	150,000	1980	10/14/12
Portal 1&2 Middle	Portal 2 Tank	100,000	1980	9/23/12
300K	300K Tank	300,000	?	11/1/12
	Water Tank Road Tank	100,000	?	2/8/15
	Milk Ranch Tanks (2)	67,000	2012 2013	No inspection yet

Table 2.6 – Strawberry Storage Tanks

Strawberry Service Area Zone/Group of Zones	Asset Name	Storage Capacity (gallons)	Year Installed	Inspection Date
K2	K2 Tank	100,000	1992	2/15/15
Strawberry View 1	Strawberry View 1 Tank	20,000	?	9/22/12
Tank Farm	Tank Farm Tank #1	15,000	?	4/2/13
	Tank Farm Tank #2	10,000	?	4/2/13
	Tank Farm Tank #3	10,000	?	4/2/13
	Tank Farm Tank #4	10,000	?	4/2/13
Rimwood	Strawberry Creek Foothills Tank	20,000	1980	?
	Rimwood Tank	67,500	?	4/7/13
Homestead	Homestead Tank	1,500	?	?
Strawberry Ridge Estates	Strawberry Ridge Estates Tank	20,000*	?	Not in service
Hardscrabble Mesa	Hardscrabble Tank	20,000	1987	9/22/12

* Not in service – reserved for future development

The 2008 CVL system assessment estimated that the storage tanks had reached between 40 percent and 64 percent of their useful lives. District Staff now estimates that the tanks are between 60 percent and 80 percent of their useful lives.

2.8.1 Storage Component Failures

The 21 active tanks provide the storage that is necessary to not only meet the peak hour demands on the system, but to also allow the wells to refill the tanks during the night when demands are lower. The PSWID operations staff is able to maintain these storage tanks in operating condition despite their age and harsh climate conditions that take degrade the coatings and steel. Seven of the tanks are in need of rehabilitation or replacement. Three of those are need attention within the next year, including two tanks that need to be replaced soon.

It is important for the District to plan for tank maintenance and replacement based on inspections. In order to routinely inspect the tanks for needed maintenance, a second tank should be provided at each location. One tank can remain in operation while the other tank is taken out of service for cleaning and inspection. This redundancy requires the ability to isolate the tanks. SCADA at all tank sites will also enhance the District's ability to operate and maintain their facilities.

2.8.2 Storage Violations

The District currently has no violations related to the storage tanks.

2.8.3 Storage Condition

The Arizona Administrative Code (AAC) Title 18, Chapter 5 (R18-5-503) recommends that the minimum storage capacity required for a community water system shall be equal to the Average Day Demand (ADD) during the peak month of the year. For PSWID, this equates to the ADD during the peak month of July.

The 2014 Master Plan analyzed the existing PSWID storage tanks against the State guidelines. The analysis assumed that all production wells (District-owned and WSAs) are considered for equalization calculations in Strawberry. Following is an excerpt from the Master Plan that summarizes the results of the storage analysis.

> *"When examined by pressure zones, Strawberry…. meet[s] state recommendations under existing and build-out conditions….[A]ll zones in Strawberry have adequate storage with the exceptions of a minor shortfall in the Homestead zone under existing and build-out demand conditions and about a 30,000 gallon shortfall in the K2/Rimwood/Strawberry Ranch 3 area under build-out demand conditions. The system also likely does not warrant the need to increase storage in the zones due to water quality concerns because of lack of tank turnover; therefore, existing storage volumes are adequate.*
>
> *Pine has adequate storage to meet state….recommendations….under existing conditions and at build-out when evaluated by pressure zones with the exception of the Pine Ranch area. The system likely does not warrant the need to increase storage in this zone due to water quality concerns because*

of lack of tank turnover; therefore, PSWID may choose to monitor the area in coming years if demands increase to review the need for additional storage in the Pine Ranch area."

It should be noted that the above excerpt from the Master Plan reports that there will be storage shortfalls in the Strawberry system at build-out. However, Table 3-6 of the Master Plan report shows that there will surplus amounts of storage in the Strawberry system at build-out under the State requirements.

2.8.4 Suitability of Storage for Continued Use

Because growth within the systems has been nominal since 2014, it is assumed that the above statements regarding adequacy of the storage tanks to meet daily demands are still true. However, beginning in 2012, District Staff has completed inspections of the oldest and most deteriorated tanks and determined that several of the tanks are in need of rehabilitation or replacement. Most of the tanks are of welded steel construction with coatings to reduce corrosion. In some cases, the coatings have failed and rusting of the steel has caused leaks to appear. In other cases, the coatings are failing to the point that, if they are not rehabilitated within a reasonable period of time, the underlying steel will rust through. The inspections also revealed other deficiencies that should be addressed, such as missing handrails, missing vent screen, etc. In addition, the tanks do not meet OSHA standards for fall protection and there are site issues such security fencing, drainage and access for maintenance purposes.

Tanks that are in need of replacement are:

- Canyon Tank #1, and
- Strawberry View 1 Tank

Tanks that are in need of rehabilitation are:

- Brookview Terrace
- Canyon Tank #2
- Portal 2 Tank
- Water Tank Road Tank

Without rehabilitation, the useful life of the tanks that are in better condition will be reduced. The tanks that are 40 to 60 years old have clearly served their expected lives, are prone to catastrophic failure, and are in need of immediate replacement as indicated above. WIFA-funded projects to replace and rehabilitate the above-listed tanks have been identified and are being implemented.

2.8.5 Adequacy of Potable Water Storage Facilities

The storage tank capacity analysis conducted for the 2014 Master Plan indicated that, ignoring fire protection storage, the existing tanks were adequate to serve the needs of the systems with the following exceptions:

1. A minor shortfall in the Homestead zone under existing and build-out demand conditions and
2. About a 30,000 gallon shortfall in the K2/Rimwood/Strawberry Ranch 3 area under build-out demand conditions.

2.8.6 Capacity of Storage

The nominal capacities of the District's storage tanks are provided in Tables 2.5 and 2.6.

2.8.7 Compliance of Storage with Federal, State, and Local Laws

The existing District storage tanks are not subject to any ADEQ Notices of Violation.

2.8.8 Energy Analysis

Not applicable.

2.9 SUPPLY AND DISTRIBUTION PIPING AND APPURTENANCES HISTORY

The majority of the installation of the District's water transmission pipelines and distribution facilities dates back to more than 30 years ago with some going back to the 1960s. The existing water distribution system contains more than 60 miles of water main of widely varying age, material type, and size, ranging in diameter from 1-inch to 8-inches. Table 2.7 summarizes the system pipes by size and material.

Table 2.7 – Pipe Summary

Diameter (inches)	Plastic Pipe Length (feet)	Ductile Iron Pipe Length (feet)	Percent of Total Length	Cumulative Percent of Total Length
1	220	0	0.06%	0.06%
2	63,855	0	18%	18%
3	51,584	0	14%	32%
4	82,048	0	23%	55%
6	145,103	1,098	41%	96%
8	13,683	0	4%	100%
Totals	**356,492**	**1,098**		

Source: PSWID GIS prepared by CH2MHill

The vast majority of the pipe in the system is plastic pipe which includes polyvinyl chloride (PVC) and acrylonitrile butadiene styrene (ABS). The District is in the process of updating the mapping of the system to include an inventory based on the type of pipe material. Current estimates are that approximately 60 percent of the plastic pipe is PVC and 40 percent is ABS. The ABS pipe and some of the PVC pipe are considered to be substandard for use in the public water systems. Thus, these material types comprise most of the pipe failures that plague the system. District Staff have also discovered small amounts of asbestos/cement pipe and galvanized pipe.

Fifty-five percent of the pipe in the system is smaller than 6 inches in diameter. Smaller diameter pipe, especially in rural systems with long runs between customers, can result in substantially lower pressures during peak usage periods.

The 2008 CVL system assessment estimated that the distribution pipes had reached 80 percent their useful lives. District Staff now estimates that the pipes are at 98 percent of their useful lives.

2.9.1 Supply and Distribution Piping and Appurtenances Component Failures

Many of the distribution system pipes were installed by private owners and developers, probably without much oversight by regulatory agencies with jurisdiction. Also, at the time, there was no "water company" to enforce standards for materials, minimum pipe sizes, trench conditions and other quality-related items. This lack of oversight and good quality construction is evident with the poor pipe materials that are discovered by District Staff and the large amount of money and effort that must be expended by the District to repair leaks in the various systems. The age of the infrastructure also contributes to the frequency of pipe breaks. Following are recently compiled data regarding pipe breaks:

- In 2017, PSWID field staff repaired 125 breaks and leaks in mains and service connections across the system.
- An average of 383 hours per month has been spent on repairing leaks and breaks along with another 101 hours per month performing "corrective" maintenance.
- Repairs of items that have failed or broken cost the District almost $240,000 last year alone.
- PSWID staff compiled data on where the main breaks occurred over the past two years. These areas are:
    - North side of Rimwood
    - Strawberry Ranch 3
    - Canyon Tank/Portal 3 Lower
    - Cool Pines Estates
    - Tall Pines/No Name
    - Old Country

  Many of these areas were also identified as problem areas in the 2014 master plan.

The system also suffers from a high rate of unaccounted for and lost water, most of which is due to leaking and broken pipes. There is significant water loss in both the Pine and Strawberry service areas, with a 13.3 percent overall system loss reported in April 2018. The 2014 Master Plan reported that, during 2013 based on PSWID supplied data, the Pine system had a total loss of 37 percent, the Strawberry system lost 12 percent, and the system as a whole lost 29 percent of the water pumped from the ground. One of the contributing factors of the high water loss is the use of ABS pipe. ABS pipe is typically used for drain, waste, and vent piping applications, not for pressurized distribution system piping. Other contributing factors are the age and condition of the system. Over time, as existing pipelines are replaced with PVC or other appropriate pipe materials, and as proactive maintenance of the distribution system is enhanced, it is expected that the system losses will decrease.

2.9.2 Appurtenance Component Failures

The mountainous terrain sometimes requires that pressure regulating valves (PRV) be used to control pressures in the system. In some areas, all of the water to numerous homes is supplied through a PRV. Some of these PRVs are old and failing and need to be replaced in order to enhance their dependability. The District is currently planning to replace and relocate three PRVs in accordance with the recommendations of the Master Plan.

2.9.3 Supply and Distribution Piping and Appurtenances Violations

The District currently has no violations related to the distribution system and appurtenances.

2.9.4 Supply and Distribution Piping and Appurtenances Condition

Given the age, substandard material, and routine failure of supply and distribution piping and appurtenances, the overall condition of the supply and distribution piping and appurtenances is considered to be in very poor or failed condition. District Management has identified numerous replacement projects that would replace at least 142,000 lineal feet of pipes in sizes ranging from 2 inch to 8 inch. Some of those replacement projects, which comprise 49,289 lineal feet of pipe, are moving ahead under WIFA and District capital funding. A list of those projects is included in Appendix G. A second series of projects, which would replace another 93,035 lineal feet of pipe is proposed by this report.

2.9.5 Suitability of Supply and Distribution Piping and Appurtenances for Continued Use

The District's distribution system suffers from aging pipes and valves, substandard materials in a large portion of the system, and routine failure of distribution piping and appurtenances. Because of these factors, the water supply and distribution system piping and appurtenances in many parts of the system are considered to be not suitable for continued use, and requires significant replacement as soon as possible.

2.9.6 Adequacy of Supply and Distribution Piping and Appurtenances

Given the current age, substandard pipe materials, and failure rate, the supply and distribution piping and appurtenances are not adequate to serve the District's needs in many portions of the system. In addition, many of the original pipes are relatively small in size. Table 2.7 shows that almost one-third of the total length of pipes in both systems are 3 inches or smaller, while more than half of the pipes are 4 inches or smaller. During peak demand periods, small pipes can decrease the level of service to system customers by creating high friction losses. Undersized pipes can also require higher system pressures to offset the friction losses and decrease the energy efficiency of the system.

2.9.7 Capacity of Supply and Distribution Piping and Appurtenances

The capacity of the supply and distribution piping and appurtenances in many portions of the system is inadequate because of the age of the pipes, type of material, and the occurrence rate of failures.

2.9.8 Compliance of Supply and Distribution Piping and Appurtenances with Federal, State, and Local Laws

The existing District supply and distribution piping and appurtenances are not subject to any ADEQ Notices of Violation.

2.9.9 Energy Analysis

Internal or external pipeline condition assessments were not performed as part of the scope of services for this PER. However, as piping ages the coefficient of friction typically increases due to tuberculation and deposition of minerals on the pipe walls. Based on age of the piping, it is estimated that 20 to 30 percent of the required energy to operate the system can be contributed to increased friction and can be considered a “loss”.

Additionally, all customer meters are read manually. This is a large labor-intensive operation to read these meters. It uses a significant amount of energy to accomplish this task. By installing remote read meters, the energy required to read the meters would be greatly reduced. It will free personnel to work on other pressing matters which will also the system to operate more efficiently. The more efficient operation of the system will save additional energy.

2.10 FINANCIAL STATUS OF EXISTING FACILITIES

The District’s Financial Statements for fiscal year 2017, as excerpted from the annual audit, are provided in Appendix C.

2.10.1 Monthly Usage Categories for Most Recent Fiscal Year

The District does not have separate usage rates for different categories of customers. All customers pay the same usage rate regardless of whether the customer is residential, commercial or other. However, the District charges a higher monthly base fee for commercial customers compared to residential, and that monthly base fee increases as the meter size increases, up to 2-inch size. The current rate structure does not reflect pricing based on the customer’s distance from the source or the customer’s ground elevation compared to the source.

The District utilizes water usage rate tiers, which are structured to charge more per gallon as the usage increases from one tier to the next higher. This rate structure encourages water conservation because the customer pays more for each gallon of water as they use more. The top tier is for 10,001 gallons and above. Additional information on these rate structures can be found in Appendix D.

2.10.2 Current Water Rate Schedule

The District's current rate schedule is included in Appendix D.

2.10.3 Current Annual O&M Costs

A summary report of the District's operation and maintenance expenses for the fiscal year 2016-2017 is included in Appendix E.

2.10.4 Current Water Distribution System Capital Improvement Program

The District's three-year Capital Improvement Program budget is included in Appendix F.

2.10.5 Water Infrastructure Finance Authority of Arizona

In early summer of 2017, several District Board members and staff met with representatives from the Water Infrastructure Finance Authority (WIFA) of Arizona to explore the possibility of securing a financial aid package for the District. The District Board committed the total annual capital improvements budget amount of $500,000 towards debt service for the loan, and WIFA staff determined that the District qualified for an $8,000,000 loan with some forgivable principal funding. The District completed the applications and documents for the financial aid package and, after processing by the WIFA staff, the District was awarded the $8,000,000 package with $500,000 forgivable principal and a 20-year term. The loan closed on February 9, 2018.

Principal payments have been deferred for the first two years of the loan. All payments will be made from the capital improvements budget of $500,000 each year with no increases to the current rates that were established July 1, 2016. The District has an extensive list of projects to be completed in three phases over the next three years including waterline replacements, tank refurbishments and/or removals/replacements in addition to well refurbishments including new pumps, motors and VFD installations. The projects being financed by the WIFA loan are shown in Appendix G. The following table provides more information for the WIFA loan.

Loan Number	**920283-18**
Closing Date	**02/09/18**
First Payment Period	**07/01/18**
Financial Assistance Terms and Conditions	
Original Loan Amount as of the Closing Date	$8,000,000.00
Forgivable Principal Amount	$500,000.00
Intended Repayment Amount	$7,500,000.00
Loan Term (years)	20
Combined Interest & Fee Rate	2.104%
Total Number of Payment Periods within Loan Term	40
Principal Repayments	
Period Principal Repayment Begin	6
First Principal Repayment Date	07/01/20
Final Principal Repayment Date	07/01/37
Combined Interest and Fee Payment Dates	
First Combined Interest and Fee Payment Date*	07/01/18
Final Combined Interest and Fee Payment Date	07/01/37
Debt Service Reserve Fund Requirements	
Total Reserve Amount	$504,851.79
Annual Amount	$100,970.36
Reserve Funded by:	01/01/23
Replacement Reserve Fund Requirement	
Begin Funding on:	07/01/23
Annual Amount	$100,970.36
Semi-Annual Deposit	$50,485.18
Annual Payment	
Year 1	$62,243.33
Year 2	$157,800.00
Years 3 through 20	$504,851.79

* Actual initial Combined Interest and Fee payment calculated only on dollar amount drawn against loan as of initial payment date.

2.10.6 Existing Debts and Required Reserve Accounts

In addition to the WIFA loan, the District had a pre-existing loan with Compass Bank that was refinanced on July 24, 2015 for $6,444,398. This 10-year loan requires a balloon payment at the end. The current principal balance is approximately $5,823,000 and the payment is approximately $451,034.80 per year. The required reserve is $250,000 which is maintained in a separate account. The District will be required to pay the balance in a balloon payment at the end of the loan period on July 24, 2025. In the meantime, the District has been making extra principal payments on a monthly basis, including a payment in July 2018 of $125,000.

2.11 WATER AND ENERGY AUDITS

The District has not performed any recent energy audits. The 2014 Master Plan reported on a water audit that was compiled by PSWID Staff and found that, during 2013, the Pine system had a total water loss of 37 percent, the Strawberry system lost 12 percent, and the system as a whole lost 29 percent of the water pumped from the ground.

NEED FOR PROJECT

3.1 INTRODUCTION

Many portions of the PSWID system are old and deteriorated; a situation that creates problems for the District and its water customers. The District desires to continue to produce and deliver its potable water to the end-users (customers) from its numerous wells, tanks, booster stations and waterlines. Under this scenario, the District needs to continue to rehabilitate and replace the components of the system, and continue to operate and aggressively maintain its production, distribution, and water storage assets.

This chapter presents a discussion on the general need for water system improvement projects in the PSWID, focusing on three main areas:

1. Health, Sanitation, and Security
2. Aging Infrastructure
3. Reasonable Growth

3.2 STATE REGULATORY INPUT AND CONCERNS

The Safe Drinking Water Act (SDWA) is the main federal law that requires the U.S. Environmental Protection Agency (EPA) to set drinking water standards that public water systems in the U.S. are required to meet, and to ensure the health of water consumers is carefully protected. In Arizona, the EPA has granted the Arizona Department of Environmental Quality (ADEQ) the authority and responsibility to oversee drinking water rules and programs. ADEQ conducts annual compliance inspections for all community water systems. If ADEQ finds the system to be in non-compliance with any of the applicable rules or regulations, a Notice of Violation will be issued to the water system owner and a certain amount of time will be allowed for the problem to be corrected. The PSWID currently has no outstanding Notices of Violation. ADEQ did have some issues with the Strawberry View 1 tank and booster station facilities. The District has recently completed a project to replace the tank, electrical meter panel, sub-panels, controller, and booster pumps, all of which has satisfied the ADEQ concerns.

3.3 HEALTH, SANITATION, AND SECURITY

Poor quality drinking water and poor sanitation are among the world's leading causes of preventable morbidity and mortality. The level of public and professional concern about water safety has been increasing, fuelled by concerns raised by outbreaks of potentially lethal diseases and the recognition of new agents of diseases and the challenges they present to health protection.

The PSWID is under public charge with the responsibility for producing, storing, and delivering safe and secure drinking water to the residential and commercial users within the communities they serve. There are a number of threats to drinking water that may pose a health risk: human threats; wastes injected underground; naturally occurring substances that contaminate drinking water; and drinking water that is not properly treated or disinfected, or which travels through an improperly maintained distribution system. Some of the naturally occurring pollutants that contaminate the drinking water source include microorganisms (bacteria, viruses, parasites, and other microorganisms), nitrates and nitrites, heavy metals, and fluoride. Potential contamination may also occur as a result of human activity. For example, activities such as mining can release large amounts of heavy metals into nearby ground water sources. Another example of human activities that can pollute ground water is improperly managed septic leaching fields.

The District has an excellent history of providing safe, high-quality water to its customers as evidenced by the good annual water quality reports and the lack of violations issued by ADEQ under its water quality rules and regulations. This excellent record is in spite of dealing with operational issues associated with aging and substandard infrastructure.

3.3.1 Health and Sanitation Needs

The minimum basic drinking water system needs to maintain health and sanitation include:

- Water sampling and testing
- High quality source water
- Backflow prevention
- Metered and monitored disinfection
- Adequate system storage
- Minimization of disinfection byproducts

3.3.1.1 Sampling and Testing

The District should continue its permanent sampling and testing location program. Sampling and testing locations are required to be distributed in different areas throughout the system (including the extremities) to obtain an accurate and timely overview of the water quality in the distribution system. Sampling and testing locations need to be strategically selected based on land use, system configuration, and ease of access. A process of continuous improvement should be based on the hydraulic water model to designate and engineer locations for required water quality sampling and testing. These locations may change over time as the system is upgraded and expanded.

3.3.1.2 High Quality Source Water

The District is blessed with high quality groundwater to pump and serve to its customers with minimal treatment. The District should continue to be diligent about testing the groundwater as it is pumped to the surface to monitor for both organic and inorganic contaminants including microbiological monitoring. The overall objective of microbiological monitoring (i.e., monitoring for total coliforms and *E. coli*) in water distribution systems is related to the protection of public health, especially to the prevention of the spread of waterborne diseases. The presence of total coliforms in groundwater indicates that contamination of the well may have occurred due to the lack of or degradation of the well's sanitary seal. Monitoring of the location and proper maintenance of septic waste systems that may be located near wells is essential to help eliminate well contamination. The District has made a commitment to disinfect the well water and monitor the residual chlorine levels in the system. Travel time, water age, and lack of disinfectant residual in the water system may increase the potential for biological growth in the outlying areas and/or reservoir sites.

Triggered source water monitoring is conducted if a total coliform-positive sample is collected. If the triggered source water sample indicates the presence of fecal coliform, corrective action is taken. From 2010 to 2013, triggered source water sampling was only required once at the end of 2012. The triggered monitoring results were absent for fecal coliform and no further action was required of PSWID by the State.

3.3.1.3 Backflow Prevention

Section R18-4-215 of the Arizona Administrative Code requires all public water systems to protect against contamination caused by backflow through unprotected cross-connections by requiring the installation and periodic testing of backflow-prevention assemblies. Article III, Section 5 of the District's Rules and Regulations, as adopted on January 19, 2017, require the customer to provide an approved backflow prevention device on the customer's side of the meter, if required by the District. Article V, Section 2.5 of the District's Rules requires the customer to maintain the backflow device, if installed. The District should ensure that all of the major water users within the PSWID service area (i.e. commercial businesses, apartment complexes, and restaurants) have backflow prevention devices installed on the main water supply line to their facilities. The lack of a backflow preventer on the water service can, under certain conditions, result in contaminated water being drawn into the District's mains, thus compromising the quality and safety of the entire water system and putting the safety of the end-users (customers) at risk. All major water users and other customers that represent a potential source of contamination within the District's service area should have a properly tested and installed backflow preventer assembly on the service connections. The District should continue its regular backflow preventer testing program.

3.3.1.4 Metered and Monitored Disinfection

There are numerous disinfection technologies used in the water industry to remove or inactivate disease-causing organisms, or to prevent the formation of harmful chemicals. Proper disinfection of the finished water in a supply system is the single most important aspect of potable water delivery and is a response to most of the regulatory requirements for municipal water system operation. The District has been using one of the simplest methods for well water disinfection, which is the introduction of chlorine (sodium hypochlorite or bleach) in liquid form into the system. The District is in the process of converting its disinfection systems from the pellet type to the liquid injection type. Typically, these chlorine injection systems are flow-paced to properly measure and dose the correct amount of disinfectant. Downstream of the injection point and throughout the system sampling locations are identified where samples can be obtained to measure the disinfectant residual to ensure that it is being maintained within regulated and effective parameters.

3.3.1.5 Adequate System Storage

For the maintenance of good health and sanitation within the PSWID system, adequate water storage to meet the peak demands must be provided. Lack of adequate storage may result in tanks being depleted during peak periods, which could cause booster stations to shut down or perform poorly. This situation could cause unusually low or zero pressures in the system, which means that customers cannot obtain water from the system for their sanitation needs.

The storage tank capacity analysis conducted for the 2014 Master Plan indicated that, ignoring fire protection storage, the existing tanks were adequate to serve the needs of the systems with the following exceptions:

1. A minor shortfall in the Homestead zone under existing and build-out demand conditions, and
2. About a 30,000 gallon shortfall in the K2/Rimwood/Strawberry Ranch 3 area under build-out demand conditions.

It should be noted that the above conclusions from the Master Plan indicate that there will be storage shortfalls in the Strawberry system at build-out. However, Table 3-6 of the Master Plan report shows that there will surplus amounts of storage in the Strawberry system at build-out under the State requirements. The water storage situation throughout the District should be assessed to ensure that the stored water can be delivered to the system areas that need peak supplies and to avoid stranding water in remote storage tanks. This analysis of the volumes of storage and where they are located with respect to the demands will also help to ensure that, during the winter when demands are low, water is not being stored unused and stagnating in certain areas.

3.3.1.6 Minimization of Disinfection Byproducts

The Environmental Protection Agency promulgated the Stage 2 Disinfectants and Disinfection Byproduct Rule (DBPR) to reduce potential cancer risks and address concerns with potential reproductive and developmental risks from disinfection byproducts (DBPs). Disinfectants are an essential element of drinking water treatment because of the barrier they provide against harmful waterborne microbial pathogens. However, disinfectants react with naturally occurring organic and inorganic matter in source water and distribution systems to form DBPs that may pose health risks. The Stage 2 DBPR is designed to reduce the level of exposure from DBPs without undermining the control of microbial pathogens. The groundwater pumped by the District's wells contain low levels of organics that can form DBPs.

The federal regulations establish maximum contaminant levels (MCLs) for disinfectants and DBPs. PSWID maintains an average Chlorine residual concentration of approximately 0.7 milligram per liter (mg/L) within the distribution system, which adequately meets state requirements. Prior to 2014, PSWID monitored total trihalomethanes (TTHMs) and five regulated haloacetic acids (HAA5s) at 10 different locations under Stage 1 DBPR. Annual monitoring from 2010 to 2013 shows that the TTHMs and HAA5 levels in PSWID's system are well below the MCLs of 80 micrograms per liter (µg/L) and 60 µg/L, respectively. Due to the low levels, the State reduced the number of monitoring locations for DBPs from 10 to 2 under Stage 2 DBPR (effective 2014). The following table provides the levels of TTHMs, HAA5, and Chlorine in the PSWID system for the years 2009 through 2016.

Test Results for Disinfection and Disinfection Byproducts

Year	TTHMs (ppb)			HAA5 (ppb)			Chlorine (ppm)		
	MCL	Low	High	MCL	Low	High	MRDL	Low	High
2009	80	ND	0	60	ND	0	4	0	1.83
2010	80	ND	ND	60	ND	ND	4	0.47	0.70
2011	80	ND	13.2	60	ND	ND	4	0.47	0.70
2012	80	ND	0.0136	60	ND	0.0063	4	0.23	1.26
2013	80	ND	13.1	60	ND	15	4	0.07	3.96
2014	80	5.7	11.2	60	ND	3.9	4	0.49	1.32
2015	80	4.8	16.5	60	ND	7.7	4	0.48	1.32
2016	80	2.2	22.6	60	ND	10	4	0.40	3.7

ppb = parts per billion
ppm = parts per million
ND = Not Detected

3.3.2 Security Needs

Drinking water is critical to the life of an individual and of society. In addition to health and sanitation needs, drinking water is essential to many businesses and other services such as health care. Contamination or loss of the local drinking water supply could have far-reaching implications for the public health and economic welfare of the community. As part of their obligation to supply potable water to its customers, the PSWID should strive to implement a secure and resilient drinking water infrastructure that provides clean and safe water as an integral part of daily life, ensuring public confidence in the District's drinking water service through a layered defense of effective preparedness and security practices.

The Federal and State governments have long been active in addressing security risks and threats through regulations, technical assistance, research, and outreach programs. As a result, an extensive system of regulations governing maximum contaminant levels of 90 contaminants, construction and operating standards (principally implemented by State regulatory agencies), monitoring, emergency response planning, training, research, and education have been developed to better protect the Nation's drinking water supply and receiving waters.

The Arizona Department of Environmental Quality (ADEQ) has adopted regulations that provide for basic protection of and security for public water systems. Section R18-4-204 of the Arizona Administrative Code (AAC) requires all public water systems to have an emergency operation plan that includes the steps to be taken to assure continuation of service in the following emergency situations:

1. Loss of a source;
2. Loss of water supply due to major component failure;
3. Damage to power supply equipment or loss of power;

4. Contamination of water in the distribution system from backflow;
5. Collapse of a reservoir, reservoir roof, or pumphouse structure;
6. A break in a transmission or distribution line; and
7. Chemical or microbiological contamination of the water supply.

Protection of the water supply is also enhanced by sanitary surveys that are conducted by ADEQ personnel or third parties approved by ADEQ. Section R18-4-208 of the AAC requires a sanitary survey be conducted every five years for a public water system, or more frequently as determined by ADEQ. The frequency of the sanitary survey is based on the quality and quantity of the source water, and whether the system is properly designed, maintained and operated.

Engineering Bulletin 10 - Guidelines for the Construction of Water Systems (May 1978), as adopted by ADEQ under Section R18-5-502 of the AAC, provides sizing and design criteria as well as other requirements and guidelines for public water systems. Bulletin 10 requires well sites to be enclosed in building or surrounded with a 6-foot high fence. Bulletin 10 states that it is desirable for booster stations to be enclosed in a structure or building and to be secured by locked doors or 6-foot high security fencing with locked gates. Storage tanks shall include a 6-foot fence, locks on access manholes, or other necessary precautions to prevent trespassing, vandalism, and sabotage.

The EPA and Department of Homeland Security (DHS) in their 2010 Water Sector-Specific Plan (https://www.dhs.gov/sites/default/files/publications/nipp-ssp-water-2010-508.pdf) addressed risk-based critical infrastructure protection strategies for, among others, drinking water utilities. The Plan describes processes and activities to enable the protection, and increased resilience, of the water sector's infrastructure. These strategies, goals and recommendations are in addition to the vulnerability assessments and emergency response plans that were mandated by the Bioterrorism Act of 2002. At present, the District has basic security provisions at all of its sites and is working to achieve "post 9-11 security" as commonly referred to in the water industry. However, these measures are not consistent and need to be upgraded.

3.3.2.1 Security Needs Program

The District is evaluating each well, tank and booster station site as a part of its ongoing program to upgrade and improve all of its facilities. An assessment of the security needs of each site is a part of that ongoing evaluation and upgrade program.

3.4 AGING INFRASTRUCTURE

The infrastructure upgrades required of the District's drinking water system are very extensive and can be grouped into four major categories that are addressed in this report: (1) source water, (2) pumping, (3) distribution, and (4) storage, each of which plays an important role in delivering safe and convenient drinking water to the public. Metering is another critical piece of the overall system infrastructure, because of the need for accuracy in delivering water to customers and charging them for that service. The District strives to maintain accurate metering by replacing worn out meters as needed.

3.4.1 Infrastructure Needs

This section provides an overview of the District's water infrastructure needs.

3.4.1.1 Source Water Upgrades

As previously discussed, the District has sufficient well capacity in the Pine system to meet the peak demands of its customers now and into the future. The Strawberry system has adequate well capacity today, but will experience a shortfall as build-out of the area approaches. However, some of the wells are very old and in need of rehabilitation. The average age of the wells in the Pine portion of the system is 38 years. The average age of the wells in the Strawberry portion of the system is 43 years. A few of the wells are 50 years old.

These older wells are subject to catastrophic failure and should be replaced in the near future. Some wells may experience drawdown issues as the regional groundwater table becomes lower, both seasonally and in response to drought conditions. The District is monitoring well drawdown measurements and has found that the wells are experiencing about a 50-foot drawdown from winter to summer. If the drawdown worsens over time due to pumping and drought, some of the wells will need to be deepened or replaced with deeper wells. The District also needs to upgrade the well pump controls to variable frequency drives (VFD) for the well pumps to replace obsolete equipment and provide energy savings.

The District has recently received a one time State Grant for energy conservation to undertake numerous projects including installation of Variable Frequency Drives on the motors of wells. The District has made the following improvements at the following locations:

Current State Grant-Funded Well Projects

Facility Name	Type of Project
Magnolia/Ralls- WM & VFD Installation	VFD
Milk Ranch Well #2	VFD
Pine Crest - Lot 25	VFD
Portal 3 - Lot 97 (WSA)	VFD
Strawberry Hollow	VFD
Strawberry Hollow (Old PSWID SH3)	VFD
Strawberry Hollow Intertie (New SH3)	VFD
Strawberry Ranch 5 - TR C	VFD
Strawberry View 1 - Lot 59	VFD

As discussed in Section 2.10.5, the District has recently received a loan from the Water Infrastructure Finance Authority of Arizona to undertake numerous projects including well rehabilitation. The District is moving ahead with the following WIFA-funded well projects:

Current WIFA-Funded Well Projects

Facility Name	Type of Project
White Oaks Glen 1 - Parcel 76E (WSA)	VFD
White Oaks Glen 1 - Parcel 82 (WSA)	VFD
Milk Ranch Well #2	Well Rehab
Pine Crest - Lot 25	Well Rehab
Milk Ranch Well #1	Well Rehab
Portal 3 - Lot 97 (WSA)	Well Rehab
Strawberry Hollow	Well Rehab
Strawberry Hollow (Old PSWID SH3)	Well Rehab
White Oaks Glen 1 - Parcel 76E (WSA)	Well Rehab
White Oaks Glen 1 - Parcel 82 (WSA)	Well Rehab

As discussed in Section 1.6, the District has the opportunity to utilize up to 500 acre-feet per year of surface water from the C.C Cragin Reservoir. However, the costs to do so may be prohibitive and the District should examine the feasibility of utilizing that source before committing its resources. Also, the reliability of the C.C Cragin Reservoir as a source of water for the District should be considered. It is reported that the current water level in the reservoir is 20 feet below the intake for the Town of Payson system that is currently under construction.

3.4.1.2 Pumping

As previously discussed, 14 of the District's 25 booster stations are in need of upgrades and rehabilitation due to their age and obsolete equipment. Six of these booster stations should be addressed within the next year including pump replacements and new VFD control systems to enhance energy efficiency. Improvements for all 14 of the booster stations that need attention are being funded by the WIFA loan. The 14 booster stations are:

- Brookview Terrace - TR A (2 Pumps)
- Pine Ranch 2 - Lot 25 (1 Pump)
- Strawberry View 1 - Lot 59 (1 Pump)
- Portal 2 - Lot 178 (1 Pump)
- Strawberry Knolls 2 - Lot 138 (2 Pumps)
- Hardscrabble Mesa (1 Pump)
- Portal 2 Common Area - Next to Lot 166 (1 Pump)
- Pine Mountain Acres - Lot 7 (2 Pumps)
- Pine Valley Homesites - Lot 109 (2 Pumps)
- Strawberry Hollow #3 (2 Pumps)

- Strawberry Mountain Shadows 1 - Lot 25 (2 Pumps)
- Strawberry Ranch 2 - TR D (Pumps Failed - Replace 2 Pumps)
- Strawberry Ranch 5 - TR C (1 Pump)

3.4.1.3 Transmission and Distribution Upgrades

While the extent of the use of substandard pipe materials and installation methods is still being discovered by PSWID Staff, the District has identified a list of 19 pipeline replacement projects that will replace failing and undersized pipe, and replace a failing PRV. That list of projects represents almost 40 percent of the system and over 142,000 lineal feet of pipe. Implementing those projects will go a long way towards eliminating the leaks and broken pipes that plague the system and cause a substantial amount of lost water and a large cost to the District's annual budget. Twelve of those projects are included in the WIFA-funded program that is currently being implemented and are listed below. An additional seven projects, totaling about 101,099 lineal feet of pipe, are recommended for implementation by this report and are listed in Table 4.2.

Current WIFA-Funded Pipe Replacement Projects

Project Name	Type	Project Cost
Circle Drive Waterline Replacement-Completed	Pipe Replacement	$196,536.90
Whispering Pines (Size 6")	Pipe Replacement	$256,289.00
Pine Creek 4" Waterline Replacement-Completed	Pipe Replacement	$146,185.08
Pinewood Haven/Rim Vista Waterline Replacement	Pipe Replacement	$805,000.00
Cool Pines Est Pipe Upgrade Phase A/Water Tank Rd 100K	Pipe Replacement	$502,940.00
Strawberry Ranch 2 & Strawberry Knolls 2 -Completed	Pipe Replacement	$1,050,000.00
Tall Pines Pipeline Upgrade Phase A	Pipe Replacement	$458,370.00
Tall Pines Pipeline Upgrade Phases B & C	Pipe Replacement	$1,270,410.00
Spruce Drive Waterline Replacement	Pipe Replacement	$115,500
Total		**$4,810,230.98**

3.4.1.4 Storage Needs

As stated earlier, the District needs, within the next year, to replace the Canyon Tank #1, replace the Strawberry View Tank #1 (currently under construction – WIFA-funded), and rehabilitate the Brookview Terrace Tank. Within the next three to five years, the District needs to rehabilitate the Canyon Tank #2, Portal 2 Tank, Water Tank Road Tank, and the Strawberry Creek Foothills Tank. This work is a part of the current WIFA-funded program.

3.4.2 Principal Infrastructure Concerns and Impact

The PSWID water system faces a number of challenges including aging and failed/failing infrastructure, increasing regulatory requirements, staffing limitations, and inadequate resources. These challenges are magnified by a condition where little change in population and water-based revenue is expected. Much of the water infrastructure in the PSWID service area is nearing or past the end of its useful life and needs to be replaced. Much of the PSWID infrastructure was installed more than 40 years ago, which is the time period pipelines of those construction materials can be expected to last.

3.4.3 Water Loss

A reasonable water loss rate for a public water system of any size is 10 percent. In 2013, the PSWID overall water system loss rate was 29 percent. In April 2018, the overall loss rate was 13.3 percent. Replacement of the substandard and failing waterlines will greatly help to continue reducing the water loss rate, with the goal of achieving 10 percent or less.

3.4.4 Management Adequacy

The District has recently hired a full-time Manager with an extensive background in water system operations, maintenance and management of public water systems. In addition, the District has retained consulting engineering firms to advise and assist with the implementation of capital improvements.

3.4.5 Existing Design Concerns

The PSWID system suffers primarily from under-design in the areas of pipe size, storage tank size and redundancy, pump redundancy, and system-wide SCADA. The major waterline replacements that are needed will alleviate most of the severely undersized waterlines. Through the WIFA-funded program, nearly 50,000 feet of existing undersized and failing pipes will be replaced with larger pipes consisting of appropriate materials. Regarding storage, there is a projected shortfall of 30,000 gallons in the Strawberry system. But, the larger need regarding storage is to replace and rehabilitate certain tanks as discussed previously. Several of the existing booster stations have only one pump. If that pump fails, there is no back-up pump and that area is out of water. The District desires to provide a redundant pump at all booster stations and redundant storage tanks or interconnections.

3.4.6 System Obsolescence

The PSWID water infrastructure needs costly upgrades. As with many utilities, when their water infrastructure was built decades ago, an adequate plan to fund its upkeep, maintenance, and replacement was not put in place. This is not the fault of the District, because it inherited the water systems that had been operated without adequate maintenance for decades. PSWID, like others, is now entering a period where many of the water pipes, tanks and booster facilities built over the last 50 years are failing and need to be replaced more or less at the same time. This aging or obsolete infrastructure and its replacement will put a tremendous financial strain on the District. PSWID is not unique in that they are limited on how much they can raise water rates, due to resistance from the customers. The District recognizes this conundrum and has embarked on an ambitious and proactive program to begin replacement and rehabilitation of its infrastructure using loans and grants.

3.4.7 Distribution System Infrastructure Safety Concerns

Safety associated with the District's water system is primarily related to protecting the quality of the water that is pumped into the pipes. Potential threats to that safety can come from contamination of the groundwater, inadequate disinfection, animal tank intrusion, lack of adequate site security, backflow events, and main breaks that allow contaminated water to enter the system. District Staff is aware of these potential threats and has implemented programs to reduce these threats. Again, the age and obsolescence of the infrastructure contributes to the occurrence, frequency and severity of these threats. The District must also address OSHA compliance for its facilities and systems, as well as OSHA-compliant personnel practices. The District must find funding for projects that will minimize the potential safety hazards represented by these threats.

3.5 REASONABLE GROWTH

The 2014 Master Plan author conducted an analysis to forecast the estimated water demand at build-out of the existing water service areas. This analysis was performed by using aerial photos and ground review to determine vacant parcels. These parcels were compared to the County's General Plan to determine future land uses. Water duties (a calculation of how much water is used on a per-acre basis by different existing land uses) were applied to the acreage for each future land use. Table 3.1 shows the future average day demand by land use for parcels that have yet to be developed, as of 2013. All water infrastructure, including wells, tanks, boosters, pipes and related facilities should be installed by the land developers who are causing the growth.

It appears that no growth has occurred within the PSWID system since the Master Plan was prepared using 2013 data. The Master Plan reported that the District served approximately 3,200 customers in 2013. In November 2017, the District served 3,142 customers.

Table 3.1 - Future Development Breakdown[1]

Land Use	Acres	Duty Factor (gpd/acre)	Average Day Demand (gpd)	Average Day Demand (gpm)
Commercial	1	295	288	0.2
Mixed Use (Mixed)	28	103	2,880	2.0
Multifunctional Corridor (Multi-Use)	43	471	20,160	14.0
Residential 0.4 du/acre	18	160	2,880	2.0
Residential 1 du/acre	342	80	27,360	19.0
Residential 2-3.5 du/acre	228	79	18,000	12.5
Residential 3.5-5 du/acre	1.3	22	28.8	0.02
Residential 5-10 du/acre	2	22	43.2	0.03
Residential 10+ du/acre	16	22	360	0.25
Totals	**679.3**		**72,000**	**50**

[1] Source: *Pine-Strawberry Water Improvement District Water System Master Plan*, CH2MHill, 2014, 2-6.

As the table shows, it was estimated by the Master Plan authors that the build-out conditions for the system will add an average demand of 72,000 gallons per day (gpd) or 50 gallons per minute (gpm). The Master Plan calculated the existing average day demand during 2010 to 2013 to be 131 gpm. The projected growth represents a 38 percent increase in water demand due to build-out of the service area. The Master Plan did not project when build-out would occur. The District should update the Master Plan and the system model to provide a plan for the water supplies and infrastructure that will be needed to serve the future development within the system.

3.5.1 Capacity Necessary to Meet Needs During Planning Period

Source Water: The Master Plan analyzed the system demands and supplies and provided a comparison by service area under existing and build-out scenarios. These comparisons are shown in Figures 1.5 and 1.6. The Pine system has adequate water supply today and at build-out to meet both the Average Day Demand (ADD) and the Maximum Day Demand (MDD). Strawberry has adequate supplies to meet ADD under existing and build-out demand scenarios and existing MDD, if WSA wells are included. However, Strawberry does not have enough supply, even with the use of WSA wells to meet MDD at build-out. PSWID has the flexibility to transfer water from Pine to Strawberry to make up for this shortfall using District-owned wells under existing conditions, but there is not enough supply available in Pine to continue this practice into the future without the use of WSA wells. The Master Plan recommended that the District either purchase or install new water supply wells, but did not provide additional details of location or size. Based on growth projections in the Master Plan, new well supplies of at least 100 gpm capacity would be needed to meet the build-out maximum day demands (Growth MDD = Growth ADD of 50 gpm x Peak Factor of 2 = 100 gpm). The computer model of the system should be updated and expanded to ensure that the new supplies are located near the future demands.

Storage: As the Master Plan stated, "…all zones in Strawberry have adequate storage with the exceptions of a minor shortfall in the Homestead zone under existing and build-out demand conditions and about a 30,000 gallon shortfall in the K2/Rimwood/Strawberry Ranch 3 area under build-out demand conditions…therefore, existing storage volumes are adequate." The system model should be updated and expanded to ensure that these storage facilities can efficiently serve the new development locations.

The Master Plan also states, "Pine has adequate storage…under existing conditions and at build-out when evaluated by pressure zones with the exception of the Pine Ranch area. The system likely does not warrant the need to increase storage in this zone [i.e. Pine Ranch (explanation added)] due to water quality concerns because of lack of tank turnover; therefore, PSWID may choose to monitor the area in coming years if demands increase to review the need for additional storage in the Pine Ranch area." Providing mixing and/or controlling the fill and draw of these tanks during low demand conditions could resolve this issue.

It should be noted that the above excerpt from the Master Plan reports that there will be storage shortfalls in the Strawberry system at build-out. However, Table 3-6 of the Master Plan report shows that there will surplus amounts of storage in the Strawberry system at build-out under the State requirements.

Booster Pumping: The 2014 Master Plan did not identify any pumping capacity shortfalls in the current conditions or at build-out. The Master Plan recommended three booster station upgrade projects, but these were intended to address existing pressure issues, not to provide for future growth.

Distribution Waterlines: With respect to the distribution system, the Master Plan focused more on issues with old and small waterlines, rather than growth. As stated previously, the system is plagued with old, substandard plastic piping that is failing, and the District has the desire to replace roughly 40 percent of the existing pipelines with high-quality, larger diameter pipes. The Master Plan identified several areas where growth of the system is expected and provided cost estimates of new pipelines that would be needed to serve those areas, which are Bradshaw, Old Country, Tall Pines, 300K, Canyon Tank Brook View Terrace, Hidden Pines, Pine Ranch 1, and Rimwood. The Master Plan identified these future pipelines as 6-inch PVC and estimated the total cost at $1,464,350. These future pipelines will likely be installed by land developers, and the District should review and approve their plans prior to construction.

3.5.2 Facilities Proposed to be Constructed to Meet Future Growth Needs

Source Water: It is estimated that an additional 100 gpm of well capacity will be needed within the overall system by the time the service area reaches build-out. Most of the existing

PSWID wells produce in the range of 30 to 60 gpm. Therefore, two to three additional wells will be needed at the time of build-out. As the system expands and develops toward build-out, the need for additional wells beyond the 100-gpm estimate, in order to provide redundancy and meet peak demands, should be monitored by the District and implemented as needed.

Storage: The Master Plan identified storage shortfalls at build-out conditions only in the Strawberry system; in the Homestead zone and the K2/Rimwood/Strawberry Ranch 3 area. But, the Master Plan did not propose projects to remedy these shortfalls. Also, it should be noted that these conclusions from the Master Plan, that there will be storage shortfalls in the Strawberry system at build-out, are contradicted by Table 3-6 of the Master Plan report which shows that there will surplus amounts of storage in the Strawberry system at build-out under the State requirements.

Booster Pumping: Based on the Master Plan and current operations, it appears that additional booster pumping capacity will not be needed to serve the build-out system conditions. The greater need at this time is to rehabilitate the existing booster stations to install new, more efficient pumps, motors and controls, and to provide redundancy. However, the District should monitor the hour meters for the pump stations where growth is occurring in order to ensure that the pumps are adequately sized to meet the demands without running an inordinate amount of time. Implementing a system-wide SCADA system will help District Staff to monitor booster operations and plan for pump replacements or upgrades.

Distribution Waterlines: Additional pipelines will be needed to serve the growth areas, but their installation can wait until the development of the areas is proposed through the Gila County approval process. The District should monitor this process to be sure they are aware of pending developments that will require their services. The District should also require that these pipes and related facilities be installed at the expense of the developers. The District should also require modeling of the system and these proposed expansions to ensure that the pipes are located and sized properly, valves are located appropriately, and low pressure and dead end area are avoided.

3.5.3 Timeline for Phased Growth Expansion

Projections described in Section 1.4 indicate that the populations of the Pine and Strawberry communities will be declining from their current levels during the years beyond 2025. However, the 2014 Water Master Plan identified nearly 680 acres of land that could develop in the future and add 72,000 gallons per day to the District's average day demand. These two pieces of information are incongruous and raise the question of how much future development, and therefore, demand for water, will be seen by the PSWID.

If growth within the PSWID service area occurs, it is impossible to predict the timeline for that growth, because multiple factors that affect development of vacant land in this portion of Arizona are involved in the process. The District should not be spending its scarce resources installing facilities in anticipation of growth. By the same token, the District should be monitoring development approvals through the County to be aware of pending development and to then work with the developers to install the necessary infrastructure.

In the meantime, the District is moving ahead with numerous system improvement projects using funding through the WIFA loan. All of those projects, however, are aimed at improving the existing facilities and operations, and are not providing capacity for future growth within the service area.

3.5.4 Estimated Number of New Customers Committed

The Master Plan's projection of vacant land development within the system resulted in a 38 percent increase in average day demand at build-out. The District currently serves about 3,148 customers. A 38 percent increase would mean an additional 1,196 customers at the time of build-out. Based on District meter readings over the last 12 months, customers consume an average of 77 gallons per day. Applying that factor to the 72,000 gallon per day increased average day demand projected by the Master Plan results in an additional 935 customers at build-out.

3.6 SUMMARY AND CONCLUSIONS

The importance of a reliable and efficient water distribution and treatment system is self-evident. The health of the communities, the protection of its water source, and future economic growth and development, are linked to the District's ability to maintain, and as necessary, upgrade these facilities. As described in this report, however, PSWID's water system components are failing, and the District does not have the funds to adequately repair and replace the necessary infrastructure. Clearly, there is a compelling need for a comprehensive and sustainable water infrastructure funding program, and significant additional investment from the federal government is needed for this purpose.

The overall major challenges for the District include:

- Substandard, failed and obsolete infrastructure past its useful life
- Deteriorated infrastructure rapidly approaching the end of its useful life
- Limited ability to fund improvements

Delaying the infrastructure improvement investment can result in health and safety risks, degrading water service, more water service disruptions, and more expenditures for emergency repairs. In addition, the failure of substandard pipe materials creates lost water and additional cost to the District not only for the repairs, but also for the water that is pumped and then wasted. Just as important is the implementation of a program to ensure that the District's drinking water remains safe and that multiple barriers against contamination are in place. These barriers include source water protection, treatment, distribution system integrity, and a public information program.

Many of the District's critical water system components have reached or exceeded their design life and must be repaired or replaced. Maintaining and repairing an aging and obsolete water system such as the PSWID presents many unique challenges. For example, maintaining and rehabilitating water storage tanks requires that they be taken out of service for cleaning and recoating. This is difficult to do without interrupting water service to customers. Also, the lack of redundant pumps and reliable controls at booster stations can result in the water service being out of commission during nights and weekends, when emergency repairs must be made. And, the very large amount of effort that must be expended in fixing numerous pipe leaks each month takes Staff away from focusing on other critical maintenance needs of the aging facilities and creates a large expense to the District.

This report serves as a foundation for the District's efforts to attack these issues and as the next step in the critical process of establishing a sustainable water infrastructure funding program.

ALTERNATIVES CONSIDERED

4.1 ALTERNATIVES CONSIDERED

This evaluation has demonstrated that major infrastructure improvements are needed in the PSWID systems in the following categories:

- Source Water (Wells)[7]
- Water Storage
- Booster Stations
- Distribution System

The existing PSWID water supply system has been developed gradually over the last several decades based solely on decentralized groundwater wells, tanks, and booster stations that are located close to the homes and businesses that they serve. Consideration of alternative improvement strategies for a water system such as the PSWID system cannot feasibly involve changing the fundamental nature of the system from decentralized well supplies to a centralized supply from a point source of surface water such as a lake or river.

Therefore, the approach utilized in this evaluation is consideration of alternative projects for each of the four system categories that are based on the criticality of the need within each category and among the categories. The District has commenced a WIFA-funded program that will rehabilitate eight wells, upgrade controls for 11 wells, replace or rehabilitate seven storage tanks, upgrade all 23 booster stations, and replace more than 49,000 lineal feet of waterlines. This report identifies additional projects for well rehabilitation and distribution pipeline replacements.

Following is a summary of the alternatives considered for each category. Detailed descriptions of the alternatives are presented later.

4.1.1 Source Water

The PSWID does not have a viable alternative to the use of groundwater to serve its customers, with the possible exception of surface water from the C.C Cragin Reservoir, the feasibility of which is questionable (see Section 1.6.1). Other than the C.C. Cragin Reservoir, there are no surface water supplies that are large enough, sufficiently dependable, or legally available to the District that are within a reasonable distance to the PSWID service areas. The available volume of unclaimed water from the C.C. Cragin Reservoir is 500 acre-feet per year, which is compared to the District's current average groundwater production of about 300 acre-feet per year. Thus, if feasible, the C.C. Cragin reservoir could represent a long-term alternative or supplemental source of water for the PSWID.

[7] The District may want to consider utilizing C.C Cragin surface water to supplement its well supplies.

However, utilizing water from the C.C. Cragin Reservoir would be substantially different from the District's current operational scheme. The District's system is currently designed to operate from decentralized well sites and booster stations. Utilizing the water from the C.C. Cragin Reservoir would require the water to enter the system at one location. A previously conceived plan for a pipeline from the C.C. Cragin Reservoir to the PSWID had the pipeline connecting at the easternmost end of the system on Highway 87. Because the system is not designed for all of the water to enter the system at that location, transmission mains, and possibly booster stations, would be needed to ensure efficient movement of the water from the source to the 27 different service zones.

It is beyond the scope of this study to determine how to convert the PSWID system to the use of surface water or to determine its feasibility. It is recommended that the District analyze that feasibility and take advantage of the C.C. Cragin water, if feasible. In the meantime, this evaluation will focus on groundwater continuing to provide the source water for the District.

The following two alternatives were considered under Source Water:

1. Rehabilitate existing wells
2. Drill new wells.

4.1.2 Distribution System

A significant portion of the District's distribution system is more than 30 years old and was constructed using substandard pipe materials such as ABS and PVC that are not intended for use in high-pressure public water systems. These pipes are failing on a regular basis. The District recorded a monthly average of more than 10 pipe breaks or leaks in the system during fiscal year 2017. District Staff have identified the locations where most of these pipe breaks occur. Many of these locations were also identified as problem areas in the 2014 Master Plan.

Alternative projects, in the traditional sense, for the distribution system, which is based on conveying water in an underground pipe system, do not exist. Therefore, alternatives for the distribution system projects are limited to the sizes and materials of the pipes. With respect to inadequate pipe size, the 2014 Master Plan identified only the Cool Pines Estates waterline replacement project, which would replace the entire system of 2-inch pipes in that area, as the only project to replace undersized pipes. The Master Plan also identified three looping projects that would tie together dead-end mains to help improve pressures during peak demands. These projects are included in the WIFA-funded program and are currently being implemented.

Making pipes unnecessarily large can lead to stagnant and stale water issues, especially considering the second-home nature of the community. Many homes in Pine and Strawberry remain empty for several months at a time, thus adding to potential stagnant and stale water issues. For these reasons, the District has decided that, unless a recognized hydraulic deficiency exists, pipes that are four inches in diameter and larger will be replaced with new pipes of the same size. Any pipes smaller than four inches will be upgraded to at least four-inch diameter.

With respect to pipe materials, it is recommended that two pipe materials be investigated for use in the pipeline replacement projects:

1. PVC pipe, which meets the requirements of AWWA Standard C900 with a pressure class of 250, and
2. Ductile Iron pipe with a pressure class of 350.

4.2 DESCRIPTION OF ALTERNATIVES CONSIDERED

The alternatives considered under the two principal categories are further developed in the following paragraphs. Descriptions include design criteria, schematic layout map, environmental impacts, land requirements, potential construction problems, sustainability considerations, and cost estimates.

4.2.1 Source Water

Drill New Wells: The District will need to add well capacity to the Strawberry system between now and build-out of the area. This additional capacity could be provided by new wells drilled by the District or by developers of the lands. The timing of these new wells is determined by the timing of the new development. Thus, new wells needed for capacity to meet build-out demands are beyond the scope of this evaluation.

The District may also need to drill new wells to solve existing or emerging water quality problems and to replace wells that are failing. Any replacement well will be a long-term project for the District due to acquisition of a site, test drilling, permitting and well completion.

It is anticipated that a new deep well will be installed near the location of the K-2 Tank Site.

Rehabilitate Existing Wells: The WIFA-funded project will provide rehabilitation and other improvements for 19 of the District's wells. In addition, the following wells should be replaced or rehabilitated within the next few years to restore their production capacities and extend their useful lives.

Table 4.1 – Wells Recommended for Rehabilitation

Name	Designation	System Location	Year Drilled	ADWR Registration No.
Strawberry Hollow Intertie (New SH-3)	SH-3	Pine	2002	55-587628
Strawberry Ranch 5 - Tract C	SR-5	Strawberry	1970	55-635779
Strawberry View 1 – Lot 59	SV1	Strawberry	*	55-635774
Milk Ranch Well 1	MR-1	Pine	2006	55-210454

* Unknown – Deepened in 1998

The rehabilitation process is intended to inspect and clean the well casing as well as attempt to solve any operational problems with the well. The rehabilitation process is generally described as follows:

1. Pull pump and motor; inspect and verify condition; rehabilitate, repair, or replace as appropriate. VFD will be added to these pumps.
2. Check condition of column piping and connections; replace as necessary.
3. Perform video inspection of casing; look for scale and other build-up; check condition of casing slots/perforations; clean and open slots, free of scale, silt, etc.
4. Wash and clean well casing; re-video; repeat until clean.
5. Reinstall equipment; conduct pumping test; determine pumping rates and drawdown with soundings.
6. Install level transducers to monitor water levels and control pumping rates accordingly.
7. To increase well capacity or pumping depth:
    a. Determine if there is water bearing strata available below current pumping level.
    b. If there is sand in the bottom, deepen operational limits and add perforations there.
    c. If no sand present, deepen hole by drilling through bottom (assumes the casing diameter is large enough to allow a drill though) and extend casing with new perforations.
    d. Re-install equipment and conduct pumping test.

4.2.2 Water Storage

The WIFA-funded project includes seven projects associated with the District's storage tanks, including the replacement of two tanks and rehabilitation of five others. There are no other tank-related projects to be included in this report.

4.2.3 Booster Stations

The WIFA-funded project includes 14 projects associated with the District's booster stations, including additional pumps, replacement of existing pumps, and the addition of VFD drives. There are no other booster station-related projects to be included in this report.

4.2.4 Distribution System

Replace Existing Pipelines: In addition to the projects to be funded by WIFA, listed in Table 4.2 are the pipeline replacement projects recommended for completion within the next few years.

Table 4.2 – Recommended Waterline Replacement Projects

Name	System Location	Replacement Pipe Diameter (inches)	Length (feet)
Wagon Wheel Way Road (crossing Fossil Creek Road)	Strawberry	6	1,200
North of Fossil Creek Road and West of Tomahawk Lane	Strawberry	4 thru 6	19,358
North of Fossil Creek Road between Tomahawk Lane and Rimwood Road	Strawberry	4 thru 6	18,510
North of Fossil Creek Road between Hwy 260 and Rimwood Road	Strawberry	4 thru 6	27,619
Strawberry View/Ralls	Strawberry	4 and 6	19,847
Portals 1 and 2 Waterline Replacement	Pine	4 thru 8	14,565
Total Length			**101,099**

4.3 DESIGN CRITERIA

The design criteria for the major water system components are summarized in Table 4.3. The information in this table should be further detailed and expanded upon to develop facility specific design criteria as part of a pre-design phase.

Table 4.3 - Design Criteria for Major Water System Components

Wells	• Water quality – meets primary Maximum Contaminant Level and close to secondary MCL standards • Total water quantity – increase if possible • Security – per EPA/ADEQ Guidelines and Standards • Site drainage • SCADA and Instrumentation & Control (I&C)
Pipelines	• Replacement pipelines shall be the same diameter, unless a hydraulic deficiency has been identified in the area, or per ADEQ minimum size criteria, but not less than 4-inch diameter • Pipe material for high-pressure applications (greater than 150 psi) shall be ductile iron or steel. Ductile iron, class 350 or PVC class 250 for normal system pressures • Cathodic protection or polywrap for ductile iron pipe • Within public right-of-way or existing PUEs • Properly restrained • Air release and blow-off valves
Monitoring, SCADA, I&C	• New software • New PLCs • Cyber security • Operational flexibility • Multiple operating points • Remote operation capability • System model • Remote read meters capability

4.4 LAYOUT MAPS

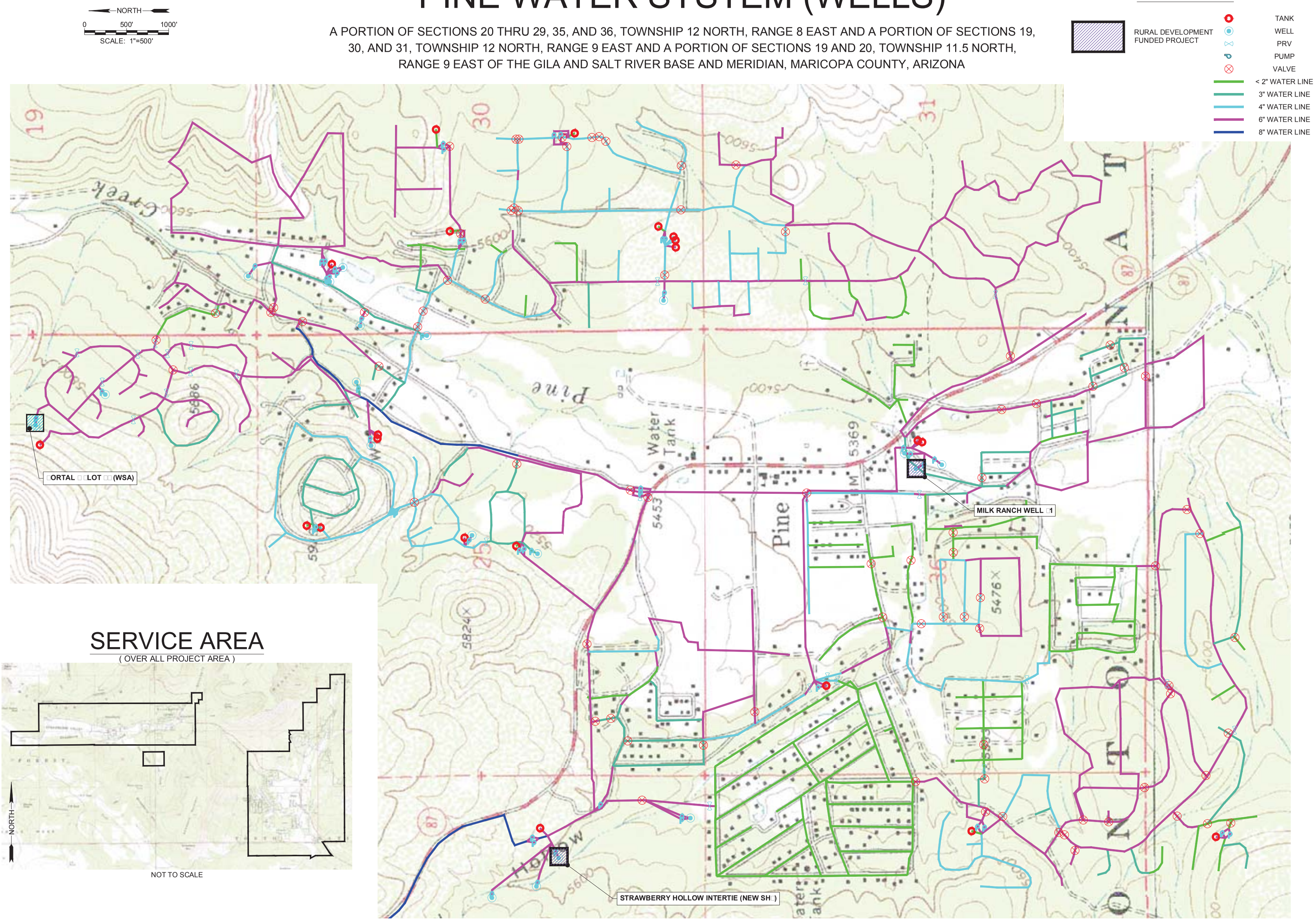
Figures 4.1 through 4.4 are maps of the District service area on which the improvement projects listed above are shown.

4.5 ENVIRONMENTAL IMPACTS

All waterline projects presented in this report will replace existing waterlines within existing roadway rights-of-way or easements. New pipelines will be installed more or less parallel to the existing pipelines in new trenches. The existing pipes will be abandoned in place. New trenching will create asphalt waste in paved streets. Asphalt waste will likely be crushed and recycled or disposed of in a local approved landfill. Some waste dirt from the new trenches will be generated and will likely be recycled locally either on the road or on the roadway

PINE WATER SYSTEM (WELLS)

A PORTION OF SECTIONS 20 THRU 29, 35, AND 36, TOWNSHIP 12 NORTH, RANGE 8 EAST AND A PORTION OF SECTIONS 19, 30, AND 31, TOWNSHIP 12 NORTH, RANGE 9 EAST AND A PORTION OF SECTIONS 19 AND 20, TOWNSHIP 11.5 NORTH, RANGE 9 EAST OF THE GILA AND SALT RIVER BASE AND MERIDIAN, MARICOPA COUNTY, ARIZONA



PINE STRAWBERRY WATER IMPROVEMENT DISTRICT
WATER SYSTEM - PROPOSED PROJECTS
PINE AND STRAWBERRY, ARIZONA

EXHIBIT 2: CAPITAL IMPROVEMENT PROGRAM

EPS GROUP
125 S. Avondale Blvd., Suite 115
Avondale, AZ 85323
T:623.547.4661 | F:623.547.4662
www.epsgroupinc.com

REVISIONS:

DESIGNER: EPS
DRAWN BY: EPS

NOT FOR CONSTRUCTION

JOB NO. 16-058
04-15-2019
SHEET NO. 2 OF 2

FIGURE 4.1

STRAWBERRY WATER SYSTEM (WELLS)

A PORTION OF SECTIONS 20 THRU 29, 35, AND 36, TOWNSHIP 12 NORTH, RANGE 8 EAST AND A PORTION OF SECTIONS 19, 30, AND 31, TOWNSHIP 12 NORTH, RANGE 9 EAST AND A PORTION OF SECTIONS 19 AND 20, TOWNSHIP 11.5 NORTH, RANGE 9 EAST OF THE GILA AND SALT RIVER BASE AND MERIDIAN, MARICOPA COUNTY, ARIZONA

LEGEND

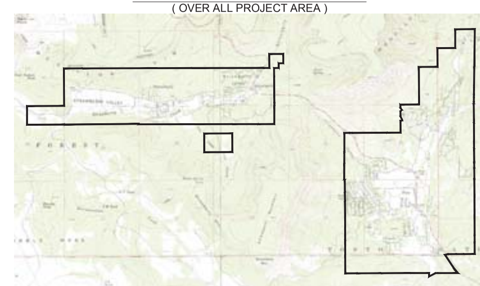
- TANK
- WELL
- PRV
- PUMP
- VALVE
- < 2" WATER LINE
- 3" WATER LINE
- 4" WATER LINE
- 6" WATER LINE
- 8" WATER LINE
- RURAL DEVELOPMENT FUNDED PROJECT

NORTH

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

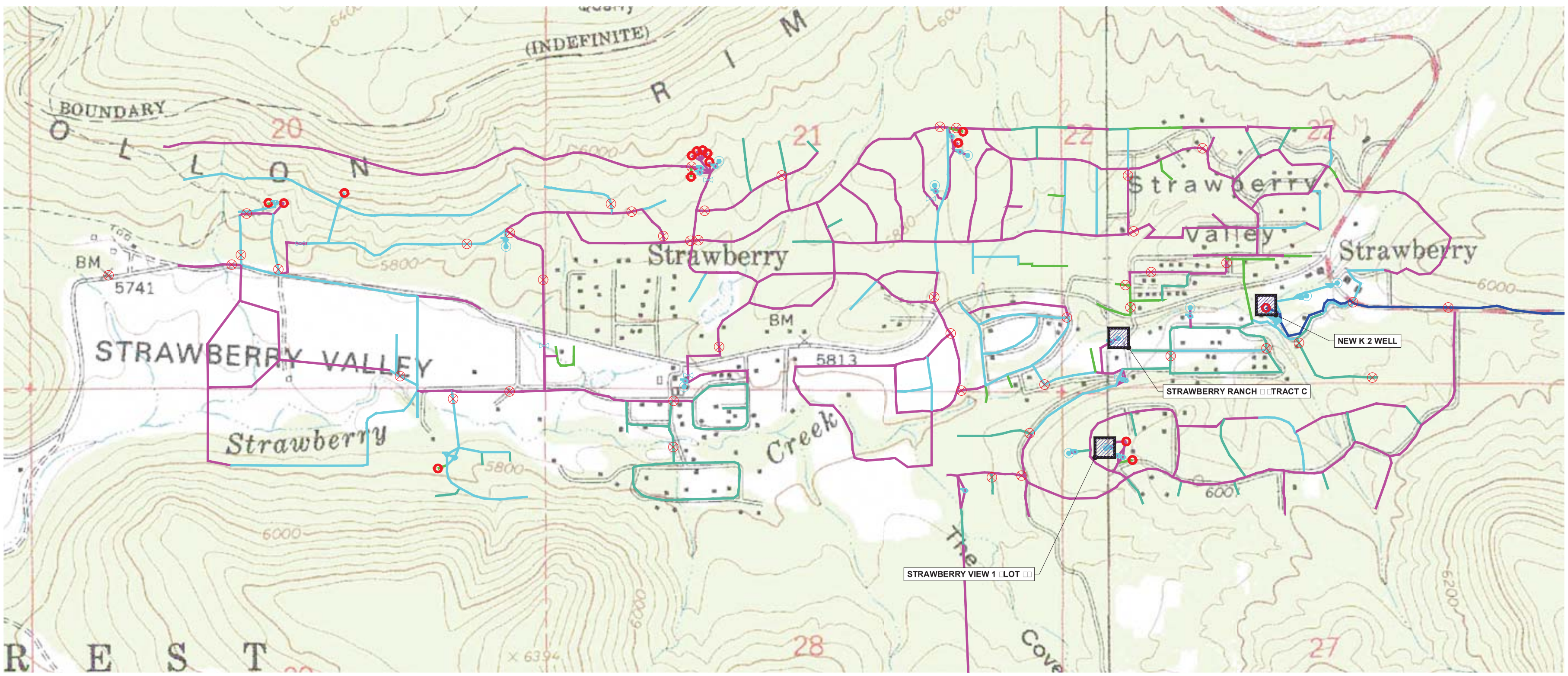
SERVICE AREA

(OVER ALL PROJECT AREA)



NORTH

NOT TO SCALE



PINE STRAWBERRY WATER IMPROVEMENT DISTRICT
WATER SYSTEM - PROPOSED PROJECTS
PINE AND STRAWBERRY, ARIZONA

EXHIBIT 1: CAPITAL IMPROVEMENT PROGRAM

EPS GROUP
125 S. Avondale Blvd., Suite 115
Avondale, AZ 85323
T:623.547.4661 | F:623.547.4662
www.epsgroupinc.com

REVISIONS:

DESIGNER: EPS
DRAWN BY: EPS

NOT FOR CONSTRUCTION

JOB NO. 16-058

04-15-2019

SHEET NO. 1 OF 2

FIGURE 4.2

PINE WATER SYSTEM (PIPES AND VALVES)

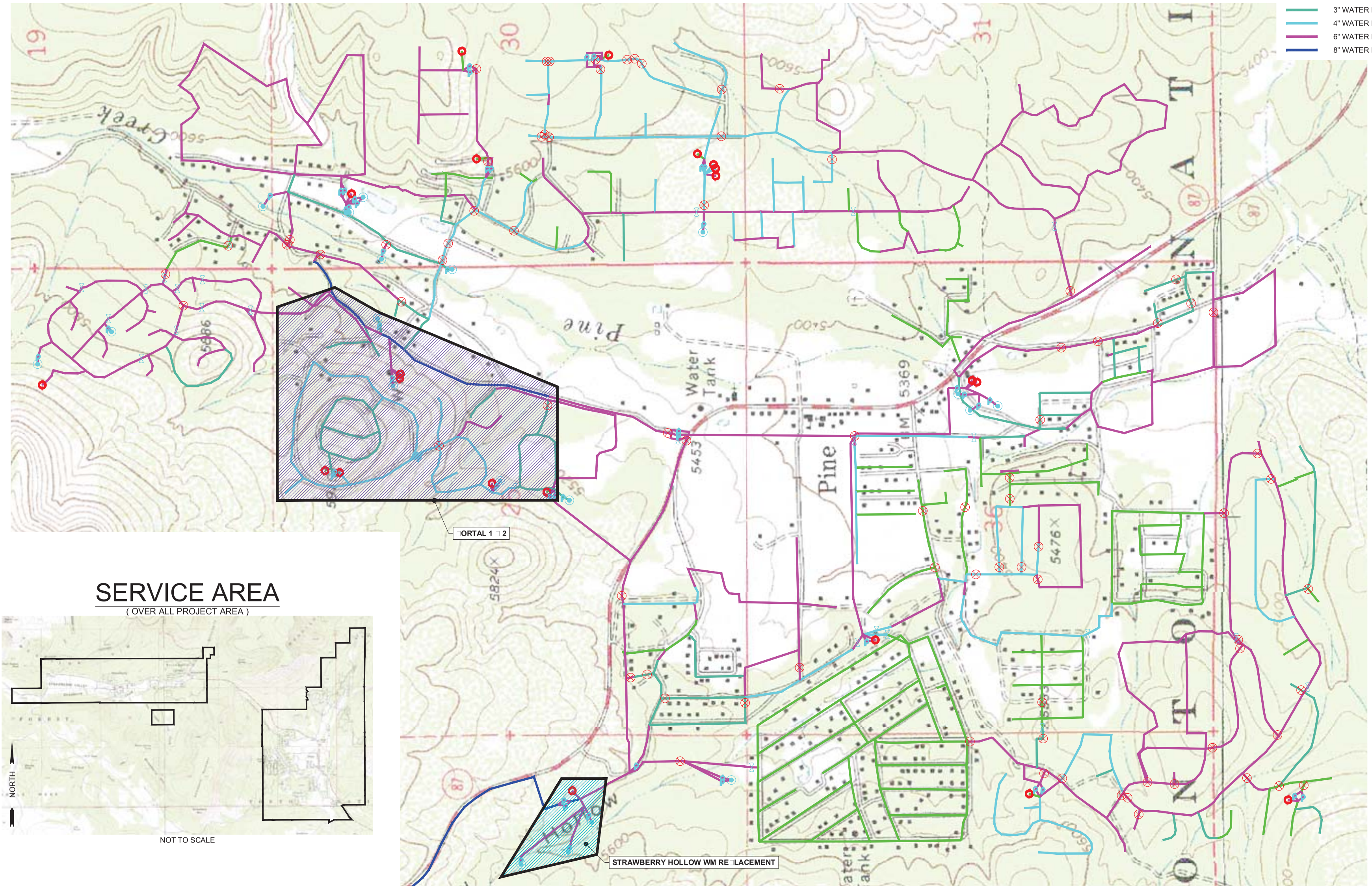
A PORTION OF SECTIONS 20 THRU 29, 35, AND 36, TOWNSHIP 12 NORTH, RANGE 8 EAST AND A PORTION OF SECTIONS 19, 30, AND 31, TOWNSHIP 12 NORTH, RANGE 9 EAST AND A PORTION OF SECTIONS 19 AND 20, TOWNSHIP 11.5 NORTH, RANGE 9 EAST OF THE GILA AND SALT RIVER BASE AND MERIDIAN, MARICOPA COUNTY, ARIZONA

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

LEGEND

RURAL DEVELOPMENT FUNDED PROJECT

- TANK
- WELL
- PRV
- PUMP
- VALVE
- < 2" WATER LINE
- 3" WATER LINE
- 4" WATER LINE
- 6" WATER LINE
- 8" WATER LINE



SERVICE AREA

(OVER ALL PROJECT AREA)

NORTH

NOT TO SCALE

16-058 - PINE STRAWBERRY WATER IMPROVEMENT DISTRICT - WATER SYSTEM

Apr 15, 2019 4:02pm V:\CAD\Pine Strawberry\16-058 Water System Map\Production Drawings\Proposed\PSWID Proposed Projects Pipes-Valves Exhibit.dwg

iduarte

EPS GROUP
125 S. Avondale Blvd., Suite 115
Avondale, AZ 85323
T:623.547.4661 | F:623.547.4662
www.epsgroupinc.com

PINE STRAWBERRY WATER IMPROVEMENT DISTRICT
WATER SYSTEM - PROPOSED PROJECTS
PINE AND STRAWBERRY, ARIZONA

EXHIBIT 2: CAPITAL IMPROVEMENT PROGRAM

REVISIONS:

DESIGNER: EPS
DRAWN BY: EPS

NOT FOR CONSTRUCTION

JOB NO. 16-058
04-15-2019
SHEET NO. 2 OF 2

FIGURE 4.3

STRAWBERRY WATER SYSTEM (PIPES AND VALVES)

A PORTION OF SECTIONS 20 THRU 29, 35, AND 36, TOWNSHIP 12 NORTH, RANGE 8 EAST AND A PORTION OF SECTIONS 19, 30, AND 31, TOWNSHIP 12 NORTH, RANGE 9 EAST AND A PORTION OF SECTIONS 19 AND 20, TOWNSHIP 11.5 NORTH, RANGE 9 EAST OF THE GILA AND SALT RIVER BASE AND MERIDIAN, MARICOPA COUNTY, ARIZONA

LEGEND

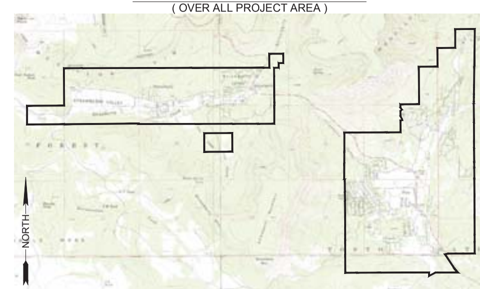
- TANK
- WELL
- PRV
- PUMP
- VALVE
- < 2" WATER LINE
- 3" WATER LINE
- 4" WATER LINE
- 6" WATER LINE
- 8" WATER LINE
- RURAL DEVELOPMENT FUNDED PROJECT

NORTH

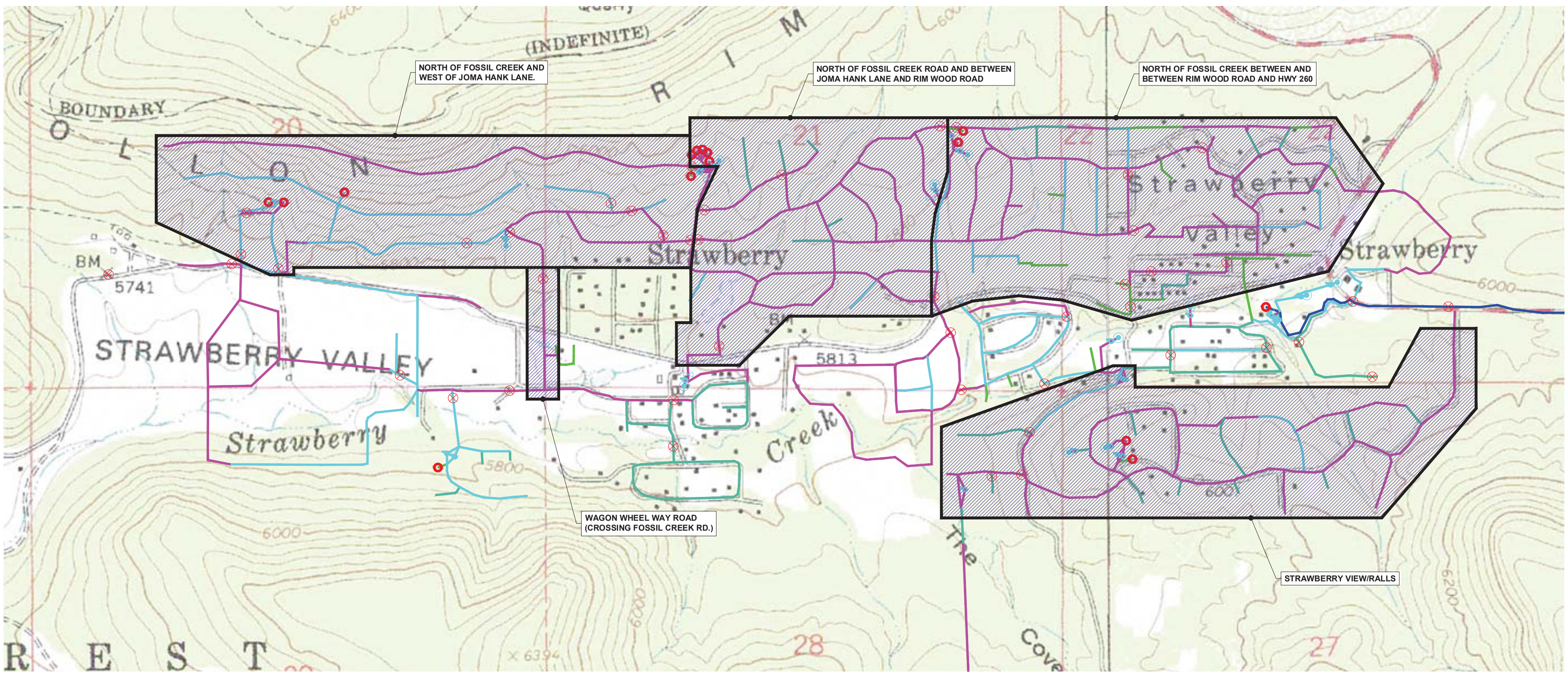
0 500' 1000'
SCALE: 1"=500'

SERVICE AREA

(OVER ALL PROJECT AREA)



NOT TO SCALE



EPS GROUP
125 S. Avondale Blvd., Suite 115
Avondale, AZ 85323
T:623.547.4661 | F:623.547.4662
www.epsgroupinc.com

PINE STRAWBERRY WATER IMPROVEMENT DISTRICT
WATER SYSTEM - PROPOSED PROJECTS
PINE AND STRAWBERRY, ARIZONA

EXHIBIT 1: CAPITAL IMPROVEMENT PROGRAM

REVISIONS:

DESIGNER: EPS
DRAWN BY: EPS

NOT FOR CONSTRUCTION

JOB NO. 16-058
04-15-2019
SHEET NO. 1 OF 2

FIGURE 4.4

shoulders. It is anticipated that little, if any, new trenching will be done outside of previously disturbed areas.

Rehabilitation of existing wells will produce residual material that is cleaned from the inside of the well casing and muddy/sandy water that is produced when the well is re-developed following cleaning. The construction documents for the well rehabilitation projects will include requirements for the Contractor to capture residuals in an on-site settling basin before allowing excess water to leave the site into natural drainageways.

If new wells are drilled, new sites for the wells may need to be acquired by the District. Replacement wells should not be drilled immediately adjacent to existing wells due to the possibility that decades of pumping may have eroded underground caverns adjacent to the well casing. Depending on the location of the new well sites, trees and undergrowth will need to be cleared from most of the site to accommodate the well, the well drilling equipment, settling basin, access drive and equipment pads. Under a permit issued by the Arizona Department of Water Resources, the well drilling operation will produce water, sand, soil, and mud that will be directed to a settling basin to allow only clear water to leave the site. Depending on the drilling method, much of the water may be recycled as drilling mud, but any that is discharged from the site will have residuals settled out beforehand.

4.6 POTENTIAL LAND REQUIREMENTS

Because all the proposed waterline replacement projects will be confined to existing rights-of-way and easements, acquisition of additional land for these projects is not anticipated. Likewise, well rehabilitation projects will be contained within the existing well sites. Drilling new wells may require acquisition of new well sites. A well site that is not associated with a storage tank will vary in size depending on location and terrain, but will typically be less than one acre. However, the District should confirm property limits and easement locations to ensure that no additional land rights are needed. This may require a field survey of each property and easement owned by the District.

4.7 CONSTRUCTIBILITY ISSUES

4.7.1 Existing Conditions That Could Affect Construction

This section presents the existing conditions that could affect the construction of the proposed improvements. The main existing conditions in the PSWID water distribution system that could affect construction include, but are not limited to, the following:

- Presence of bedrock or cobbles during excavation
- Extensive permitting required
- Potential archeological issues (minimized if construction limited to existing right-of-way or easements)
- Potential environmental issues (minimized if construction limited to existing right-of-way or easements)

- Off-season (winter) construction to avoid service disruption due to construction during peak season (summer) water consumption
- Potential for excavations in snow and frozen ground during winter
- Potential for excavation/site flooding during monsoon rains
- Traffic control and protection on streets and highways
- Construction disruption to residents and local businesses including business access
- Maintaining service during construction and new component switchovers
- Remote geographical location for materials and supplies
- Limited skilled/local labor availability
- Lack of information about the existing District infrastructure
- Adequate District staff to oversee the design, construction, and start-up and commissioning efforts
- Lack of staff training (safety, design review, construction oversight, facility operation, and management etc.)

4.7.2 Conditions That Could Affect Operation of the Facilities

This section presents the existing conditions within the system that could detrimentally affect the operation of the proposed improvements. The main existing conditions in the PSWID water distribution system that could affect system operation include, but are not limited to, the following:

- Extensive operational permitting
- Extensive regulatory compliance and monitoring
- Potential environmental issues
- Expediting project schedule to remain ahead of continued system deterioration
- Remote geographical location for replacement parts and supplies
- Limited skilled/local labor availability
- Lack of information about the existing District infrastructure
- Adequate District staff to oversee the operation, maintenance, upkeep, security, and record keeping for the Proposed Project
- Adequate budget

4.8 SUSTAINABILITY CONSIDERATIONS

Table 4.4 is a summary of the potential sustainability considerations for the projects recommended by this report.

Table 4.4 - Sustainability Considerations for Water Distribution System Improvements

Projects	Water and Energy Efficiency	Green Infrastructure	Other Aspects of Sustainability
Rehabilitate Existing Wells	• More efficient pumps • Reduced electrical use • Increased production	• Rehabilitate existing facilities	• To be determined and planned for during Preliminary Design Activities
Install New Wells	• More efficient Pumps • Reduced electrical use • Increased production • Eliminate water quality issues (sanding)	• Reduce water stream of water by reducing pump to waste requirement due to reduced sanding of well	• To be determined and planned for during Preliminary Design Activities
Replace Failing Water Lines	• Eliminate leakage with new piping • Energy savings • Reduction in lost water	• Reduce water loss • Reduce operation costs • Reduce energy use	• To be determined and planned for during Preliminary Design Activities
Prepare System Maps and Water Model with Operating Procedures Manual	• Less time and energy wasted trying to locate water lines • More efficient operation of system	• Reduce water loss • Reduce operation costs • Reduce energy use	• To be determined and planned for during Preliminary Design Activities
Install SCADA System	• Less time and energy wasted with manual operation • More efficient Operation	• Reduce water loss • Reduce operation costs • Reduce energy use	• To be determined and planned for during Preliminary Design Activities
Install Electronic Read Water Meters	• Less time and energy wasted with manual operation • More efficient Operation	• Reduce water loss • Reduce operation costs • Reduce energy use	• To be determined and planned for during Preliminary Design Activities

4.9 COST ESTIMATES

Estimates of the implementation costs for the recommended projects identified in the previous sections are presented in the following tables. The project cost estimates include construction costs, engineering, construction management, permitting, and a construction contingency amount.

4.9.1 Rehabilitate Existing Wells

The cost estimate to rehabilitate one of the District's wells is shown in Table 4.5. The rehabilitation scope of work is described in Section 4.2.1.

Table 4.5 – Well Rehabilitation Cost Estimate

	Quantity	Unit Price	Estimated Cost
Construction Cost			
Inspect, clean and rehab existing well	1	$90,000	$90,000
Non-Construction Cost			
Bid Documents		5%	$4,500
Construction Management		5%	$4,500
Construction Contingency		10%	$9,000
Total Estimated Project Cost			**$108,000**

As listed in Table 4.1, four wells are recommended to be rehabilitated. The total estimated cost for all four wells is $432,000.

4.9.2 Drill New Wells

The estimated cost to drill a new well within the District's service area is shown in Table 4.6. The estimated depth of 1,500 feet for the new well is based on an average of the existing District wells in the area. The proposed depth of a new well would be determined by a hydrogeologist based on a study of a particular site.

Table 4.6 – Estimated Cost to Drill New Well

	Quantity	Unit Price	Estimated Cost
Construction Cost			
Site acquisition (0.5 acre)	1	$75,000	$50,000
Mobilization, Demobilization	1	$42,000	$42,000
Clear site	1	$4,000	$4,000
Drill and case 8-inch hole (feet)	1500	$500	$200,000
Install surface casing & well seal	1	$25,000	$10,000
Construct well head & appurtenances	1	$50,000	$12,000
Install submersible well pump	1	$50,000	$10,000
Piping and valves	1	$50,000	$50,000
Electrical and controls	1	$75,000	$50,000
Fence, site improvements	1	$20,000	$20,000
Subtotal			$1,141,000
Non-Construction Cost			
Bid Documents		10%	$114,100
Construction Management		10%	$114,100
Construction Contingency		15%	$171,150
Total Estimated Project Cost			**$1,540,350**

The total cost to drill a new well is estimated to be $1,540,350.

4.9.3 Waterline Replacement Projects

The recommended waterline replacement projects are described in Table 4.2. A cost estimate for each project is included in Table 4.7.

Table 4.7 – Waterline Replacement Projects Estimated Costs
Wagon Wheel Way Road (crossing Fossil Creek Road)

	Quantity (feet)	Unit Price	Estimated Cost
Construction Cost			
New 6" Waterline	1,200	$125.00	$150,000
Non-Construction Cost			
Plans, Specs, and Estimates		10%	$15,000
Construction Management		10%	$15,000
Construction Contingency		15%	$22,500
Total Estimated Project Cost			**$202,500**

North of Fossil Creek Road and West of Tomahawk Lane (all waterlines)

	Quantity (feet)	Unit Price	Estimated Cost
Construction Cost			
New 4" Waterline	3,864	$115.00	$444,360
New 6" Waterline	15,494	$125.00	$1,936,750
Subtotal	**19,358**		**$2,381,110**
Non-Construction Cost			
Plans, Specs, and Estimates		10%	$238,111
Construction Management		10%	$238,111
Construction Contingency		15%	$66,654
Total Estimated Project Cost			**$2,923,986**

North of Fossil Creek Road and Between Rimwood Road and HWY 260 (all waterlines)

	Quantity (feet)	Unit Price	Estimated Cost
Construction Cost			
New 4" Waterline	9,703	$115.00	$1,115,845
New 6" Waterline	17,916	$125.00	$2,239,500
Subtotal	**27,619**		**$3,355,345**
Non-Construction Cost			
Plans, Specs, and Estimates		10%	$335,535
Construction Management		10%	$335,535
Construction Contingency		15%	$167,377
Total Estimated Project Cost			**$4,193,791**

North of Fossil Creek Road and Between Rimwood Road and Tomahawk Road (all waterlines)

	Quantity (feet)	Unit Price	Estimated Cost
Construction Cost			
New 4" Waterline	10,583	$115.00	$1,217,045
New 6" Waterline	7,927	$125.00	$990,875
Subtotal	**19,069**		**$2,207,920**
Non-Construction Cost			
Plans, Specs, and Estimates		10%	$220,792
Construction Management		10%	$220,792
Construction Contingency		15%	$182,557
Total Estimated Project Cost			**$2,832,061**

Strawberry View/ Ralls

	Quantity (feet)	Unit Price	Estimated Cost
Construction Cost			
New 4" Waterline	8,064	$115.00	$927,360
New 6" Waterline	15,494	$125.00	$1,472,875
Subtotal	**19,069**		**$2,400,235**
Non-Construction Cost			
Plans, Specs, and Estimates		10%	$240,024
Construction Management		10%	$240,024
Construction Contingency		15%	$139,104
Total Estimated Project Cost			**$3,019,386**

Portals 1 & 2 Waterline Replacement

	Quantity (feet)	Unit Price	Estimated Cost
Construction Cost			
New 4" Waterline	12,590	$115.00	$1,447,850
New 6" Waterline	1,175	$125.00	$146,875
New 8" Waterline	800	$135.00	$108,000
Subtotal	**14,565**		**$1,702,725**
Non-Construction Cost			
Plans, Specs, and Estimates		10%	$170,273
Construction Management		10%	$170,273
Construction Contingency		15%	$217,178
Total Estimated Project Cost			**$2,260,448**

The total estimated cost for all six waterline replacement projects is $15,432,171.

4.9.4 Administrative Projects

The Administrative projects are included in Table 4.8.

Table 4.8 – Water System Category Cost Estimate Summary by Alternative

Alternatives	Total Estimated Cost
Prepare Water Model with Standard Operating Procedures	$300,000
Install Supervisory Control and Data Acquisition (SCADA) System	$500,000
Install Electronic Read Meters	$2,500,000
Three Administrative Projects	**$3,300,000**

4.9.5 Summary of Estimated Costs

Table 4.9 provides a summary of the project costs for the recommended projects described above. Included in the estimate is the Annual Operation and Maintenance (O&M) cost for each project. Annual O&M costs were derived from the District's 2017 O&M Report which is included as Appendix E.

Table 4.9 – Water System Category Cost Estimate Summary by Alternative

Alternatives	Construction Cost	Non-Construction Cost	Annual O&M Cost	Total Estimated Cost
Rehabilitate Four Existing Wells	$360,000	$72,000	$81,300	$513,300
Drill New Well	$1,141,000	$399,700	$81,300	$1,621,650
Five Waterline Replacement Projects	$12,197,335	$3,234,836	$120,960	$15,553,131
Three Administrative Projects	$2,500,000	$800,000	$39,000	$3,339,000

SELECTION OF AN ALTERNATIVE

5.1 INTRODUCTION

In an evaluation such as this at a preliminary engineering level, selection of alternatives would be based on a life-cycle cost analysis and a comparison of the alternatives using the calculated net present value. In the case of the PSWID system, few alternatives exist for improving such a system without changing the fundamental way in which the system operates.

5.1.1 Source Water

In Section 4.1.1, two alternatives were presented for the source water component of the PSWID system; 1) Rehabilitate existing wells and 2) Drill new wells. As has been previously discussed, there are no viable alternatives to groundwater wells for providing source water to the system, with the possible exception of surface water from the C.C. Cragin Reservoir, the feasibility of which is questionable. Absent that option, the District will continue to rely on its existing groundwater wells, probably in perpetuity.

Because groundwater wells are expensive to permit and install and are not always successful in producing the quality and quantity of water desired, the District must use their existing wells as long as possible, i.e. to extend their service lives to the maximum. Loss of a groundwater well is usually caused by a failure of the steel casing and/or its perforations. Regular cleaning and video inspections of each well will allow District Staff to know when a well is approaching the end of its useful life and begin planning for its replacement. Depending on the geologic conditions, the replacement well may need to be drilled some distance away from the old well, which may require acquiring a new site, which will add time and complexity to the replacement process.

There are no alternatives for drilling new wells. No other option of source water is available. No other sources of water are available.

5.1.1.1 Life Cycle Cost Analysis – Source Water

Life cycle cost analyses (net present value) were developed to allow comparison of the two Source Water alternatives. The planning period for these analyses is 20 years, and a discount rate of 0.2 percent was used (from the current Appendix C of OMB circular A-94). The economic life of a well is assumed to be 50 years for the purpose of calculating the salvage value. However, wells can be operational for 70 or more years depending on how well the casing and formation around the casing withstand the age and pumping of the well. It was assumed that the Annual O&M expense would be the same for all wells. Table 5.1 is a summary of the life cycle cost analyses for each of the alternative well projects.

Table 5.1 – Life Cycle Cost Analysis Summary for Well Projects

Project	Capital Cost	Annual O&M Cost	Capital Cost Present Value	Annual O&M Cost Present Value	Salvage Value Present Worth	Net Present Cost
Strawberry Hollow Intertie Well (New SH-3)						
Rehabilitate	$108,000	$81,300	$108,000	$2,432,710	($167,000)	$2,370,710
Drill New Well	$1,540,350	$81,300	$1,540,350	$2,432,710	($460,000)	$3,613,060
Strawberry Ranch 5 – Tract C (SR-5)						
Rehabilitate	$108,000	$81,300	$90,000	$2,432,710	($167,000)	$2,370,710
Drill New Well	$1,540,350	$81,300	$1,540,350	$2,432,710	($460,000)	$3,613,060
Strawberry View 1 – Lot 59 (SV1)						
Rehabilitate	$108,000	$81,300	$90,000	$2,432,710	($167,000)	$2,370,710
Drill New Well	$1,540,350	$81,300	$1,540,350	$2,432,710	($460,000)	$3,613,060
Milk Ranch Well #1 (MR1)						
Rehabilitate	$108,000	$81,300	$90,000	$2,432,710	($167,000)	$2,370,710
Drill New Well	$1,540,350	$81,300	$1,540,350	$2,432,710	($460,000)	$3,613,060

For all four well projects, the net present cost of drilling a new well is higher, and therefore less desirable, than rehabilitating the existing well. Furthermore, drilling groundwater wells, especially in a mountainous region, is not an exact science. Failure of a new well to produce the desired quantity and quality of water, or any water at all, is a possibility.

5.1.1.2 Non-Monetary Factors – Source Water

Non-monetary factors, including social and environmental aspects of these projects, should also be considered. Several factors are shown in Table 5.2 along with a score of positive, neutral, or negative.

Table 5.2 – Non-Monetary Factors for Well Projects

Non-Monetary Factors	Rehabilitate Existing Wells	Drill Replacement Wells	Comment
Social	Positive	Negative	Disruption due to construction of new well. Abandoning operational wells.
Environmental	Positive	Negative	Disposal of residuals. Land use.
Sustainability	Neutral	Negative	Use existing wells as long as possible.
Operator Training	Neutral	Neutral	
Permitting	Positive	Negative	New well permitting more rigorous.
Community Objections	Positive	Negative	Abandoning operational wells.
Health and Safety	Neutral	Positive	New well could have more sanitary protections.
Land Acquisition	Positive	Negative	
Constructability Issues	Positive	Negative	New well could be unsuccessful.
Adaptability/Expandability	Negative	Positive	Take advantage of new well in good producing location.
Regulatory Compliance	Neutral	Negative	New well water quality could be out of compliance.
Overall Score	**Positive**	**Negative**	

Considering the Cost of drill a new well compared to rehabbing an existing well and the overall score of the non-monetary factors, it is recommended that the District rehabilitate the four wells identified in Section 4.2.1. During the rehabilitation process, District Staff should evaluate the condition of the wells, especially SV-1 which is the oldest well, and begin planning for their replacement based on age and condition.

5.1.2 Distribution System

In Section 4.1.2, it was noted that alternatives to distributing water to the District's customers through an underground pipe system do not exist and that PVC and Ductile Iron be investigated as alternative materials for replacement waterlines.

5.1.2.1 Life Cycle Cost Analysis – Distribution System

Research indicates that PVC and Ductile Iron are very competitive as materials for underground municipal water supply pipes. PVC pipe suppliers claim that it has an indefinite life, while Ductile Iron suppliers claim a useful life of at least 100 years. PVC pipe claims to be as much as 37 percent less expensive to install than Ductile Iron pipe including both the cost of the pipe and installation costs. If all other factors are deemed to be equal for both types of pipe, then a life cycle cost analysis would show that PVC pipe has an advantage due to its lower capital cost. This is one of the reasons that PVC pipe has become so popular with utility systems over the last 30 years.

5.1.2.2 Non-Monetary Factors – Distribution System

Non-monetary factors, including social and environmental aspects of the alternative pipe materials, should also be considered. Several factors are shown in Table 5.3 along with a score of positive, neutral, or negative.

Table 5.3 – Non-Monetary Factors for Waterline Replacement Projects (Materials)

Non-Monetary Factors	PVC Pipe	Ductile Iron Pipe	Comment
Social	Positive	Negative	Higher cost of DIP perceived as wasteful.
Environmental	Neutral	Neutral	
Sustainability	Neutral	Neutral	Efficient manufacturing. Recyclable.
Operator Training	Neutral	Neutral	
Permitting	Neutral	Neutral	
Community Objections	Positive	Negative	Higher cost of DIP perceived as wasteful.
Health and Safety	Negative	Positive	PVC more easily damaged.
Land Acquisition	Neutral	Neutral	
Constructability Issues	Neutral	Neutral	PVC lower cost offset by higher care during installation.
Adaptability/Expandability	N/A	N/A	
Regulatory Compliance	Neutral	Neutral	Both meet ADEQ requirements.
Overall Score	**Positive**	**Negative**	

Considering the installation cost advantage of PVC pipe and a slightly better score in non-monetary factors, it is recommended that the District utilize PVC pipe that meets the requirements of AWWA C900, Class 250 specifications for its waterline replacement projects. However, it is recommended that the District bid PVC and Ductile Iron pipe materials side-by-side in one of its upcoming larger replacement projects in order to determine which material is more cost effective in that region.

5.1.3 Administrative Projects

In Section 4, it was noted that there is a big benefit making the system more efficient and saving energy by installing these administrative projects.

5.1.3.1 Life Cycle Cost Analysis – Administrative Projects

These projects are now standard operating procedure. There is no alternative to not completing these projects. By not having these projects the water system is not operating at peak efficiency, operating at less than peak efficiency is not an option.

5.1.2.2 Non-Monetary Factors – Distribution System

Non-monetary factors, including social and environmental aspects of the alternative pipe materials, should also be considered. Several factors are shown in Table 5.3 along with a score of positive, neutral, or negative.

Non-Monetary Factors	Admin. Projects	Comment
Social	Positive	Less efficient operations is perceived as wasteful.
Environmental	Positive	Helps eliminate wasted water
Sustainability	Positive	Helps eliminate wasted water.
Operator Training	Positive	Helps the operator understand the system
Permitting	Positive	Helps the designer/operator understand the system making permitting easier
Community Objections	Positive	Makes meter reading more accurate and dependable
Health and Safety	Positive	Reducing trips to site by the operators
Land Acquisition	Positive	Helps planning where the most efficient land acquisition for the system
Constructability Issues	Positive	Helps the operator locate existing lines
Adaptability/Expandability	Positive	Helps the designer/operator understand the system making it possible to adapt the system to changes
Regulatory Compliance	Positive	Helps the operator understand the system making compliance easier to maintain
Overall Score	**Positive**	

These Administrative Projects allow the system to operate more efficiently. They allow the operators to understand the system and how it works so that can more easily adapt to system changes. They free up the operators' time to allow them to more efficiently operate the water system.

PROPOSED PROJECT (RECOMMENDED ALTERNATIVE)

6.1 PROPOSED PROJECT

6.1.1 Recommended Alternatives for Implementation

Following are the recommended alternatives for each category of system improvements:

Source Water:	Rehabilitate four existing wells at an estimated cost of $513,300. Install a new well at an estimated cost of $1,621,650.
Distribution System:	Complete six projects to replace 101,099 feet of existing pipelines at an estimated cost of $15,553,131.
Administrative Projects:	Complete three administrative projects at an estimated cost of $3,339,000.

6.1.2 Description of Proposed Project

It is recommended that the proposed project consist of the following principal water system improvement elements:

Rehabilitate Existing Wells: The Proposed Project will generally include the work items outlined in Section 4.2.1 for the following wells: Strawberry Hollow Intertie (New SH-3), Strawberry Ranch 5 – Tract C (SR-5), Strawberry View 1 – Lot 59 (SV1), and Milk Ranch Well #1 (MR1).

Install New Wells: The Proposed Project will generally include the work items outlined in Section 4.2.1 for the following well: New K2 Well.

Replace Existing Pipelines: The Proposed Project includes installation of 101,099 feet of new PVC pipelines and valves in sizes of 4-inch through 8-inch to replace existing failing pipes. The specific projects are as listed in Table 4.7.

Complete Administrative Projects: The Proposed Project includes completion of three administrative projects per section 4.9.4. The specific projects are as listed in Table 4.8.

6.1.3 Proposed Project Layout

The locations of the specific projects described above are shown on Figures 4.1 through 4.4. Administrative project not shown on the Figures.

6.2 PRELIMINARY PROJECT DESIGN

6.2.1 Well Rehabilitation

The well rehabilitation process will generally follow the scope of work described in Section 4.2.1. The overall goal of the project is to clean and inspect each of the four wells and, if possible, to increase the pumping capacity and/or pumping depth. The overriding criteria for this work will be to not adversely affect the current quantity or quality of the water produced by the well.

6.2.2 New Well Construction

The new well construction process will generally follow the scope of work described in Section 4.2.1. The overall goal of the project is to produce new water sources for the district.

6.2.3 Pipeline Replacements

The general criteria for design and construction of the six waterline replacement projects is as follows:

1. During final design of each project, verify pipe sizes of replacement waterlines to ensure that the District's standards for peak velocity are not exceeded.
2. Locations of replacement and new valves will be reviewed to improve operational control of the system and optimize the number of services that may be shut down due to a main break.
3. Develop in concert with the contractor a phased construction plan to allow switchover of services to the new pipes without excessive downtime.

6.2.4 Administrative Projects

The general criteria for administrative projects are as follows:

1. Obtain bids from qualified contractors to complete this work. Review with Contractor the needs of the system to meet the goals of the district.
2. Obtain costs of software and equipment needed.
3. Prepare an implementation plan to accomplish the projects.

6.3 PROPOSED PROJECT SCHEDULE

Taking wells out of service for rehabilitation may affect the District's ability to meet peak demands. Therefore, the well rehabilitation work should be conducted during the months of October through May when overall system demand is lower, as shown in Figure 6.1. Likewise, the pipeline replacement work will include short duration shutdowns while services are switched over to the new pipelines. These projects should also be done during the winter and early spring months. Due to their elevation, the communities of Pine and Strawberry can experience significant snowfall and freezing temperatures. Pipeline installation during the winter may be affected by winter conditions and longer contract times should be considered.

It is envisioned that these projects will be phased over a three-year period in order to improve the manageability of the program and help limit the overall disruption to the community due to construction within the roads and temporary shutdowns of the water supply. The pipeline replacement projects would be designed during the spring and summer with permitting and bidding in the late summer or early fall. Thus, a Notice to Proceed can be issued to the contractor in October with construction occurring during the next six months. The well rehabilitation and new well construction projects will be of a much shorter duration and could be accomplished during one winter. The Administrative Projects can be completed at any time. The Figure 6.1 illustrates a possible scenario for scheduling of the 10 projects.

Figure 6.1 – Possible Project Schedule

Project	Year 1				Year 2				Year 3			
	S	F	W	S	S	F	W	S	S	F	W	S
SH-3 Well Rehab	D	D	C	C								
SR-5 Well Rehab	D	D	C	C								
SV1 Well Rehab	D	D	C	C								
K-2 Well	D	D	C	C								
Milk Ranch #1 Rehab					D	D	C	C				
Wagon Wheel Way Road	D	D	C	C								
North of Fossil Creek Rd & West of Tomahawk					D	D	C	C				
North of Fossil Creek Rd (Tomahawk to Rimwood)					D	D	C	C				
North of Fossil Creek Rd (Rimwood to Hwy 87/260)					D	D	C	C				
Strawberry View/Ralls									D	D	C	C
Portals 1 & 2									D	D	C	C
SCADA									D	D	C	C
Electronic Read Meters			D	D	C	C						
Water Model	D	D	D									

D = Design, Permitting, and Bidding
C = Construction

6.4 PERMIT REQUIREMENTS

The permitting requirements for the waterline replacement projects will be relatively straightforward. Any significant work on a public water system must be approved and permitted through the Arizona Department of Environmental Quality (ADEQ). District Staff and the District's engineering consultants are already familiar with this process. Working within public streets and roads will require a permit to be issued by the Gila County Engineering Department. These permits are routine and should not represent undue delays for the projects. Working within easements on private property will require at least a check of the easement language to determine if prior notice or approval of the property owner is required before construction can be started.

Construction of New Wells and Well Rehabilitation will require permitting through ADEQ and the Arizona Department of Water Resources. These permits are routine and should not represent undue delays for the projects.

6.5 TOTAL PROPOSED PROJECT COST ESTIMATE (ENGINEER'S OPINION OF PROBABLE COST)

The total project cost estimate prepared as part of this study includes two components: construction costs and non-construction costs. The sum of the construction and non-construction costs represents the capital cost for constructing the facility and associated infrastructure. Engineering, construction management, legal, and administration fees have been incorporated into the total project cost estimate (although the District may chose to fund these services through alternative means). The total project cost estimate is provided in Table 6.1.

Table 6.1 – Total Project Cost Estimates

Alternatives	Pipeline Length (feet)	Construction Cost	Non-Construction Cost	Total Estimated Project Cost
SH-3 Well Rehabilitation		$90,000	$18,000	$108,000
SR-5 Well Rehabilitation		$90,000	$18,000	$108,000
SV1 Well Rehabilitation		$90,000	$18,000	$108,000
Milk Ranch #1 Rehab		$90,000	$18,000	$108,000
New K-2 Well		$1,141,000	$399,350	$1,540,350
Wagon Wheel Way Road	1,200	$150,000	$52,500	$202,500
North of Fossil Creek Rd & West of Tomahawk	19,358	$2,381,110	$542,876	$2,923,986
North of Fossil Creek Rd (Tomahawk to Rimwood)	18,510	$2,207,920	$624,141	$2,832,061
North of Fossil Creek Rd (Rimwood to Hwy 87/260)	27,619	$3,355,345	$838,446	$4,193,791
Strawberry View/Ralls	19,847	$2,400,235	$619,151	$3,019,386
Portals 1 and 2	14,565	$1,702,725	$557,723	$2,260,448
SCADA		$250,000	$250,000	$500,000
Water Model		$300,000		$300,000
Electronic Read Meters		$2,000,000	$500,000	$2,500,000
Totals	**101,099**	**$16,248,335**	**$4,456,187**	**$20,704,522**

6.6 ANNUAL OPERATING BUDGET

A summary of the District's annual operating budget for the previous fiscal year is presented in Appendix E. Most, if not all, of the projects proposed by this report will have a positive effect on the District's operation and maintenance costs. Rehabilitation of existing wells will increase the efficiency of the wells and reduce the operating costs. Replacement of failing and leaking waterlines will reduce manpower costs for fixing leaks and will reduce water loss which decreases the amount of water to be pumped. Reducing the amount of water that is pumped will reduce power costs.

The waterline replacement projects alone will substantially reduce the District's expenses. It has been reported that the system operators spent an average of 383 person-hours per month during 2017 on repairing waterline breaks and leaks. Much of this time was overtime paid for nights, weekends and holidays. At an average rate of $40 per hour, that amount of time costs the District over $180,000 per year. District Staff estimated that repairing items that have failed or broken during 2017 cost the District almost $240,000.

It is difficult to quantify at this time the amount of savings that the District will enjoy by implementing these rehabilitation and replacement projects. The District recently ended its long relationship with its contract operating company and is now operating the system with its own employees. This transition represents a major change in how the District accounts for the cost of operating and maintaining its water systems. The District will need to complete several months of operations under this new approach before its costs can be reliably quantified.

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations developed as a part of this evaluation are based on the District Manager's overall assessment of the condition of the water system components and the Engineer's expertise. District staff and the District's consultants were directly involved in the identification of the system failings and needs, and their involvement is reflected in the recommendations outlined in this report.

7.1 CONCLUSIONS

1. Many of the District's wells, pipelines and other facilities are in excess of 40 years old and have reached or are nearing the end of their useful lives.
2. A substantial amount of the pipelines that were installed over the years have been of substandard materials and/or installation leading to an inordinate amount of expense for repairs.
3. Some of the pipelines are undersized and need to be upgraded in order to improve water service to the homes and businesses.

7.2 RECOMMENDATIONS

1. The District should submit an application to the USDA Rural Development agency for funding of the projects outlined in this report.
2. If successful, the District should embark on a three-year program to implement the well and waterline projects outlined in this report.