ANGELS CAMP WATER AUDIT

FINAL

PREPARED FOR
CITY OF ANGELS CAMP

OCTOBER 12, 2011

STETSON
ENGINEERS INC.

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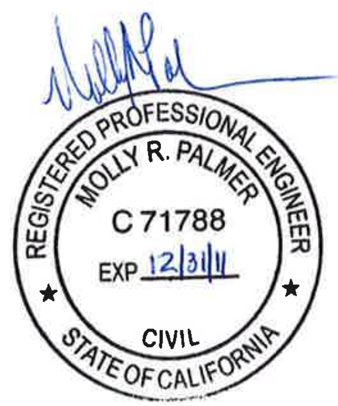

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LIST OF ABBREVIATIONS, ACRONYMS AND CONVERSION FACTOR TABLE

AF	acre-feet
AFY	acre-feet per year
AL	Action Level
alum	aluminum sulfate
AWWA	American Water Works Association
CCI	Consumer Cost Index
CCR	California Code of Regulations
CCWD	Calaveras County Water District
CDPH	California Department of Public Health
cfs	cubic feet per second
CIP	Capital Improvement Plan/Project
City	City of Angels or Angels Camp
CT	chlorine contact time
DWR	California Department of Water Resources
EPA	United States Environmental Protection Agency
FERC	Federal Energy Regulating Committee
FPUD	Foresthill Public Utility District
ft	feet
FY	fiscal year
GCSD	Groveland Community Service District
GIS	Geographic Information System
gpm	gallons per minute
LF	linear feet
MCL	Maximum Contaminant Level
MDD	Maximum Day Demand
MG	million gallons
MGD	million gallons per day
MSL	mean sea level
NCPA	Northern California Power Authority
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
PG&E	Pacific Gas and Electric
PRV	pressure reducing valves
psi	pounds per square inch
psig	pounds per square inch, gage
PVC	polyvinyl chloride
RFP	Request for Proposals
SBCWD	Stinson Beach County Water District
SCADA	Supervisory Control and Data Acquisition
UPA	Utica Power Authority
UPUD	Union Public Utility District
UWMP	Urban Water Management Plan

VFD .... variable frequency drive
WTP .... water treatment plant
WWTP .... wastewater treatment plant
WY .... water year

CONVERSION FACTORS

Volume	1 acre-feet	=	43,560 ft^3	=	325,851 gallons
	1 ft^3	=	7.48 gallons	=	62.4 lbs of water
	1 million gallons	=	3.07 acre-feet		
Rates	1 cfs	=	450 gpm	=	646,320 gallons/day
	1,000 gpm	=	2.23 cfs	=	4.42 acre-feet/day
	1 MGD	=	1,120 acre-feet/yr	=	3.07 acre-feet/day
	1 cfs	for	24 hours	=	1.983 acre-feet
	1cfs	for	30 days	=	59.5 acre-feet
	1cfs	for	1 year	=	724 acre-feet

1.0 INTRODUCTION

Angels Camp, also known as the City of Angels (City) is an incorporated city in Calaveras County, California at the foothills of the Sierra Nevada Mountains. It has a population of approximately 3,800 people and an area of 3.6 square miles (US Census Bureau, 2011). It is located at an elevation of approximately 1,380 ft, mean sea level (MSL).

The City's Water and Wastewater Treatment Department provides drinking water to the City. Facilities include one water treatment plant (WTP), one storage tank, and approximately 32 miles of distribution pipelines. The City has requested that an audit be performed on its drinking water system, in order to ensure compliance with all laws and to develop future projects that will best meet the needs of the City's residents. The following paragraphs describe the purpose of this water audit.

The City's water conveyance system dates back to the 1850s when miners constructed ditches to convey water from the North Fork Stanislaus River to Angels Creek. The modern-day WTP, known as the Angels Water System, was originally owned and operated by Pacific Gas and Electric (PG&E). The City acquired the system from PG&E in 1984 and has operated it since. In 2002, the City published its Water Master Plan, a planning document for water needs and infrastructure. This document covered the planning horizon of 2001 through 2015. In 2010, the City recognized that most of the proposed projects in the 2002 Master Plan had been completed or were not currently needed. As such, they issued a request for proposals for a water audit, which is to be the first step in developing the City's next Water Master Plan.

The results of this audit will be recommendations for future projects that are necessary to:

- comply with all laws
- operate a system that meets industry best-practices; and
- meet the future water needs of the City's residents.

Section 2.0 of the audit includes background information on the City, its source supply, and its existing treatment and distribution systems.

Section 3.0 is a summary of laws and regulations that apply to the City's drinking water system, and includes an assessment of compliance with state laws, the state permit, and local codes.

As part of the audit, the City requested that the staffing levels of the Water and Wastewater Treatment Department be reviewed. Section 4.0 presents the results of this assessment.

Section 5.0 is the assessment of project needs, organized into three categories of treatment plant, distribution system, and administrative/planning. That section concludes with a summary table that lists each proposed project and gives a brief overview, including the rationale for recommending it and a budgetary-level cost estimate.

A schedule for developing the next Water Master Plan and associated capital improvement plan (CIP) is presented in Section 6.0.

2.0 BACKGROUND AND EXISTING SYSTEM DESCRIPTION

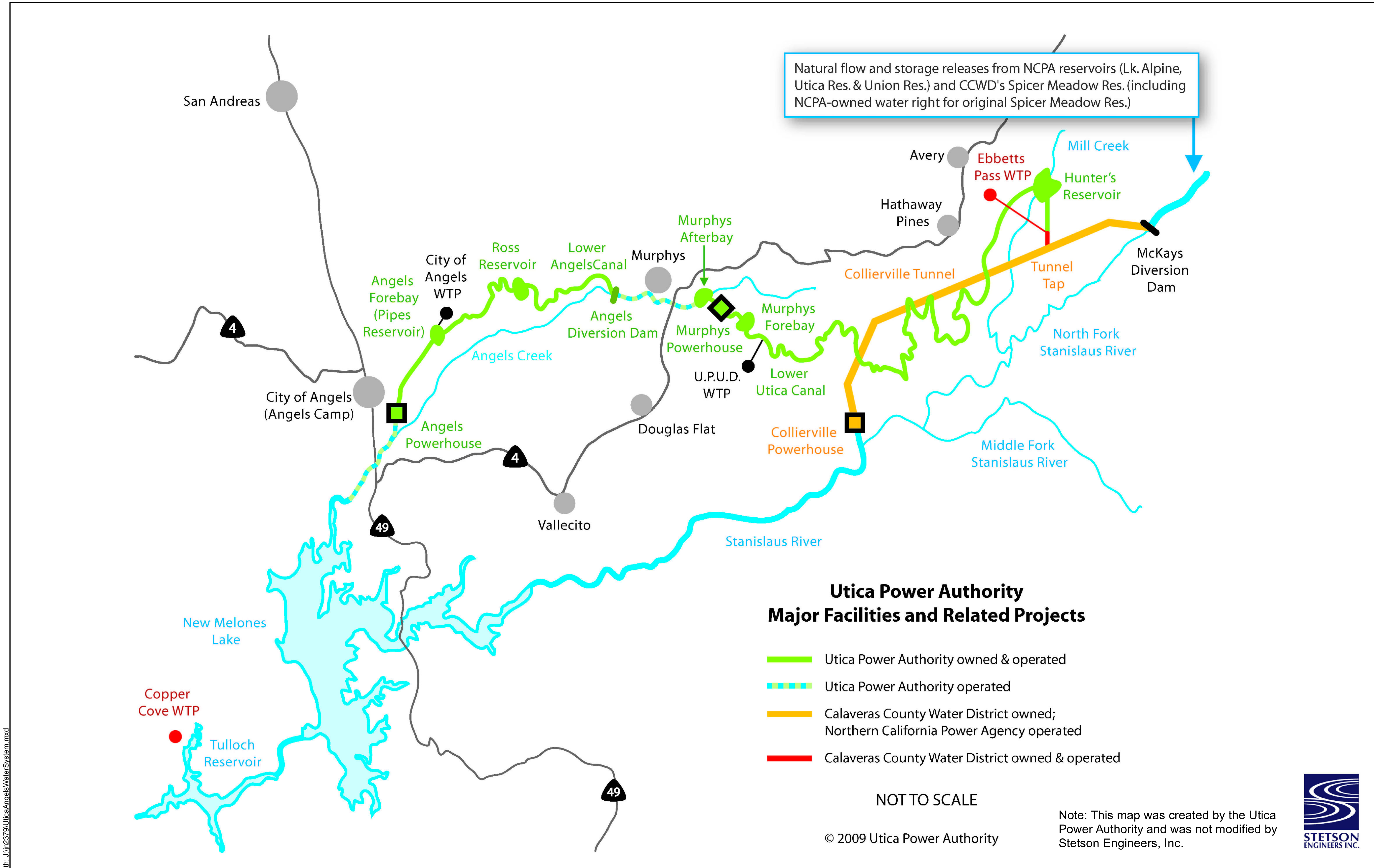
The City's water supply comes from the Stanislaus River through a flume and canal system. The City has contractual rights for up to 1,600 acre-feet per year (AFY) of water from the Stanislaus River. Water is stored in a forebay, where it is then taken into the headworks of the City's WTP. After treatment, water is stored in a 2.5-million gallon (MG) storage tank, which feeds the City's distribution system. The distribution system has five pressure zones and is entirely fed by gravity from the storage tank. This section describes the source water supply, water rights, and existing treatment and distribution systems in the City.

2.1 WATER SOURCE

The City's source of drinking water is the North Fork Stanislaus River. The River drains the Sierra Nevada Mountains and is one of the largest tributaries to the San Joaquin River. Water on the North Fork Stanislaus River is stored in four upstream reservoirs: Alpine, Utica, Union, and Spicer. Water is released from these reservoirs downstream into the River, where it is then diverted into the Collierville Tunnel to Hunter's Reservoir. Water is released from Hunter's Reservoir into the Utica Canal System. The Utica Power Authority (UPA) owns and operates the canal (or flume) system, which dates back to the late 1800s. The system is used for two hydropower projects, and also delivers water to multiple entities, including the town of Murphys and the City as shown on Figure 1.

Near the diversion point into the canal system is Hunter's Reservoir, with a capacity of approximately 260 acre-feet (AF). Between Hunter's Reservoir and the Town of Murphys, the flume system is known as the Utica Canal and is approximately 21 miles long. In Murphys, water is diverted for municipal supply. Water is also used for the Murphys powerhouse (known as the Utica Project). After the Utica Project, water enters Angels Creek and is diverted into Angels Ditch, which has a capacity of about 45 cubic feet per second (cfs) and a length of about 5.5 miles (Angels Camp, 2006). Ross Reservoir is located on this portion of the system. It has a capacity of approximately 100 AF, though it is normally maintained at about 90 AF. Storage at Ross Reservoir represents about a 30-day emergency supply of water for the City. Below Ross Reservoir, water travels to the Angels Forebay, where the City diverts water to their WTP. Finally, the flume system continues to the Angels powerhouse (known as the Angels Project). There, any unused water discharges into Angels Creek, which is tributary to New Melones Lake.

FIGURE 1



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2.2 WATER RIGHTS

The City's water system is part of a larger system that generates hydroelectric power and conveys water to various customers and municipalities in Calaveras County. The City's WTP, known as the Angels Water System, was previously owned by PG&E, and was acquired by the City in 1984. A series of agreements between the City and PG&E allocates 1,600 AFY to the City.

2.2.1 Background

The flume system dates back to the 1850s when miners constructed ditches to bring water from the North Fork Stanislaus River to Angels Creek. The diversion and hydropower facilities were mostly constructed for mining, but also provided domestic and irrigation water to local residents. The Utica Mining Company owned the system from the 1880s until 1946, when the company was sold to PG&E (Paterson, 2009). The two hydroelectric power projects of the system are the Utica Hydroelectric Project (Federal Energy Regulating Committee [FERC] License 2019) and the Angels Hydroelectric Project (FERC License 2699).

In addition to the WTP, PG&E also sold the two hydropower projects in the 1990s. Two utilities, Calaveras County Water District (CCWD) and Northern California Power Authority (NCPA), negotiated the purchase of the PG&E hydropower projects: NCPA took ownership of three reservoirs on the Stanislaus River, while the newly-created UPA took ownership of the flume system and the Angels and Utica Projects (Paterson, 2009).

The UPA is a joint powers authority that was officially formed in December 1995. The FERC approved the transfer of both hydropower licenses to UPA in 1997 (Unites States Federal Register, 1997). UPA originally consisted of the City, Union Public Utility District (UPUD), and CCWD, but CCWD withdrew in 2004. UPA operates the two hydropower projects and the flume conveyance system. Revenues from power generation serve primarily to maintain the flume system and water conveyance to the City and UPUD.

2.2.2 Existing Contracts

The City has two contracts with PG&E which set the City's allocation of water. In addition, there is an existing contract between CCWD and NCPA which sets the schedule of maximum delivery to the Utica/Angels projects.

2.2.2.1 City-PG&E Contracts

The City purchased its water treatment system from PG&E in 1984. The purchase agreement from that transaction, along with a second agreement in 1992, is the basis of the contractual allocation of water that the City is entitled to. The purchase agreement signed by PG&E and the City in 1984 outlines the provisions of the purchase and states that PG&E will deliver 800 AFY at no cost to the City, with an option to purchase an additional 800 AFY (Angels Camp/PG&E, 1984). However, a later agreement, signed in 1992, modifies this provision such that the additional 800 AFY are provided at no cost (Angels Camp/PG&E, 1992). Thus, the two agreements provide the City with up to 1,600 AFY at no cost.

2.2.2.2 Other Contracts

In 1995, CCWD entered into a contract with the NCPA[1] that set a schedule of maximum delivery to the Utica/Angels projects (CCWD/NCPA, 1995). The agreement ties deliveries to the annual California Department of Water Resources (DWR) forecasts on the Stanislaus River, and reduces deliveries in dry conditions. UPA has indicated that this agreement currently governs the quantity of water that it is entitled to receive in any one year (Pyle, 2011).

The deliveries are related to DWR's May 1 runoff forecast at the Stanislaus River below Goodwin Reservoir which is located approximately 1.5 miles downstream of Tulloch Reservoir (Figure 1). In normal to wet years, maximum annual deliveries are 33,514 AF. In dry years, this quantity may be reduced anywhere between 48% and 90% annually. Implications of the CCWD/NCPA contract, as related to water shortages during dry conditions, are discussed further in Section 2.3.

2.2.3 Greenhorn Creek Development

The Greenhorn Creek development diverts water from Angels Creek to irrigate its golf course (Greenhorn Creek Golf Resort). These diversions were made as part of an agreement between the City and Gold Cliff Golf and Country Club (City/Stevenot, 1994). These diversions, since they occur within City limits, count as part of the City's annual contractual allocation of 1,600 AF, and therefore decrease the total amount available at the WTP. Recent usage by the development is outlined below, so that the impact to the City's water supply may be understood.

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[1] NCPA owns and operates two reservoirs upstream of the UPA system: Lake Alpine, Utica Reservoir; and it has water rights in Spicer Meadow Reservoir.

Meter records were available for the development's diversions from Angels Creek for January 2009 through December 2010. In 2009, the development used 167 AF, while in 2010 it used 129 AF. This means that in these two years, the total allotment available to the City at the WTP was 1,433 and 1,471 AF, respectively. Table 2-1 shows the monthly water usage by Greenhorn Creek development in 2009 and 2010.

Greenhorn Creek development also meets its irrigation needs by using tertiary treated water from the City's Wastewater Treatment Plant (WWTP). In the future, if the City wishes to use its entire 1,600 AF allocation at the WTP, two potential options include: (1) Greenhorn Creek development negotiating a separate contract with UPA to purchase water diverted from the Creek; or (2) Greenhorn Creek development satisfying its demands using other water sources, perhaps all tertiary treated wastewater. Greenhorn Creek development's usage of the City's contractual water allotment may be particularly important in shortage situations.

TABLE 2-1 GREENHORN CREEK DEVELOPMENT WATER USAGE

Year	Month	Water Pumped from Angels Creek (AF)	Tertiary Treated Wastewater from WWTP (AF)	Total Water Usage (AF)
2009	Jan	0.00	0.00	0.00
	Feb	0.00	0.00	0.00
	Mar	0.00	0.00	0.00
	Apr	0.00	0.00	0.00
	May	0.00	0.00	0.00
	Jun	28.71	25.20	53.91
	Jul	52.69	21.18	73.87
	Aug	44.67	14.62	59.29
	Sep	28.72	23.28	52.00
	Oct	12.05	0.00	12.05
	Nov	0.00	0.00	0.00
	Dec	0.00	0.00	0.00
	Total	166.83	84.28	251.11
2010	Jan	0.00	0.00	0.00
	Feb	0.00	0.00	0.00
	Mar	0.00	0.00	0.00
	Apr	0.00	0.00	0.00
	May	5.32	11.37	16.69
	Jun	31.00	18.71	49.71
	Jul	40.23	22.96	63.19
	Aug	52.33	20.93	73.26
	Sep	0.00	23.77	23.77
	Oct	0.00	0.00	0.00
	Nov	0.00	0.00	0.00
	Dec	0.00	0.00	0.00
	Total	128.88	97.74	226.62

2.3 SOURCE WATER RELIABILITY AND SHORTAGE CONDITIONS

The reliability of the City's source water from the North Fork Stanislaus River is determined by the contractual agreement that governs maximum deliveries to the Angels/Utica Projects (see Section 2.2.2.2). The agreement relates deliveries to DWR runoff forecasts, as described below.

2.3.1 Contractual Maximum Deliveries

Maximum deliveries to the Angels/Utica system are stipulated in the 1995 agreement between CCWD and NCPA. The contract specifies six categories of runoff conditions: one "normal to wet" category, and five divisions of "dry years". Deliveries are tied to DWR unimpaired runoff at the Stanislaus River below Goodwin Reservoir located downstream of the City. DWR estimates unimpaired runoff for all the major rivers in the state. Unimpaired runoff is defined as the natural runoff measured at a gage after all upstream diversions, impoundments, and other manmade alterations have been accounted for. Table 2-2 lists the contractual maximum deliveries for each of the six categories of unimpaired runoff.

TABLE 2-2 CONTRACTUAL MAXIMUM DELIVERIES FOR ANGELS/UTICA PROJECTS

Category	Range of May 1 Forecast of Unimpaired Runoff [1] (AF)	Total May through April Maximum Deliveries (AF)	Percent Reduction from 'Normal to Wet Year' (%)
Normal to Wet	500,001 and greater	33,514	n/a
Dry	400,001 to 500,000	30,151	90%
Dry	320,001 to 400,000	26,830	80%
Dry	140,001 to 320,000	22,716	68%
Dry	100,001 to 140,000	19,605	58%
Dry	0 to 100,000	16,107	48%

Source: CCWD/NCPA, 1995.
Note:
1. Unimpaired runoff is the May 1 forecast of total unimpaired runoff from April through July into the Stanislaus River below Goodwin Reservoir

2.3.2 Historical Unimpaired Runoff and Shortage Assessment

The DWR historical unimpaired runoff estimates have been reviewed in order to characterize the frequency of occurrence of the "Dry" categories[2]. Table 2-3 shows monthly unimpaired runoff in the Stanislaus River below Goodwin Reservoir for water year (WY) 1956 through WY 2005.

[2] Note that the historical data are estimates of the actual unimpaired flow at the Stanislaus River below Goodwin Reservoir. The contract and delivery schedule is based upon the May 1 forecast each year for the April – July runoff. As such, the forecasted runoff is only DWR's best estimate of the future runoff, and the forecasted value may not match the actual unimpaired runoff.

TABLE 2-3 UNIMPAIRED RUNOFF IN THE STANISLAUS RIVER BELOW GOODWIN RESERVOIR (1,000'S AF)

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Total	Apr-Jul Total
1956	11.2	16.2	13.5	14.6	61.3	115.8	136.2	280.6	188.5	38.1	10.8	7.2	894	643
1957	12.5	14.7	19.1	35.1	117.4	171.6	282.1	567.7	325.0	100.4	27.1	4.8	1,678	1,275
1958	11.7	10.8	7.6	36.8	66.4	87.0	148.1	114.7	68.0	16.7	3.6	12.9	584	347
1959	6.4	4.7	5.0	14.4	61.2	101.7	160.9	156.6	71.3	10.0	1.3	0.6	594	399
1960	0.0	10.9	11.8	10.0	24.1	46.0	107.9	120.1	57.3	7.0	4.9	3.8	404	292
1961	2.9	6.1	9.3	10.9	95.4	76.2	271.3	250.8	206.2	56.3	6.7	2.9	995	785
1962	14.3	7.7	19.1	67.3	216.4	66.9	155.9	417.3	219.3	63.3	12.8	7.5	1,268	856
1963	9.7	47.9	28.5	35.6	30.9	50.5	122.0	183.1	106.0	20.7	4.7	3.9	643	432
1964	4.6	21.9	368.1	221.4	104.1	100.8	240.7	307.6	243.5	95.7	38.2	10.1	1,757	888
1965	8.2	46.4	37.5	41.5	39.3	101.2	204.6	167.2	40.9	11.5	3.6	1.4	703	424
1966	3.2	24.7	113.9	89.8	80.9	196.3	176.3	492.8	490.5	212.4	36.8	13.9	1,932	1,372
1967	9.1	10.1	13.3	23.8	95.0	89.6	143.8	161.3	70.2	13.1	7.3	3.8	640	388
1968	7.7	38.5	48.9	355.2	181.2	153.5	345.9	594.9	335.6	116.2	24.3	8.6	2,211	1,393
1969	17.2	19.5	73.6	355.3	118.3	142.5	123.4	254.5	172.3	29.5	10.5	3.8	1,320	580
1970	5.3	39.2	72.1	78.8	71.0	108.6	172.4	238.9	208.8	65.0	11.1	2.9	1,074	685
1971	6.6	21.2	51.2	31.7	53.9	140.7	135.1	208.2	107.4	16.0	2.0	1.9	776	467
1972	12.0	17.3	44.8	116.8	127.9	125.9	211.2	417.2	168.3	28.9	6.1	4.9	1,281	826
1973	10.9	103.2	106.3	158.7	64.1	200.4	246.6	372.4	209.2	62.1	19.6	6.9	1,560	890
1974	0.0	14.6	23.1	28.0	70.9	143.4	122.9	400.8	332.3	76.4	18.9	10.3	1,242	932
1975	32.0	26.1	21.5	18.4	19.4	43.1	75.2	99.4	17.4	0.9	7.7	10.3	371	193
1976	2.2	4.5	3.8	5.9	7.6	13.4	34.9	44.5	36.2	0.0	0.0	2.2	155	116
1977	0.0	5.5	37.5	108.6	108.4	223.2	261.1	392.7	302.1	97.7	26.2	27.1	1,590	1,054
1978	15.6	7.5	16.3	79.0	107.9	160.5	205.6	385.0	141.7	28.2	9.3	7.4	1,164	761
1979	10.9	23.1	31.5	383.5	256.9	136.5	201.9	320.5	267.7	133.6	25.9	12.6	1,804	924
1980	9.5	7.4	11.5	40.2	39.9	82.5	164.4	164.6	57.1	6.3	2.9	4.8	591	392
1981	9.5	99.7	187.1	169.3	329.1	253.2	432.7	440.6	251.3	108.7	25.6	38.3	2,345	1,233
1982	88.4	121.7	160.4	182.8	245.1	411.5	213.3	504.0	632.4	286.5	76.6	28.9	2,952	1,636
1983	23.8	225.1	153.5	144.2	98.4	137.0	156.5	297.1	147.8	41.3	9.5	0.0	1,434	643
1984	11.0	47.7	31.2	26.1	48.1	78.6	206.0	171.2	52.5	3.5	0.0	2.3	678	433
1985	0.0	40.3	43.5	99.0	532.1	352.7	252.9	300.5	214.7	56.5	19.1	25.1	1,936	825
1986	13.4	3.2	8.9	12.8	28.9	58.5	103.7	94.2	27.1	11.2	6.0	4.2	372	236
1987	3.1	10.4	13.5	26.5	35.0	59.1	86.2	83.0	39.8	12.4	5.9	3.3	378	221
1988	8.8	6.0	13.9	17.6	29.9	181.1	233.5	161.5	93.5	23.6	7.5	1.3	778	512
1989	22.3	17.4	12.6	24.8	24.0	82.5	133.8	87.3	51.2	12.0	1.1	0.0	469	284
1990	3.1	2.1	3.4	2.9	1.4	81.1	97.2	182.7	106.4	21.3	3.4	6.1	511	408
1991	12.3	14.2	12.8	18.3	72.1	78.4	135.8	95.0	16.6	18.5	6.2	5.7	486	266
1992	6.0	7.9	26.6	182.1	108.3	234.1	248.6	407.0	240.9	76.1	16.6	2.7	1,557	973
1993	9.7	9.8	13.2	15.4	28.8	61.4	106.1	159.4	41.1	4.3	0.0	5.9	455	311
1994	5.1	24.2	25.6	229.6	100.1	414.5	276.1	484.4	459.6	261.2	50.1	17.8	2,348	1,481
1995	10.6	10.1	42.0	86.2	275.7	215.1	254.7	377.0	175.5	38.0	3.7	0.5	1,489	845
1996	6.6	49.8	265.4	659.4	90.5	129.5	179.7	230.9	110.1	21.9	11.0	4.4	1,759	543
1997	11.6	17.0	19.8	145.7	249.5	230.8	245.4	340.9	510.7	245.2	40.4	28.0	2,085	1,342
1998	15.3	31.1	38.9	101.2	196.7	124.5	172.8	370.3	215.1	48.8	15.8	17.3	1,348	807
1999	9.2	17.9	11.9	91.5	188.8	159.8	222.3	292.1	128.0	23.9	6.9	9.7	1,162	666
2000	13.3	12.9	11.9	22.5	35.8	95.9	133.6	200.0	28.4	5.0	2.0	3.7	565	367
2001	5.4	21.4	57.2	62.2	54.8	103.0	213.5	217.0	96.6	15.8	3.9	2.3	853	543
2002	3.2	30.5	48.0	57.7	54.9	91.5	152.1	322.9	177.7	20.0	10.9	4.9	974	673
2003	2.3	7.9	47.0	42.4	75.9	164.2	175.0	152.9	61.2	17.1	5.2	0.0	751	406
2004	16.8	23.3	41.3	146.3	110.9	194.4	211.4	533.3	291.9	100.8	15.2	6.4	1,692	1,137
2005	12.5	11.1	210.2	199.5	138.0	229.3	470.1	537.9	277.2	77.3	22.7	15.7	2,201	1,362
Avg	10.9	28.2	53.8	102.5	107.4	142.0	191.3	283.1	177.8	57.1	13.7	8.2	1,176	709
Min	0.0	2.1	3.4	2.9	1.4	13.4	34.9	44.5	16.6	0.0	0.0	0.0	155	116
Max	88.4	225.1	368.1	659.4	532.1	414.5	470.1	594.9	632.4	286.5	76.6	38.3	2,952	1,636

Source: DWR California Data Exchange Center, station code SNS (http://cdec.water.ca.gov/). In 1,000's AF. Unimpaired runoff is defined as the natural runoff at a gage after all upstream diversions, impoundments, and other manmade alterations have been accounted for.

The historical data were assessed for the frequency of occurrence of each of the dry year conditions. The data show that the five dry conditions (less than 500,000 AF of unimpaired April through July runoff) occur in 19 of the 50 years (38% of years). The driest condition (less than 100,000 AF) did not occur in the 50-year historical period[3]. The second-driest condition occurred once (2% of years). The three other dry categories occurred five or more times each (10% or more). Table 2-4 gives the historical frequency of occurrence for the five dry conditions and for normal to wet conditions.

TABLE 2-4 HISTORICAL FREQUENCY OF OCCURRENCE OF RUNOFF CONDITIONS

Range of April through July Unimpaired Runoff (AF)	No. of Years in 50-Yr Period	% of 50-Yr Period
500,001 and greater	31	62%
400,001 to 500,000	6	12%
320,001 to 400,000	5	10%
140,001 to 320,000	7	14%
100,001 to 140,000	1	2%
0 to 100,000	0	0%

The frequency of occurrence of drought in the 50-year historical period does not necessarily reflect what will happen in the future. Future years may have a lower or higher occurrence of drought conditions. However, the historical data show that drought conditions have occurred in the recent past, and they should be planned for in the future.

2.3.3 Shortage Analysis for City of Angels

Currently, the contractual maximum deliveries only specify how much water would be delivered to UPA. According to Attachment A to the 1995 Restated Agreement, UPA is contractually entitled to a maximum of 33,514 AFY in normal to wet WYs and 16,107 AFY in the driest WYs. UPA in turn has agreements with UPUD, the City, the two hydroelectric projects, and multiple irrigation users to provide water to these entities. All water UPA receives is fully allocated. Currently, the average summer time (May through October) usage is 21,000 AFY (Pyle, 2011). If the forecasted runoff was less than 100,000 AF, monthly deliveries to UPA would be reduced between 14% and 24% between May and October (Pyle, 2011).

However, there is no shortage plan in place to determine how much water each entity would receive if DWR unimpaired runoff forecasts predicted a dry year and a reduction in water delivery to UPA would occur. In the event that deliveries are curtailed during very dry

[3] Even though the driest condition did not occur in the historical period, it may occur in the future.

conditions, the City currently has no way of determining what its water allocation would be. Accordingly, one of the recommendations of this audit is to pursue a shortage plan with UPA so that water deliveries to the City during drought conditions may be determined. This is essential to securing a reliable water supply for the City.

2.3.4 Emergency Water Supplies

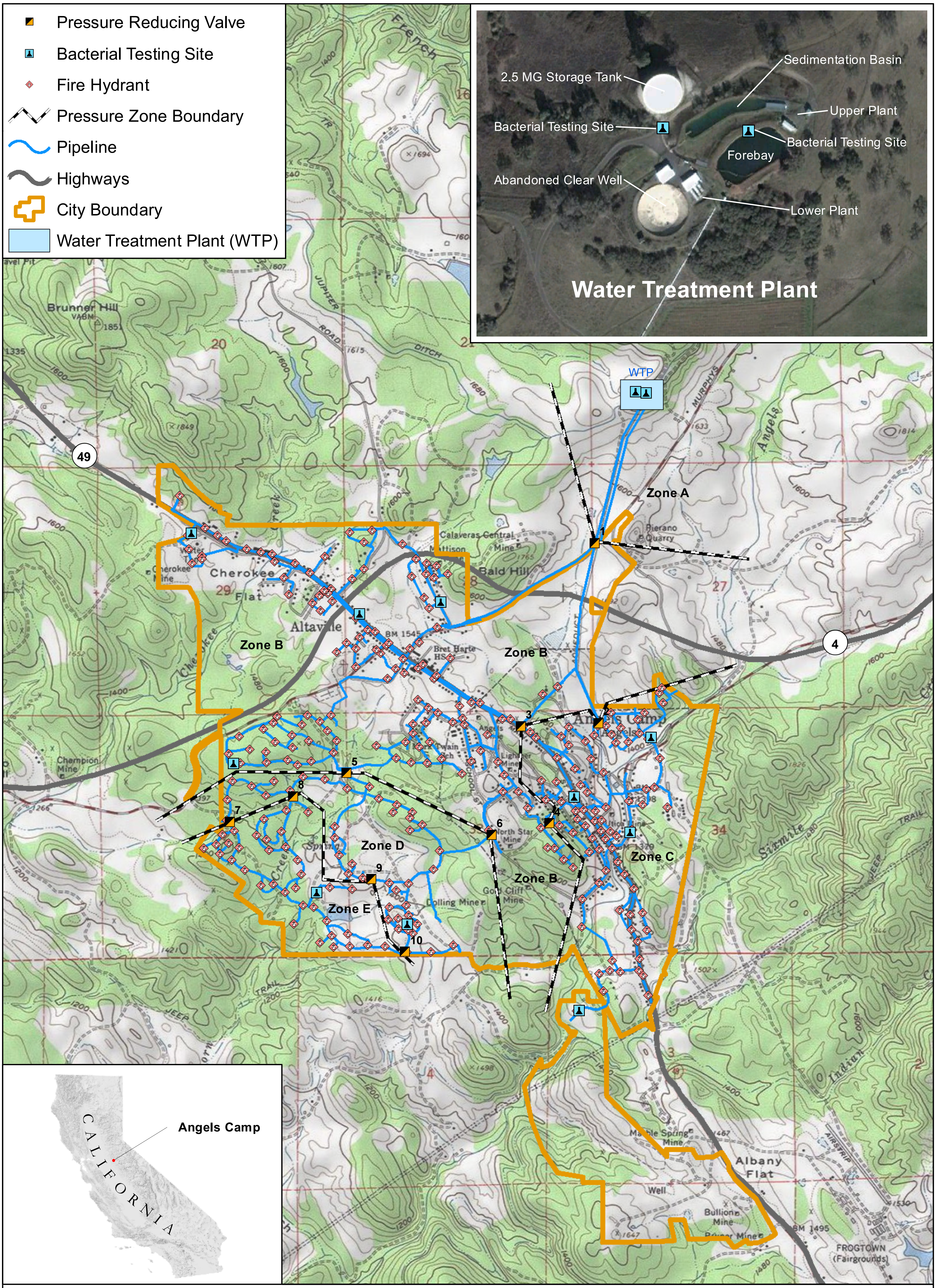
Currently, the City has a single source of supply through the Angels/Utica water system. In the event of an interruption of supply, there are limited options for emergency supplies to the City. The largest emergency supply is at Ross Reservoir, located approximately 3 miles upstream of the Angels Forebay. Storage at Ross Reservoir represents about a 30-day emergency supply of water for the City. If the canal system is compromised upstream of Ross Reservoir, this emergency supply could be utilized. However, if the canal system is compromised downstream of Ross Reservoir, the only emergency water available to the City is the remaining water in the ditch, water in the Angels Forebay (approximately four AF), and any water remaining in the treatment plant in the sedimentation basin and storage tank.

In September 2001, a fire known as the "Darby Fire" destroyed a portion of the wooden flume system that delivers water to the City. Since the City is fully dependent on the wooden flume system for its water source, the City, along with other water purveyors affected by the damaged flume system, had to come up with alternative water supplies. One of the alternative water supplies was named the "Schmauder-Tryon Mine Project" in which roughly 500,000 gallons per day were pumped out of an abandoned mine shaft and directed to the City's WTP (Calaveras County OES, 2001). This alternative was designed for a 30-day period. Another alternative named the "Temporary Flume Bypass" consisted of a temporary overland pipe system that pumped 6.6 million gallons per day (MGD) of water into the canal system (Yosemite Gold Country, 2001).

The water shortage due to the Darby Fire is an example of why it is important to have emergency water supplies available. Recommendations related to developing alternative water supplies are discussed in Section 5.1.3.

2.4 WATER TREATMENT PLANT

The WTP serving the City is a conventional surface water treatment plant located off of Murphys Grade Road. The plant is operated 365 days a year and its operators have been certified by the California Department of Public Health (CDPH). The general layout of the WTP is shown in Figure 2 and on Plate 1.



LOCATION MAP AND EXISTING WATER SYSTEM FACILITIES
ANGELS CAMP, CA

N

0 2,500 5,000 Feet

Note: See Plate 1 for pipe diameters
Sources: City of Angels Camp GIS data., 2011.
1:24K Topo, Angels Camp, 1973. USGS

STETSON ENGINEERS INC.

Path: J:\jn2379\Location_ExistingInfrastructure.mxd

FIGURE 2

2.4.1 Treatment Process

Raw water enters the plant via the Angels Canal and is stored in the UPA owned and controlled Angels Forebay. The forebay is considered the raw water source for the treatment plant. The treatment plant is broken down into two separate plants: Upper Plant and Lower Plant. These plants can be run as a unit or individually. The Upper Plant consists of the flocculation pond, settling basin, and the building where influent flow is measured, alum is added, and chlorination occurs. The Lower Plant consists of the filter and chlorination buildings.

2.4.1.1 Upper Plant

Raw water flows from the forebay through a 12-inch control valve. Aluminum sulfate (alum) and chlorine are injected, as a coagulant and disinfectant respectively, into the raw water. Water is then conveyed into a flocculation pond/settling basin. The water first enters a mixing area where a series of paddles slowly mix the water in order to produce large particles that settle easily called "floc." As the water moves through the flocculation portion, the water moves around baffles which allow for proper chlorine contact time. By the time the water (and floc) has reached the sedimentation portion, the floc is heavy enough to settle out of the water column and to the bottom of the basin. The flocculation pond/settling basin is periodically drained and the sludge is removed.

2.4.1.2 Lower Plant

Water flows by gravity from the flocculation pond/settling basin to the filter control building. Chlorine is added to the pre-filtered water as a disinfectant. Four pumps (used separately or in combination to achieve desired flow) force water through three four-cell pressure filters. The pressure filters contain a 46-inch thick bed of gravel, sand, coal, and garnet that filters out the remaining small particles.

Each filter has a capacity of 720 gallons per minute (gpm). As required by CDPH, one filter is designated as backup, bringing the total plant capacity to 1,440 gpm (2.0 MGD). In general, all three filters are operated at once, but at a maximum of 2/3 total capacity (480 gpm). In the event of a filter failure during peak demands, the two remaining filters could be operated at full capacity.

A 0.8% sodium hypochlorite solution is added to the raw water and the pre-filtered water and is generated on-site and stored in a 1,000 gallon storage tank located in the chlorination building. The sodium hypochlorite is fed by two chemical feed pumps into the water lines. The chlorine solution can also be added to the discharge pipe to the distribution system if necessary.

Caustic soda and orthophosphate are also added to the treated water in order to adjust the pH and for controlling pipe corrosion. These chemicals are stored in the filter and chlorination buildings, respectively.

2.4.2 Storage

The finished water is stored in a 2.5 MG baffled tank where it receives the required chlorine contact time and is held for distribution to the system.

2.4.3 Operational Conditions

Under normal operating conditions, the plant runs 24 hours a day, 365 days a year. Operators control the production at the plant in order to minimize plant turn-ons and shutoffs. They work to maintain a steady production flow with stable water levels in the storage tank. However, level probes located in the 2.5 MG storage tank will automatically turn the plant on or off if the water levels drop too low or high, respectively. If the probes detect low water levels in the tank, a signal is sent to turn on the Upper Plant, start the filter pumps and chemical feeds, and open the filer valves. When high water levels are detected in the tank, a signal is sent to shut off all valves and pumps, stopping the flow of water into the plant.

Under normal operation, the manual valve at the inlet structure to the treatment plant is fully open. Flow rates are adjusted using a touch screen located in the filter building. Settings are determined from town usage. Normal winter flow rates are 300 to 400 gpm and 800 to 1,300 gpm in the summer. The treatment plant is equipped with a number of alarms that detect process failures throughout the plant.

2.4.3.1 Sodium Hypochlorite Generation

Sodium hypochlorite is generated on-site through the plant's Sodium Hypochlorite Generation System which has a capacity of 100 gallons per day (62.5 gallons per hour). Water is sent through a water softener and then is used to dissolve salt into a 3% concentration brine solution. The brine is then passed through a cell containing titanium electrodes that receive a low voltage DC current producing a dilute 0.8% sodium hypochlorite solution. The solution is stored in a day tank for distribution. Production is controlled by an ultra sonic level control in the day tank.

2.4.3.2 Filter Backwashing

When the total flow through the filters reaches six MG [two MG per filter as per the City's Water Supply Permit (Section 3.3)], backwash is required. The filters are backwashed approximately every five days in the summer and every 15 days in the winter. The backwash process consists of three stages: bed lift, surface wash, and filter to waste. Each filter has four cells and each cell is backwashed individually. Bed lift is achieved by backwashing the filter cell with water from the sedimentation basin for eight minutes at 900 gpm. During the surface wash stage, finished water from the storage tank stirs up the top layer of the filter bed to achieve the needed cleaning. During the filter to waste stage, water from the sedimentation basin is used to settle the filter media and remove any remaining particles from the filter bed. The backwash water is sent to a ditch system and ultimately to a series of stock ponds downstream. The total amount of water used for backwashing all three filters is 135,180 gallons (45,060 gallons per filter).

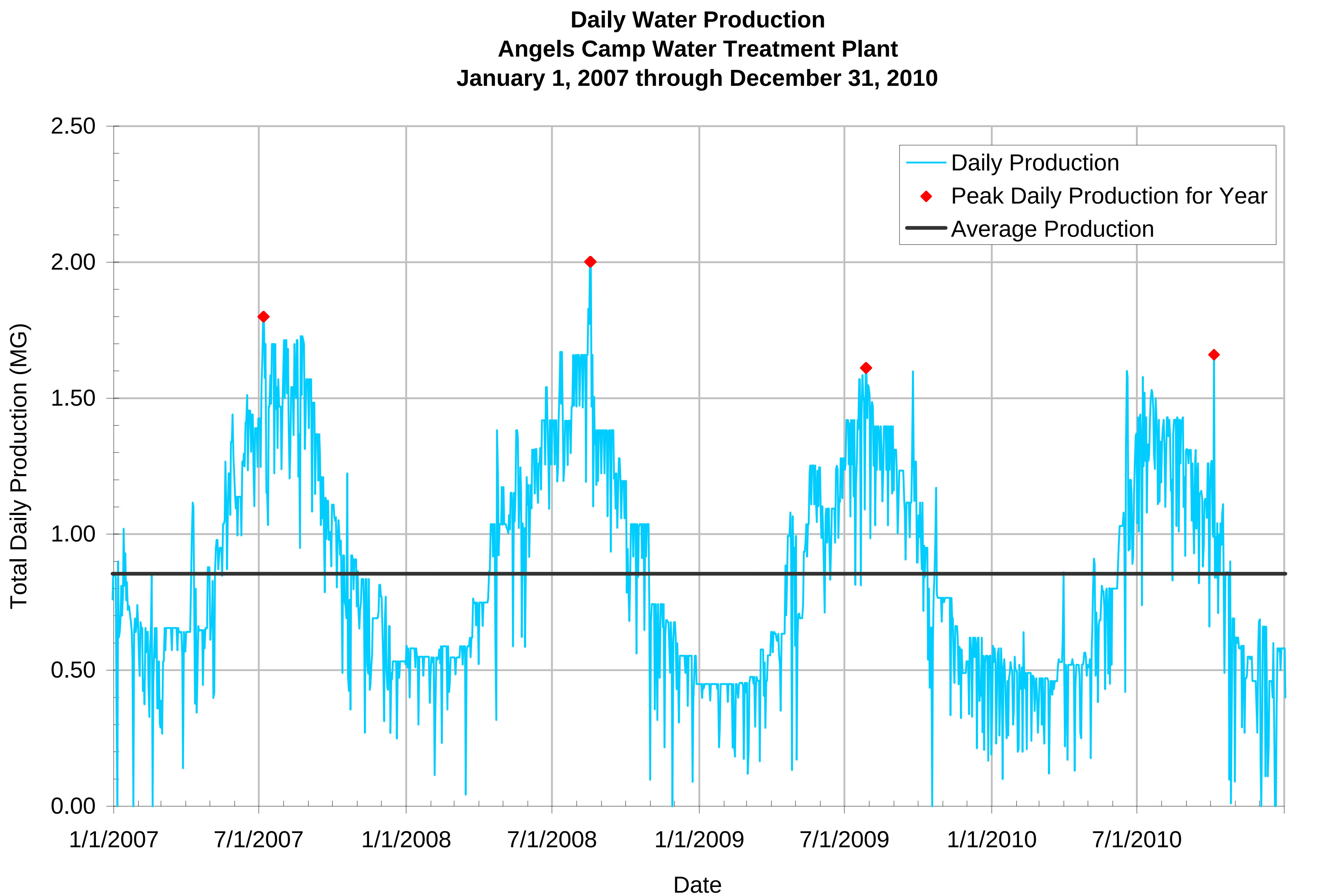
The backwash cycle is manually initiated but then is controlled automatically for all three filters. The time to backwash all three filters is approximately 2.75 hours. As currently configured, all three filters are off-line during the backwash cycle, and as such, all demands during a backwash cycle are met from the storage tank.

2.4.3.3 Winter Turbidity Shutdowns

Currently, when turbidity of the raw surface water is too high (above three Nephelometric Turbidity Units [NTUs]) following a winter storm, the treatment plant must shut down until turbidity levels return to acceptable levels. The longest duration shutdown has been two consecutive days. Since 2006, the total number of days of shutdowns has ranged from zero to four days (one day in 2006, two in 2007, zero in 2008 and 2009, four in 2010, and one in 2011). Because these events occur in the winter, water demands are met from the storage tank. However, this represents a problem for the WTP. For example, if the storage tank has a volume of approximately 2.1 MG (not quite full), and the shutdown occurs for two days with typical winter demands of about 0.5 MG, the tank will be at 1.1 MG after two days. This is within 0.15 MG of the allowable minimum of 0.95 MG in the tank (the approximate minimum set by the City's permit – see Section 3.3.2). If this scenario continued for a third day, the water levels in the tank would drop below the allowable minimum. Recommendations to fix this problem are addressed in Chapter 5.0.

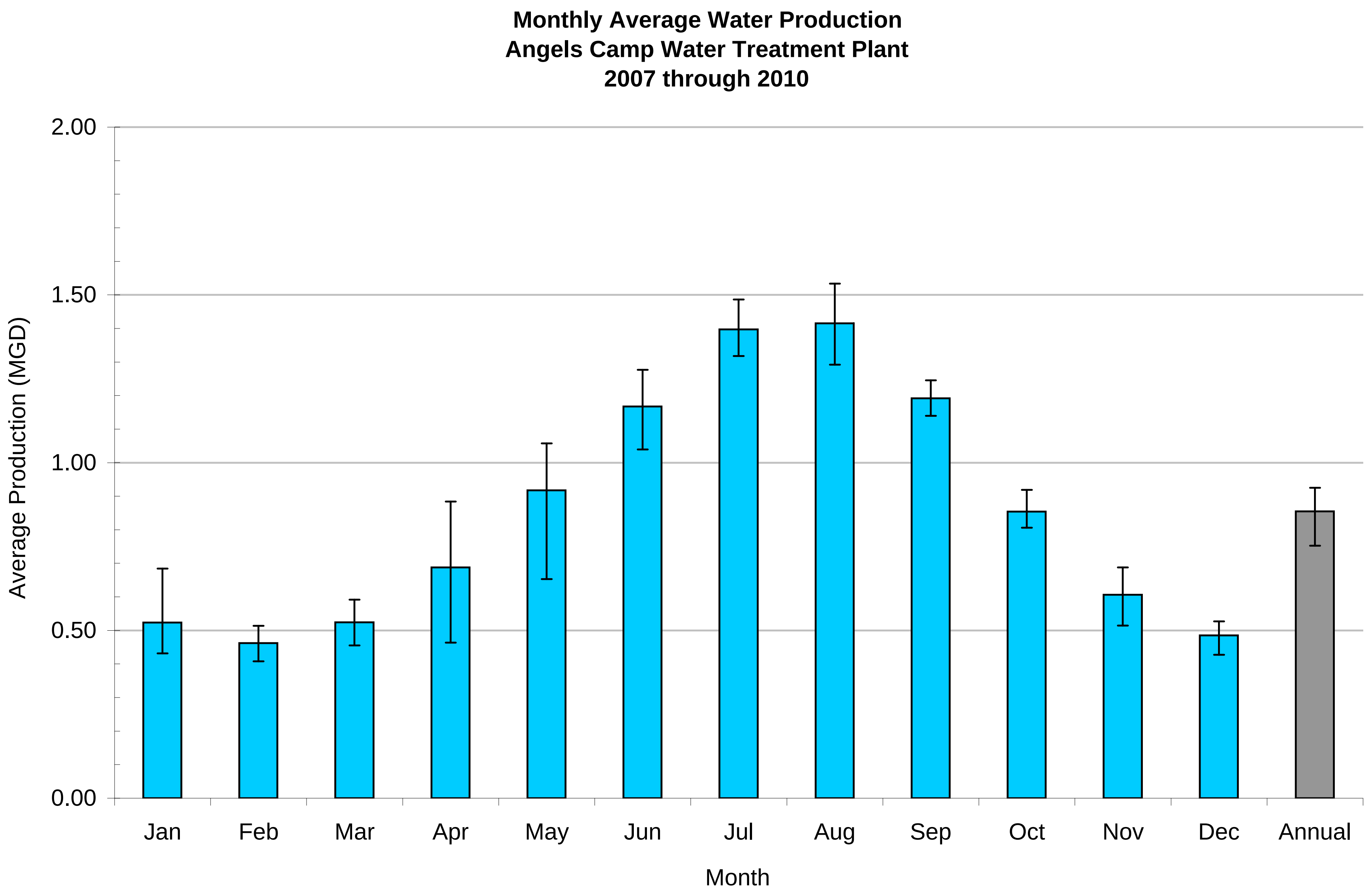
2.4.4 Historical Water Production

Historical water production values for 2007 through 2010 were provided by the City. Daily data were provided, from which a monthly summary has been prepared in Table 2-5 and Figure 3. Figure 4 shows a graph of the average monthly production for those four years. From 2007 to 2010, average daily production at the plant was 0.85 MGD. Using a daily production of 0.85 MGD over an entire year, the City uses an average of 952 AFY which is 60% of the City's



Source: Angels Camp, 2011b
Daily data are from the meter located at the headworks of the water treatment plant.

FIGURE 3



Source: Angels Camp, 2011b
Based on daily production for January 1, 2007 through December 31, 2010.
Error bars represent the maximum and minimum monthly production during the four-year period.

FIGURE 4

maximum allocation. The maximum monthly production, on average, occurs in July or August[4] and is 1.42 MGD.

Daily metered usage data[5] were not available, so maximum daily demands and peaking factors have been developed from the daily production data for 2007 through 2010. The maximum daily production occurs most often in July and August, but also happened once during October. The maximum daily production during this period was 2.0 MGD, which occurred on August 17 and 18, 2008. For the four-year period, the average maximum day production was 1.77 MGD. Assuming an average day demand of 0.85 MGD, the maximum day demand (MDD) peaking factor is approximately 2.1 (1.77 MGD/0.85 MGD). This peaking factor is reasonable and typical of water systems, especially those such as the City's system that primarily serve residential customers (AWWA, 2005; Mays, 2000).

TABLE 2-5 MONTHLY AVERAGE AND TOTAL ANNUAL WATER PRODUCTION, 2007 – 2010

	Monthly Average Production (MGD)				Average
Month	**2007**	**2008**	**2009**	**2010**	**(MGD)**
January	0.68	0.53	0.43	0.44	0.52
February	0.51	0.51	0.41	0.42	0.46
March	0.59	0.59	0.45	0.46	0.52
April	0.69	0.88	0.71	0.46	0.69
May	0.98	1.06	0.98	0.65	0.92
June	1.28	1.28	1.08	1.04	1.17
July	1.49	1.43	1.35	1.32	1.40
August	1.52	1.53	1.31	1.29	1.42
September	1.21	1.25	1.17	1.14	1.19
October	0.86	0.92	0.81	0.83	0.85
November	0.69	0.61	0.61	0.51	0.61
December	0.53	0.50	0.48	0.43	0.49
Annual Avg.	0.92	0.93	0.82	0.75	0.85
Max. Monthly	1.52	1.53	1.35	1.32	1.43
Min. Monthly	0.51	0.50	0.41	0.42	0.46
Total Annual Production					
(MG)	337	339	299	275	312
(AF)	1,034	1,039	918	843	958

Source: Angels Camp, 2011b
Notes: All values are based upon the single meter at the headworks of the plant; therefore, these numbers include water used to backwash the filters.

[4] During the four-year period, the maximum monthly production occurred in both July and August (two years during July, and two years during August).
[5] Daily usage data were not available, annual usage data are presented in Section 2.5.3.

Table 2-6 gives the maximum production and estimated MDDs and peaking factors for the recent four-year period. Hourly metered usage data were not available, but the estimated hourly peak demand is 2,400 gpm (3.4 MGD) on peak days during the summer (Walker, 2011). With MDD of 1.77 MGD, this equates to a peak hourly demand factor of about 1.9 and a maximum day peaking factor of 2.1.

TABLE 2-6 MAXIMUM DAILY PRODUCTION AND PEAKING FACTORS

	2007	2008	2009	2010	Average
Average Daily Production (MG)	0.92	0.93	0.82	0.75	0.85
Maximum Daily Production (MG)	1.80	2.00	1.61	1.66	1.77
Date of Maximum Day Production	July 6/ July 7	Aug 17/ Aug 18	July 27/ July 28	Oct 5	n/a
Maximum Day Peaking Factor[1]	2.0	2.2	2.0	2.2	2.1

Notes:
1. The MDD peaking factor is the ratio of the maximum daily production to the average daily production.

2.4.5 Recent and Planned Improvements

In 2010 and 2011, the WTP underwent a series of upgrades. Included were a new slidegate at the Forebay; a new meter and pipeline at the headworks; and a new floc drive in the floc basin. The 20-horsepower pump that feeds the filters was also placed on a variable frequency drive (VFD) to improve efficiency of pumping during lower winter flows. At the time of this writing, an upgrade to a Supervisory Control and Data Acquisition (SCADA) system is also planned, and for purposes of project planning in this report, will be considered a completed project.

2.5 WATER DISTRIBUTION SYSTEM

The City's distribution system consists of five pressure zones all fed by gravity from the single tank located at the WTP. Pressure is reduced in each zone by pressure reducing valves (PRVs). The following section describes the connections, usage, and infrastructure of the distribution system.

2.5.1 Connections

The City's water system serves a population of approximately 3,500 people through 1,764 metered connections. Most connections (1,501) are residential, though there are some commercial, industrial, and agricultural connections. Table 2-7 lists the connection types and number of each.

TABLE 2-7 NUMBER AND TYPE OF METERED WATER SYSTEM CONNECTIONS

Type of Connection	Number of Metered Connections
Single Family Residential	1,469
Multi-Family Residential	32
Commercial/Institutional	207
Industrial	3
Landscape Irrigation	47
Agricultural Irrigation	3
Other	3
Total	1,764

Source: DWR, 2010
Note: In addition to the metered connections listed here, the City reports that there are 350 unmetered connections. These connections consist of fire hydrants and other connections for fire services.

2.5.2 Water Rates and Connection Fees

The City's water rates were last modified in August 2009. The current water rates are given in Table 2-8. All rates and fees are effective August 2009. Monthly base rates are shown in A of Table 2-8. Base rates for outside the city are approximately twice as much as those inside the city limits. In addition to monthly base rates, quantity rates have also been established based on the volume of water metered (B of Table 2-8).

TABLE 2-8 WATER RATES

A. Water Service Monthly Base Rates[1]

Meter Size (inches)	In-City Base Rate	Outside-City Base Rate
¾ x 5/8	$39.75[3]	$75.31
¾	$47.39	$85.87
1	$62.66	$117.45
1.5	$78.45	$149.08
2	$120.09	$236.05
3	$228.13	$454.68
4	$344.08	$686.56
6	$502.11	$1,002.74

TABLE 2-8 WATER RATES (CONTINUED)

B. Quantity Rates (in Addition to Monthly Base Rates)[4]

Quantity	Cost per 100 cubic feet ($/100 ft^3)
First 500 cubic feet	$1.083
Any over 500 cubic feet	$1.626

Notes:
1. All rates effective August 2009
2. Monthly base rates include 1,000 ft^3 of water
3. For each additional residential unit or equivalent hooked to one meter, where such is allowed, a charge of $27.91 per month shall be made for each such additional unit.
4. Quantity rates are for water use greater than the 1,000 ft^3 included in the base rate.

Connection fees are given in Table 2-9. These are the fees charged to customers in order to setup a service connection (with meter installation) to the distribution system. Table 2-9 consists of three individual tables: A – Single Unit Residential Meter Fees, B – Meter Fees for Multiple Units on a Single Meter, and C – Meter Fees for Commercial, Industrial, and other non-residential uses.

TABLE 2-9 CONNECTION FEES

A. Single Unit Residential Meter Fees

Meter size (inches)	Fee
5/8	$8,782
3/4	$9,880
1	$10,977
1.5	$13,172
2	$15,369
3	$17,564
4	$21,956
6	$32,933

Source: City Council Resolution 06-20 (June 2006)

TABLE 2-9 CONNECTION FEES (CONTINUED)

B. Meter Fees for Multiple Residential Units on a Single Meter

Connection Type	Fee
Mobile Home/Each Unit of Multifamily	Meter fee + $ 7,685 per additional unit
Duplexes	Meter fee + $ 7,910 per additional unit
Granny Flat	Meter fee + $ 3,515 per additional unit
Motels & Hotels	Meter fee + $ 7,685 per additional unit

Source: City Council Resolution 06-20 (June 2006)

C. Meter Fees for Commercial, Industrial, and Other Non-Residential

Connection Type	Fee
Restaurants	Meter fee + $ 22 per square ft of seating area
Markets	Meter fee + $ 2.20 per square ft of floor area
Car Wash	Meter fee + $ 220 per stall
Laundromats	Meter fee + $ 220 per washer
Other Non-Residential	Meter fee + Fixture Units/30 x $ 5,490
Landscape	No fee, if criteria of Resolution 06-20 met

Source: City Council Resolution 06-20 (June 2006)

2.5.3 Historical Water Usage

The City's metered water usage, as reported to DWR, is presented in Table 2-10. For the last four years (2007-2010), annual usage averaged 302 MG per year. The majority of usage (63%) was by single family residential users, while commercial/institutional users consumed the second-highest percentage (25%). The remaining 12% of usage was by multi-family residential, industrial, irrigation, and other users.

TABLE 2-10 ANNUAL METERED WATER USAGE BY LAND USE TYPE, 2007 - 2010

	Metered Usage, MG				Average	
Usage Type	**2007**	**2008**	**2009**	**2010**	**MG**	**Percent of Total**
Single Family Residential	203	202	188	166	190	63%
Multi-Family Residential	17	19	16	14	17	5%
Commercial/Institutional	81	81	72	67	75	25%
Industrial	2	2	2	1	2	1%
Landscape Irrigation	16	16	14	13	15	5%
Other	2	1	1	0	1	0.3%
Agricultural Irrigation	3	3	3	2	3	1%
Total	325	323	295	264	302	100%

Source: "Public Water System Statistics" Reports, 2007 through 2010. See DWR, 2010

2.5.4 System Losses and Unaccounted-For Water

A comparison of water production and metered usage gives the amount of water produced that is not accounted for at metered connections. This water is called 'unaccounted-for water' or 'non-revenue water', as the City does not collect water fees for this portion of water. Unaccounted-for water usage in the system may include authorized unmetered usage, such as fire flows from fire hydrants or flushing flows at valves or dead-end blow-offs. Water also may be lost from the system due to pipe breaks or leaks. Additionally, in the City's system, total production is metered at the headworks of the water treatment plant and therefore includes water used in the treatment process, such as for backwashing and cleaning. Thus, the City's unaccounted-for water also includes the authorized use of water for the treatment process.

It is desirable to minimize unaccounted-for water in a system in order to maintain efficiency, reduce wasted water, and maximize revenue from water rates. Table 2-11 compares the total annual production to the total metered usage for 2007 through 2010. Unaccounted-for water ranges from 2% to 5% per year of the total annual production. These unaccounted-for water percentages are low and indicate good system performance. Losses of less than 10% are generally considered acceptable. However, the American Water Works Association (AWWA) recommends that the impact of the losses be quantified in terms of revenue lost and that programs to detect and repair leaks be implemented if economically appropriate. More information about water losses and unaccounted-for water may be found in AWWA Manual M36, Water Audit and Loss Control Programs (3rd Edition, 2009).

TABLE 2-11 ESTIMATE OF UNACCOUNTED-FOR WATER, 2007-2010

	2007	2008	2009	2010	Average
Total Annual Production[1], MG	337	339	299	275	312
Total Annual Metered Usage, MG	325	323	295	264	303
Unmetered/Unaccounted-for Water					
MG	12	16	4	10	11
as percent of production	4%	5%	2%	4%	3%

Sources: Production: Table 2-5; Metered Usage: Table 2-10.
Notes:
1. Production values are based on the single water meter at the headworks of the treatment plant and therefore, production includes water used in the treatment process (i.e. for backwashing, cleaning, etc.). Thus, the unaccounted-for water estimates also include the water used in the treatment process.

2.5.5 Pressure Zones

There are five pressures zones in the City's service area, all served by gravity from the 2.5 MG storage tank at the WTP. The five zones are known as Zones A through E. Zone A is at the head of the system at the water treatment plant. Zone A feeds Zone B. Zone B is then connected to both zones C and D. Zone E is fed by Zone D. The zones are previously shown on Figure 2.

Zone A consists of the WTP, storage tank, and a 14-inch pipeline that serves the rest of the zones. Zone A has the highest elevations in the system, ranging from about 1,560 feet (ft) to 1,800 ft.

Zone B is the largest zone in the system, both in terms of land area and number of pipelines and connections. It includes most of the City's commercial areas along Highways 4 and 49. Zone B serves elevations of about 1,480 ft to 1,560 ft.

Zone C is located to the southeast of Zone B and includes the City's historical commercial area. It covers an elevation range from about 1,360 ft to 1,480 ft. Zone D is located to the south of Zone B and is primarily residential. The elevation range in Zone D is from about 1,400 ft to 1,480 ft. Zone E is to the southwest of Zone D and is also primarily residential, serving homes at elevations from about 1,300 ft to 1,400 ft.

The distribution system information for pipes, valves, and hydrants that follows (Sections 2.5.6, 2.5.7, and 2.5.8, respectively) is broken down by zone.

2.5.6 Pipe Characteristics

The City has approximately 32 miles of water distribution pipes in its system. The most common diameter is 6-inch, which represents 36% of the total pipe length in the system. 8-inch is the second-most common at 31% of the total pipe length. Table 2-12 gives the total pipe length by zone and by diameter. Pipes locations are shown on Figure 2. Pipe diameters are shown on Plate 1.

A full inventory of pipe installation dates and materials was not available from the City, but system maps were reviewed and general trends in pipe age and material are noted here. Pipes located in Zones B and C in the older parts of town are made of asbestos concrete, spiral weld steel, ductile iron, or galvanized steel. These pipes are generally 50 years old or more. The condition of the older pipes in Zones B and C is not known. Typical life expectancy of such pipes can be 50 years or more. Steel pipes tend to have shorter life expectancies due to corrosion. The need to replace older pipes is generally indicated by failures requiring repairs: when these failures become frequent, replacement of the entire line is indicated. A small number of pipes in these areas have been replaced with C-900 polyvinyl chloride (PVC) pipe. C-900 refers to the AWWA standard for PVC pipe. Pipes in the Angel Oaks (Zone B) and Greenhorn Creek (Zones D and E) subdivisions are made of C-900 PVC pipe, and were constructed in the 1990s and 2000s.

TABLE 2-12 PIPE LENGTHS BY PRESSURE ZONE

Pipeline Diameter (inches)	Length of Pipe by Zone (feet)					Total System Length (feet)	Percent of System Length (%)
	Zone A	Zone B	Zone C	Zone D	Zone E		
2	0	449	700	335	117	1,602	1%
4	0	16,800	9,809	745	749	28,104	17%
6	0	30,860	18,975	3,204	7,514	60,554	36%
8	0	23,862	7,375	10,939	9,565	51,741	31%
10	0	7,864	4,169	3,703	0	15,735	9%
12	0	1,603	0	0	0	1,603	1%
14	3,257	45	0	0	0	3,302	2%
unknown	0	336	44	3,924	51	4,355	3%
Total	3,257	81,818	41,072	22,851	17,996	166,995	100%

Source: Angels Camp, 2011a

2.5.7 Valves

The City provided Geographic Information System (GIS) coverage of the distribution system valves. The layer contained approximately 400 valves. The number of valves in each zone is presented in Table 2-13 and the valve locations are shown on Plate 1. Some valves had descriptions, such as blow-offs, air-release, pressure-reducing, etc. However, one third of the valves had no description and therefore a full list of valve type and number cannot be presented here. As such, one recommendation of this audit is to fully inventory the valves (see Section 5.2.1).

TABLE 2-13 NUMBER OF VALVES BY ZONE

Zone	Number of Valves	Percent of System Total (%)
Zone A	0	0%
Zone B	248	40%
Zone C	127	20%
Zone D	132	21%
Zone E	113	18%
Total	620	100%

Source: Angels Camp, 2011a

Table 2-14 presents a list of the ten PRVs in the system. The numbered PRVs are also shown on Figure 2 and Plate 1. The City's PRV inspection sheets for the last two years were reviewed and a summary of the typical pressure ranges is presented in the table.

TABLE 2-14 LIST OF PRESSURE REDUCING VALVES

PRV Number on Figure 2	Valve Name/Location	Zone Trans-ition	Typical Range of Pressures[1], In (psi)	Typical Range of Pressures[1], Out (psi)
1	Water Plant	A to B	123-126	98-110
2	Stelte Park	B to C	160-174	104-110
3	Museum	B to C	90-140	60-70
4	Mark Twain Rd & Echo St	B to C	--[2]	--[2]
5	Greenhorn Cr Dr & Gateway Park	B to D	125-130	60-70
6	Gold Cliff Rd & Fire Access Rd	B to D	118-125	50-54
7	Blair Mine Rd & Mill Rd	D to E	100-120	85-117
8	Smith Flat Rd & Blair Mine Rd	D to E	87-100	50-85
9	Selkirk Ranch Rd & Springhouse Rd	D to E	70-92	48-80
10	Smith Flat Rd & Selkirk Ranch Rd	D to E	90-105	--[2]

Source: Angels Camp, 2011c

Notes:

1. Pressure range is the range of pressures measured in 2009 and 2010 at each valve.

2. PRV 4 does not have gages and pressure readings are unknown; the outlet gage at PRV 10 has been broken since 2007.

2.5.8 Hydrants

According to 2011 GIS data, the City has approximately 300 fire hydrants. Hydrant locations are shown on Figure 2. Table 2-15 lists the number of hydrants in each pressure zone. Most of the hydrants (47%) are in Zone B. The GIS data layer does not show any hydrants in Zone A; however, there are hydrants at the WTP. The hydrants in this zone should be added to the City's GIS database.

TABLE 2-15 NUMBER OF HYDRANTS BY ZONE

Zone	Number of Hydrants	Percent of System Total (%)
Zone A[1]	0	0%
Zone B	140	47%
Zone C	81	27%
Zone D	43	14%
Zone E	36	12%
Total	300	100%

Source: Angels Camp, 2011a

Note: GIS data shows zero hydrants in this zone, but there are known hydrants located at the WTP.

2.5.9 Backflow Prevention

The City utilizes backflow preventers to protect its system from contamination if the pressure within a pipe is reduced. Types of backflow preventers the City uses include reduced pressure principal devices, double checks, and pressure vacuum breaker assemblies (Walker, 2011). The City tests its backflow preventers annually as required by state regulations.

3.0 REGULATORY REQUIREMENTS AND COMPLIANCE

The main regulatory body that oversees public drinking water systems in California is the CDPH. California law gives authority to CDPH to regulate and enforce federal and state drinking water standards. The CDPH oversees public drinking water systems in three primary ways:

1. Establishment and Enforcement of Drinking Water Rules and Regulations
2. Issuance of Public Water System Permits
3. Certification of Treatment and Distribution System Operators

Some standards related to drinking water are not determined by CDPH, but are instead left to individual municipalities to determine. This section outlines the state and local laws that govern the City's public drinking water system as well as the City's compliance with the regulations.

3.1 CALIFORNIA LAW AND DRINKING WATER STATUES

California law consists of 29 codes. Laws related to public drinking water systems are mainly contained in the Health and Safety Code, though some laws exist in other codes such as the Water Code. The Health and Safety Code includes the Safe Drinking Water Act (Div 104, Part 12, Chapter 4). The following is a partial list[6] of statutes contained within the Health and Safety code that gives CDPH authority to regulate public drinking water systems:

- CDPH regulatory authority and responsibilities: § 116270, 116287, 116325
- Authority for CDPH to issue permits: § 116525
- Operator certification program: § 106875-106910

3.2 CALIFORNIA CODE OF REGULATIONS

Regulations related to public water systems are contained in Titles 17 and 22 of the California Code of Regulations (CCR). Generally, most rules and regulations for public drinking water systems are contained in Title 22, Division 4 (Environmental Health). However, relevant regulations may be found in other areas of Titles 17 and 22.

[6] There are many other statues that apply to drinking water systems, but the few summarized here are related to CDPH authority and their primary responsibilities.

As part of this audit, California regulations were reviewed with the intent of identifying any areas in which the City is not in compliance. The following sections outline the most important aspects of state regulations as they apply to the City. An assessment of compliance with each section is given. Projects necessary to achieve compliance are recommended later in this report in Section 5.0. The list of regulations below is organized into four categories: source supply, treatment processes, distribution system, and water quality sampling requirements. Only relevant regulations have been included here. The full set of regulations may be found online (CCR, 2011).

Some criteria, such as storage volumes and fire flows, are not specifically mandated in CDPH regulations, but are instead determined by the water supply permit or local codes. These issues are discussed in Sections 3.3 and 3.4, respectively.

3.2.1 Source Supply Requirements

The primary regulation that governs source supply in the CCR is the following:

> *At all times, a public water system's water sources(s) shall have the capacity to meet the system's maximum day demand (MDD)* [22 CCR §64554 (a)]

Currently, under normal operating conditions, the City is able to meet MDD. However, there are some operating conditions in which meeting MDD is a concern. First, following winter storms, high levels of turbidity prevent the WTP from operating for as long as two days (see Section 2.4.3.3). When this occurs, the source supply is not available at all.

Second, future uncertainty about the City's water supply allocation during drought conditions is a concern. As discussed in Section 2.3.3, the City does not have a shortage plan in place with UPA that determines how much water they would get during a drought. Times of emergency, such as another fire on the flume system, could lead to interruption of the City's water supply. Recommendations for addressing these issues include exploring alternative water supplies (such as wells) and adding a sedimentation basin or pre-filtration process to address turbidity. These recommendations are discussed in Chapter 5.0.

3.2.2 Treatment Processes Requirements

Currently, there are two areas of non-compliance in the treatment process, both related to the backwash of the filters. First, backwash water is not currently being disposed of properly. There is also concern that current backwash configuration may not provide sufficient redundancy.

3.2.2.1 Backwash Discharge

The CCR's regulation on discharging filter backwash is as follows:

> *Each report of waste discharge related to discharges of pollutants from point sources to navigable water shall be filed and processed in compliance with the applicable federal regulations governing the National Pollutant Discharge Elimination System (NPDES) permit program promulgated by EPA* (23 CCR § 2235.1)

The City discharges its filter backwash into a ditch system that leads directly into a creek behind the WTP without a NPDES permit which is not in compliance with the CCR. Solutions to this problem include pursuing an NPDES permit in order to continue to release the water into the creek or discharging the backwash water into the wastewater collection system. Details of potential solutions are discussed in Section 5.1.1.

3.2.2.2 Backwash Redundancy

Title 22 requires that multiple filter units be utilized in order to provide redundant capacity when a filter is out of service for backwash or maintenance. An excerpt from the regulations is below (emphasis added):

> *(a) The following reliability features shall be included in the design and construction of all new and existing surface water treatment plants:*
>
> *(1) Alarm devices to provide warning of coagulation, filtration, and disinfection failures. All devices shall warn a person designated by the supplier as responsible for taking corrective action, or have provisions to shut the plant down until corrective action can be taken.*
>
> (2) ***Standby replacement equipment available to assure continuous operation and control of unit processes for coagulation, filtration and disinfection.***
>
> *(3) A continuous turbidity monitoring and recording unit on the combined filter effluent prior to clearwell storage.*
>
> (4) ***Multiple filter units which provide redundant capacity when filters are out of service for backwash or maintenance.***
>
> *(b) Alternatives to the requirements specified in section 64659(a) shall be accepted provided the water supplier demonstrates to the satisfaction of the Department that the proposed alternative will assure an equal degree of reliability.*
>
> (22 CCR § 64659)

Items (a)(2) and (a)(4) state that filtration should be operated continuously, and that there should be redundant filters during backwash. As discussed in Section 2.4.3.2, the City's current backwash process requires that all three filters be off-line at once, which means that the WTP is not producing water for 2.75 hours. This issue represents a potential area of non-compliance and should be addressed. Potential solutions for this problem include adding a fourth filter with redundancy during backwash, or reconfiguring existing pipes, valves and pumps to allow for necessary backwash redundancy (see Section 5.1.2).

3.2.3 Distribution System Requirements

Within the City's distribution system, there is currently one area of potential non-compliance and one area of compliance significant to mention. These are minimum pressure and backflow prevention, respectively.

3.2.3.1 Minimum Pressure

An important regulation for distribution systems is minimum pressure. An excerpt from 22 CCR § 64602 is as follows:

> *(a) Each distribution system shall be operated in a manner to assure that the minimum operating pressure in the water main at the user service line connection throughout the distribution system is not less than 20 pounds per square inch (psi) at all times.* (22 CCR § 64602)

Compliance with minimum pressure requirements for the City is not known at this time and is not easy to assess without rigorous pressure testing or a hydraulic pipe network model of the distribution system. Generally, water systems rely upon customer complaints to assess areas of low pressure. The City has reported that there are some known areas of low pressure within the system, but the pressure in these areas has not been studied. Implementation of a hydraulic pipe network model is recommended in order to identify deficiencies and demonstrate compliance with minimum pressure requirements.

3.2.3.2 Backflow Prevention

One of the backflow prevention regulations is the testing and maintenance of backflow preventers. A portion of 17 CCR § 7605 is stated below:

> *(c) Backflow preventers shall be tested at least annually or more frequently if determined to be necessary by the health agency or water supplier. When devices are found to be defective, they shall be repaired or replaced in accordance with the provisions of this Chapter.* (17 CCR § 7605)

The City tests their backflow preventers at least annually and is in compliance with the regulation. It has also adopted this regulation in its municipal code (see Section 3.4).

3.2.4 Water Quality Sampling Requirements

There are a number of regulations described in the CCR regarding maximum concentration and sampling frequency for various water quality parameters including bacterial, inorganic, and organic constituents. Descriptions of these regulations are shown below as well as regulations regarding mandatory consumer confidence reports that the system must distribute to its customers annually.

3.2.4.1 Bacterial Sampling

Bacterial sampling requirements are covered in 22 CCR § 64421 through § 64423. One of the more significant regulations stated in these sections is that the water supplier must submit an updated sample siting plan to CDPH at least once every ten years and at any time the plan no longer ensures representative monitoring of the system [22 CCR § 64422 (c)]. Another regulation of significance is the minimum number of routine total coliform samples as described in Table 64423-A in the CCR. Based on its monthly population served and number of service connections, the City is required to take a minimum of six samples per month.

The City's sample siting plan was last updated in 2002; therefore an update to the plan is due in 2012. The current siting plan states that the City is taking five monthly samples. This is lower than the minimum number mandated by the CCR. Due to the increase in connections since 2002, the sampling plan should be updated to include six samples per month. See Section 5.3 for recommendations for compliance with CCR's bacterial sampling requirements.

3.2.4.2 Inorganic and Organic Constituent Sampling

In addition to bacterial sampling, the City must sample for inorganic and organic constituents on a routine basis. Constituent concentrations must comply with the primary maximum contaminant levels (MCLs) listed in Table 64431-A (22 CCR § 64431) and Table 64444-A (22 CCR § 64444) for inorganic and organic constituents, respectively.

As stated in 22 CCR §64432 (c)(1), systems using approved surface water shall sample annually for inorganic constituents unless more frequent monitoring is required. For organic constituents, as long as there are no detections, systems shall sample annually [22 CCR § 64445 (b)]. If an organic constituent is detected, the system must sample more frequently pursuant to the detailed schedule described in 22 CCR § 64445 (c).

Based on the 2009 consumer confidence report and personal communication with the City, it is in full compliance with the inorganic and organic constituent sampling requirements set forth in the CCR. More information on consumer confidence reports is described in the following section.

3.2.4.3 Consumer Confidence Reports

As described in 22 CCR § 64480 through 22 CCR § 64483, each water system must distribute an annual consumer confidence report to its customers on an annual basis that describes the water source and water quality found within the system. Consumer confidence reports include a table of common contaminants in water systems stating the range of concentrations within the water system, the MCL, the public health goal, and common sources of the contaminants. The City is in compliance with this regulation and produces consumer confidence reports on an annual basis.

3.3 PROVISIONS OF EXISTING WATER SUPPLY PERMIT

CDPH regulates site-specific aspects of public water supply systems through their public water supply permit program. The City's permit dates back to 1968, when PG&E owned the system and first acquired a permit for it. The history of the permit, including amendments and existing requirements, is discussed below.

3.3.1 Permit History

The first permit for the system (No. 68-13) was issued on April 26, 1968 to PG&E, then the owner of the system. After the City acquired the treatment plant, they applied for and were granted a new full permit on March 11, 1987 (No. 87-014). Since the full permit was issued, the City has been granted two amendments, the first on September 12, 1996 (amendment No. 03-10-96PA-001 REVISED), and the second on June 5, 2003 (amendment No. 03-10-03PA-006).

The original permit covered one single-media filter. The first amendment in 1996 covered a series of upgrades to the plant including: a second mixed-media filter; conversion of the original single-media filter to a mixed-media filter, and other changes to corrosion control, chlorination, and plant automation. The most recent amendment was filed in June 2001 and granted on June 5, 2003. This amendment covered the addition of the 2.5-MG storage tank, a new third filter, and abandonment of the open clearwell.

3.3.2 Current Permit Provisions

The most recent permit amendment added 13 new conditions to the permit. They are summarized below. For the full text of the conditions, see Amendment No. 03-10-03PA-006.

1. Filtration rate shall be 3 gpm/ft^2 or less.
2. The City shall revise the plant operations plan and emergency disinfection plan to reflect improvements.
3. The third filter will be used to provide redundant capacity and cannot be used to accommodate future growth.
4. Grab sample monitoring of turbidity shall continue in lieu of continuous monitoring of settled water.

5. The City shall comply with all rules and regulations of the California Safe Drinking Water Act and California Health and Safety Code. The only sources approved for potable water supply are the Active Raw (0510003-001) and Treated Raw (0510003-003) sources.
6. All water supplied for domestic purposes shall meet all MCLs and Action Levels (ALs) established by the State.
7. All personnel will be properly certified with the State. The system is a T3 system.
8. The WTP shall provide total treatment for at least 3.0 logs reduction of Giardia cysts and 4.0 logs for reduction of viruses through filtration and disinfection.
9. The WTP shall provide a minimum of 0.5 log Giardia cyst inactivation through disinfection. The City shall utilize a baffling factor of 0.7 for the filters and 0.3 for the storage tank and shall maintain a minimum volume of 937,500 gallons of water in the storage tank to provide needed disinfection contact.
10. The maximum plant flow rate shall not exceed 1,440 gpm at any time.
11. The City shall monitor the bacteriological quality of the influent water to the WTP by determining the coliform levels in the raw water at least one time per week.
12. The City is no longer required to follow requirements related to the old open clearwell.
13. The City shall calculate the chlorine contact time (CT) on at least a weekly basis, and preferably on a daily basis.

3.3.3 Compliance with Current Permit

Currently, most of the conditions in the permit Amendment are being complied with. The conditions that require action are No. 2 and No. 9.

3.3.3.1 Operations and Maintenance Plan

Once recent upgrades to the WTP (which are still under way) are complete, the operations and maintenance plan must be updated. This is included in the list of recommended projects in Chapter 5. This is required to satisfy Condition No. 2 of the permit.

3.3.3.2 Storage

Condition No. 9 of the permit states that the minimum tank volume must be maintained at 937,500, or approximately 0.95 MG. This corresponds to a water level of about 15 ft in the tank. Accordingly, that 0.95 MG should be considered emergency storage, and the tank should not be routinely operated below 15 ft. That means the operating storage for the storage tank is 1.55 MG.

A concern related to the capacity of the storage tank is peak summer demands when backwashing is required. During the summer, the backwash cycle generally must be run every five days. The duration of a backwash cycle is approximately 2.75 hours, and in that time, the entire WTP is off-line and not producing any water. As such, all water must be provided from the storage tank. With an MDD of about 1.8 MGD, and assuming a typical demand distribution, hourly demands on a peak day can be up to 2,300 gpm. For 2.75 hours, this represents a demand of about 0.38 MG that must be served from the tank. With this demand, if the tank volume were to start below 1.33 MG when the backwash cycle begins, the tank level could drop below the allowable limit of 0.95 MG. This potential problem may be solved by adding a storage tank or by implementing redundancy during the backwash cycle. These projects are discussed further in the recommended projects chapter (Sections 5.1.4 and 5.1.1).

3.3.3.3 Filter Backwash

An additional compliance issue is related to the backwash process. Currently, all three filters are off-line during the backwash cycle, meaning the plant is not producing any water, and all water is being supplied from the storage tank. As part of the 2003 permit amendment, CDPH issued an engineer's report evaluating the system. The reports states that:

> *With the use of the third filter unit that is a subject of this permit, the City can maintain its production of water at 1,440 gpm, even when one filter is being backwashed. One purpose of having the redundant third filter is to allow that filter to be utilized at normal loading rates (up to 3 gpm/ft^2) while one of the other filters is prevented from producing filtered water due to the need for backwashing. The City will be able to…[shift] the load to the redundant filter when one of the other filters is out for backwash* (Permit 03-10-03PA-006, page 5).

These statements clearly indicate that CDPH did not intend for all three filters to be off-line at once. Because of this, CDPH could find that the City is in violation of the permit requirements and state regulations on redundancy for filters (see Section 3.2.2.2). This matter should be corrected and is addressed in Section 5.1.2 of this audit.

3.4 CITY OF ANGELS MUNICIPAL CODE AND STANDARDS

The City's municipal code contains many provisions related to the water system. Most of these are contained in Title 13 (Public Services) and Title 14 (Water System).

3.4.1 General Water System Requirements

Title 14, entitled "Water System", contains ordinances covering a variety of topics related to the water system. Administrative provisions cover billing, financial responsibilities, service connections fees, and water rates. Current meter connection fees and rates were presented previously in Section 2.5.2.

The municipal code also contains many provisions related to infrastructure requirements. A selected list of important ordinances is given below:

- The standard single-family water service connection is a one-inch service pipe and a five-eighths-inch meter (§ 14.35.010)
- Each water service connection shall be installed in a public street or in an easement or right-of-way under the control of the water system (§ 14.35.100)
- The inside diameter of every water main installed shall be six inches; however, the city may prescribe a smaller size. (§ 14.45.050)
- The city shall prepare improvement standards[7] for the construction of water system facilities. A copy of the improvement standards shall be filed with the city clerk after approval and adoption by resolution of the city council. The improvement standards shall govern all extensions, additions and revisions to the water distribution system. (§ 14.45.070)
- The City shall maintain, repair, and replace water meters. (§ 14.50.020)
- An appropriate backflow prevention assembly shall be installed by and at the expense of the property owner at each user connection where required to prevent backflow from the water user's premises to the domestic water system. (§ 14.55.020)
- Backflow prevention assemblies must be tested at least annually and immediately after installation, relocation or repair. (§ 14.55.040)
- The City has an emergency water conservation plan in which conservation measures and penalties may be enforced during emergency conditions. (§ 14.90)

3.4.2 Fire Protection Requirements

The City's fire flows are codified in Section 13.04 of the municipal code, Fire Protection Water Services. The general provisions for fire hydrants and flows are as follows:

- Hydrant spacing shall not be greater than 300 ft.
- All fire hydrants in residential areas shall have two 2 ½-inch National Standard thread male outlets. In addition, those in commercial areas shall have one 4 ½-inch steamer outlet with a full 4 ½-inch valve opening.

[7] See Section 3.4.3 for more information on improvement standards

- Gate valves shall be installed between every fire hydrant and the main line.
- Fire flows shall be uninterrupted flows for a sustained period of at least two hours, at rates set forth in city resolution 21-78.

City Resolution 21-78 sets the following minimum fire flows by land use type. Flows set forth in Table 3-1 are to be calculated on the basis of a residual pressure of 20 pounds per square inch gage (psig) in the distribution system under flowing conditions.

TABLE 3-1 FIRE FLOWS FROM RESOLUTION 21-78

Land Use	Minimum Flow (gpm)
Rural residential (<2 lots/acre)	500
Single family residential (<2 lots/acre)	500
Single family residential (≥ 3 lots/acre)	750
Multiple residential up to a fourplex; neighborhood businesses of one story	750
Multiple residential units of > 4 units, 1 and 2 story; light commercial and light industrial	1,500
Multiple residential, three stories, heavy commercial, or heavy industrial	2,000

3.4.3 Improvement Standards

In accordance with municipal code Section 14.45.070, the City adopted its latest set of improvement standards in 2010 (Resolution 10-42). Improvement standards for the City are the requirements for all new construction. They should not be confused with regulations for the existing system, as they do not necessarily apply to the existing system. However, the improvement standards are representative of the City's approach to system best practices and may be used as guidance for determining where improvements are needed in the existing water system.

Section 16 contains the design standards for the Water System. Included are many detailed instructions for water system expansion. Here, a summary of important standards related to system storage, distribution, and water quality are presented:

- Maximum pipeline velocity shall be 10 feet per second, including during fire flows. (§ 16.06)
- Minimum design flows shall be determined by fire flow requirements. General requirements are as follows (§ 16.06):
  - Single family developments: 1,000 gpm for two hours.

- For multi-family, commercial, and industrial developments: 1,500 gpm for two hours.
- Average per capita water usage: 150 gallons/day/person; maximum day peaking factor will be 3. (§ 16.06.1)
- Minimum pipe size will be 6-inch for any looped system.
- Water mains serving industrial or commercial areas shall be no less than 8-inch in diameter.
- Transmission lines will be sized to pass the maximum day flow plus fire flow.
- Services with more than 80 psi static pressure shall be equipped with a pressure regulator set to 60 psi maximum.
- Storage requirements[8] will be the sum of fire storage, emergency storage, and system peaking (or operational) storage:
  - Fire storage shall be based upon the appropriate fire flow and required duration.
  - Emergency storage will be based on a four-hour duration of the MDD.
  - System peaking (operational) storage will be 20 percent of the MDD.
- The distribution system shall be zoned to provide the pressure range set forth below. Lines shall be sized for the more rigid of the following conditions:
  - Minimum pressure 40 psi.
  - Maximum pressure 150 psi.
  - Fire Flow plus Maximum Daily Flow at 20 psi residual pressure.
- Maximum spacing of fire hydrants shall be 500 feet in residential zones and 250 feet in commercial areas.

Note that the fire flow rates specified in the City's resolution (Table 3-1) differ from the flow rates specified in the improvement standards shown here. Hydrant spacing also differs: the resolution specifies 300 ft spacing, while the improvement standards specify 250 ft for commercial areas and 500 ft for residential. It is assumed that since both the resolution and improvement standards are adopted by the City Council, the more recent values in the improvement standards are to be complied with for future development.

[8] Note that these requirements for storage are written to apply to new developments and expansion, and do not necessarily apply to the existing system and storage tank.

3.4.4 Compliance with City's Municipal Code

In general, the provisions of the City's municipal code relate to future expansion and development of the water system. No major areas of non-compliance with the City code have been identified. However, there appear to be contradictory standards related to fire flows and hydrant spacing that should be resolved. A 1978 resolution has less stringent fire flow requirements than the City's most recent improvement standards. Additionally, the improvement standards specify different hydrant spacing from City Code. Municipal code section 13.04 states that hydrant spacing shall be no greater than 300 ft. However, the improvement standards state that spacing up to 500 ft is acceptable in residential areas[9]. This discrepancy should be resolved; currently, the improvement standards directly contradict a section of adopted code. A possible solution to this issue would be to update Title 13 of the municipal code to refer to the most recent improvement standards.

[9] The newer communities of Angel Oaks and Greenhorn Creek appear to have been constructed using hydrant spacing closer to 500 ft, so at some point after the 1978 resolution was passed, the City changed to using different standards.

4.0 STAFFING ASSESSMENT

A staffing assessment was conducted as part of this audit. The purpose of the assessment is to determine whether City staffing levels are comparable to similar water systems. To do so, Stetson gathered information on existing staffing for City employees and compared it to local data by surveying seven water suppliers.

4.1 CURRENT CITY STAFFING

City staffing levels were gathered from City staff (Walker, 2011). The most current information is presented below.

4.1.1 Staffing Levels

The current staffing levels were provided by the supervisor of the Water and Wastewater Treatment Department. Currently, the department has six employees who share duties to operate both the WTP and WWTP. Of the six employees, five are operators (each dual certified to run both types of plants) and one is a maintenance technician who is operator-certified but does not currently work under an Operator title (Walker, 2011). On weekdays, one operator works at the WTP, one operator works at the WWTP and wastewater sprayfields, and one senior supervising operator oversees both plants. On weekends, there is one operator each at the WTP and WWTP. All employees, with the exception of the senior supervisor, work four 10-hour shifts per week. The senior supervisor works five 8-hour shifts Monday through Friday.

Table 4-1 summarizes the current staffing levels by weekday and weekend shifts for water and wastewater treatment facilities only. Two positions, one technician and one operator, are currently not staffed. The total current staffing equates to 24 shifts per week, which are staffed by the six employees. Personnel for distribution and collections are staffed separately within the public works department. Discussion with the public works supervisor indicated that 1.5 staff members are dedicated to water distribution maintenance on weekdays for 8-hour shifts, and zero staff on weekends (Kitchell, 2011).

TABLE 4-1 BREAKDOWN OF CURRENT STAFFING LEVELS FOR THE WATER/WASTEWATER TREATMENT DEPARTMENT BY WEEKDAY AND WEEKEND

	Weekday Shifts		Weekend Shifts		Weekly
Location, staff type[1]	**Each Day**	**Total**	**Each Day**	**Total**	**Total**
WTP, operator	1	5	1	2	7
WWTP, operator	1	5	1	2	7
Maintenance, technician	0	0		0	0
Sprayfields, operator	1	5		0	5
Support, operator	0	0		0	0
Supervisor, senior operator	1	5		0	5
Total		20		4	24
		Shifts per week per employee[2]			**4.0**
		Employees required to fulfill all shifts[3]			**6.0**

Source: Walker, 2011
1. Includes operators and maintenance staff for water and wastewater treatment facilities only.
2. Assumes 10-hour shifts for all employees and a 40-hour work week.
3. The WWTP requires more staffing than the WTP; of the six operators, it is estimated that on weekdays, 2.5 shifts are dedicated to the WTP, while 1.5 shifts are dedicated to the WTP. On the weekend, the split is one shift per plant. This means that of the 6 employees, 3.6 are required for the WTP, while 2.4 are required for the WTP.

4.1.1 City Staffing Ratios

As shown in Table 4-1 (footnote 3), when shifts are divided amongst the water and wastewater treatment duties, approximately 2.4 operators staff the WTP, while 3.6 operators staff the WWTP. Existing city staffing levels are broken down for each service function in Table 4-2. In order to compare the City's staffing levels to those of other water purveyors, two ratios were computed for each set of service functions: first, the ratio of the average annual water treatment plant production to employees was computed. This ratio is representative of how much staffing there is relative to the total production of the WTP. Second, the ratio of number of connections to employees was computed. This ratio is representative of how much staffing there is relative to the size of the distribution system. A ratio using population was also considered, but was not used due to the fact that some purveyors in the survey have different year-round and seasonal populations.

TABLE 4-2 CURRENT CITY STAFFING RATIOS

Service Function	Current Staffing (employees)	Average Annual Water Production to Staffing Ratio[1] (MG/ employee)	Number of Connections to Staffing Ratio[2] (connections/ employee)
Water Treatment Only	2.4	130	740
Wastewater Treatment Only	3.6	87	490
Distribution Only	1.5	208	1,180
Water Treatment & Distribution	3.9	80	450
Water & Wastewater Treatment	6.0	52	300
All Treatment & Distribution	7.5	42	240

Notes:
1. Based on 312 MG per year.
2. Based on 1,773 connections.

4.2 STAFFING SURVEY

4.2.1 Staffing Levels of Other Water Purveyors

Each water purveyor that was surveyed has a unique system and staffing organization. In order to compare other systems to the City, information was sought about each system's operations and organization. Some utilities oversee both water and wastewater treatment and share operators amongst them (as is done by the City). Other utilities only oversee water treatment. Another factor is the inclusion or exclusion of collection and distribution from the treatment department. Sometimes treatment and distribution are overseen and staffed together, while in other cases, they are separate (as is the case for the City). Table 4-3 provides information for each water supplier on the services overseen, and which employees are shared amongst each department.

Because system organization varies, each purveyor has been assessed individually in the sections below. For each, the system characteristics have been taken into account in order to come up with reasonable comparisons to the City. Comparable staffing rates, such as number of connections per operator, or MG of production per operator, have been presented. The comparison is based on a similar service function to the City and calculates the same ratios shown in the table using the system's number of staff, annual water production, and number of connections provided by the water purveyor.

TABLE 4-3 STAFFING COMPARISON TO OTHER WATER PURVEYORS

		General System Information[1]					Services Overseen			Staff Summary										
Public Water Supplier	**County**	**California PWS ID**	**Connections Served**	**Population Served**	**Population Type[2]**	**Source Water Type(s)[3]**	**Water Treatment[4]**	**Wastewater Treatment**	**Collection/ Distribution**	**No. of WTPs**	**Total Annual Production (MG)**	**No. of Operators**	**Operator Types[4]**	**Lowest Grade Employed**	**Highest Grade Employed**	**Maintenance and Support Staff**	**Total Staff**	**Shared with other WTPs?**	**Shared with WWTP?**	**Shift Duration (hours)**
Calaveras County Water District	Calaveras	multiple[6]	12,534	31,336	R	SW	☑	☑	☑	5[6]	1,433	43	Td, D	I	IV	shared	48	☑	☑	8, 10
Foresthill Public Utility District	Placer	3110003	1,919	5,500	R	SW	☑	☐	☑	1	327	6	T, D	II	III	0[7]	6	☐	☐	8
Gridley, City of	Butte	0410004	2,077	6,403	R	GW	☐	☑	☑	0	767	8	Td, D	II	II	0	8	☐	☑	8
Groveland Community Service District	Tuolumne	5510009	3,293	3,400	R	SW	☑	☑	☑	3	145	6	Td, D	I	III	shared	6	☑	☑	8
Jackson, City of	Amador	0310001	2,089	5,223	R	SW	☐	☐	☑	0	343	7	Td, D	I	IV	0	7	☐	☐	9
Stinson Beach County Water District	Marin	2110004	721	1,500	R	SW/GW	☑	☑	☐	1	55	4	Td, D	II	III	0	4	☐	☐	8
Union Public Utility District	Calaveras	0510001	1,531	4,300	R	SW	☑	☐	☑	1	240	4	T, D	II	III	0	4	☑	☐	8
Angels Camp	Calaveras	0510003	1,773	3,441	R	SW	☑	☑	☐	1	312	6	Td, D		III	0	6	☐	☑	10

Notes:
1. CDPH, 2011; PWS = Public Water Supplier
2. R = primarily residential; W = wholesaler
3. SW = surface water; GW = groundwater
4. T = certified for water treatment; Td = dual certified for water/wastewater treatment; D = certified for distribution
6. CCWD has five water systems which are staffed by the same personnel. The PWS IDs of their five systems are: 510017 (Copper Cove); 510016 (Ebbetts Pass); 510006 (Jenny Lind); 510004 (Sheep Ranch); and 510005 (West Point).
7. Office staff of GM, Business Manager and Customer Service Representative occasionally support field staff.

4.2.2 Calaveras County Water District (CCWD)

CCWD operates five WTPs within five sub-systems in Calaveras County. It also provide wastewater treatment and collection and distribution services. The five water systems serve approximately 31,000 people through 12,500 connections. Total annual production at the five WTPs is 1,433 MG. It has 43 operators plus five maintenance support staff for a total of 48 employees. Its operators are dual certified and operate both the water and wastewater treatment plants (Perley, 2011).

Though CCWD and the City have different size service areas, production and connection ratios may be used to compare their staffing levels. For comparison, the City's staffing levels for water treatment, wastewater treatment, and distribution are used. With City staffing of 7.5 employees for the three major service functions (last row of Table 4-2), the City has a production ratio of 40 MG/employee and a connection ratio of 240 connections/employee. A comparison of the City to CCWD - Copper Cove is shown in Table 4-4. The City's production ratio is higher than CCWD's by approximately 20%. However, the City's connection ratio is lower than CCWD's by approximately 8%. These numbers show that the relative staffing levels are similar when connection ratios are used, but that the City has fewer staff than CCWD when production ratios are compared.

TABLE 4-4 STAFFING RATIO COMPARISON: CITY AND CCWD

Ratio Type[1]	City	CCWD
Annual Water Production (MG/employee)	40	33
Number of Connections (connections/employee)	240	260

Notes:
1. Descriptions of the ratios are provided in Section 4.1.1.

4.2.3 Foresthill Public Utility District (FPUD)

FPUD is located in Placer County. It serves 5,500 people through 1,919 connections. The district has one WTP which treats surface water with an annual production of 327 MG in 2010. It currently has six employees that staff the WTP and oversee the distribution system. It does not oversee a WWTP (Carnahan, 2011).

To compare to the City, the staffing levels for water treatment and distribution are used here. This corresponds to City staffing of 3.9 employees (fourth row of Table 4-2). A comparison of the City to FPUD is shown in Table 4-5. The production and connection ratios indicate that the City has proportionally fewer employees than FPUD.

TABLE 4-5 STAFFING RATIO COMPARISON: CITY AND FPUD

Ratio Type[1]	City	FPUD
Annual Water Production (MG/employee)	80	55
Number of Connections (connections/employee)	450	320

Notes:
1. Descriptions of the ratios are provided in Section 4.1.1.

4.2.4 Gridley, City of

The City of Gridley is located in Butte County. Its water department serves approximately 6,400 people through 2,100 connections. The city's total annual water production was 767 MG in 2010. Its supply source is groundwater, and does not have a full WTP. Rather, they perform disinfection wellhead treatment only. The city's water department also oversees wastewater treatment and water distribution. Gridley has eight employees that staff its water treatment, wastewater treatment, and distribution (Davis, 2011).

For comparison, the City's staffing levels for water treatment, wastewater treatment, and distribution are used. With a City staffing of 7.5 employees for the three major service functions (last row of Table 4-2), the City has a production ratio of 42 MG/employee and a connection ratio of 240 connections/employee. A comparison of the City to Gridley is shown in Table 4-6. Gridley has a production ratio of 96 MG/employee, and a connection ratio of 260 connections/employee. Both of Gridley's ratios are higher than the City's, indicating that they have relatively fewer staff than the City does.

TABLE 4-6 STAFFING RATIO COMPARISON: CITY AND GRIDLEY

Ratio Type[1]	City	Gridley
Annual Water Production (MG/employee)	42	96
Number of Connections (connections/employee)	240	260

Notes:
1. Descriptions of the ratios are provided in Section 4.1.1.

4.2.5 Groveland Community Service District (GCSD)

GCSD is located in Tuolumne County and serves a population of 3,400 people through 3,293 connections. It has three WTPs with an annual production of 145 MG in 2010. The district oversees water treatment, wastewater treatment, and water distribution. Similar to the City, they share dual-certified operators between their water and wastewater treatment plants (Randi, 2011).

Since GCSD oversees all three service functions, City staffing levels for all treatment plus distribution (last row of Table 4-2) have been used to compare to the City. GCSD has six employees[10] that staff water treatment, wastewater treatment, and distribution compared to the City who has 7.5 employees for the three major service functions. A comparison of the City to FPUD is shown in Table 4-7. These indicate that GCSD has proportionally more employees for water and wastewater treatment, but proportionally fewer employees for the distribution system. GCSD may need more treatment operators due to the fact that it operates three WTPs.

TABLE 4-7 STAFFING RATIO COMPARISON: CITY AND GCSD

Ratio Type[1]	City	GCSD
Annual Water Production (MG/employee)	42	24
Number of Connections (connections/employee)	240	550

Notes:
1. Descriptions of the ratios are provided in Section 4.1.1.

4.2.6 Jackson, City of

The City of Jackson operates its own water system. It supplies water to approximately 5,200 people through 2,100 connections. Total annual production is approximately 343 MG. It does not have a full WTP, as it purchases water from Amador Water Agency and then performs disinfection prior to distribution. Jackson's water staff consists of seven operators who operate the disinfection process and oversees water distribution. It does not oversee wastewater treatment (Daly, 2011).

For comparison to the City, the staffing levels for water treatment and distribution are used here. This corresponds to City staffing of 3.9 employees (fourth row of Table 4-2). With a City staffing of 3.9 employees, the City's production ratio is 80 MG/employee, while the connection ratio is 450 connections/employee. A comparison of the City to Jackson is shown in Table 4-8.

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[10] GCSD has six operators and shares maintenance and support staff with other departments. The level of support for these employees is unknown and could not be considered in the staffing ratios.

Jackson's corresponding ratios are 49 MG/employee and 300 connections/employee. Both of Jackson's ratios are lower than the City's, indicating that the City has relatively fewer employees when compared to Jackson.

TABLE 4-8 STAFFING RATIO COMPARISON: CITY AND JACKSON

Ratio Type[1]	City	Jackson
Annual Water Production (MG/employee)	80	49
Number of Connections (connections/employee)	450	300

Notes:
1. Descriptions of the ratios are provided in Section 4.1.1.

4.2.7 Stinson Beach County Water District (SBCWD)

SBCWD is a small water purveyor in Marin County. It operates one WTP which treats a blend of surface water and groundwater with an average annual production of about 55 MG. It has 721 connections and serves a population of 1,500. Its staff does not oversee distribution. It does not have a WWTP, but they do have oversight of septic systems in their service area. It currently has four employees that oversee the WTP and septic systems. Three of its employees operate the WTP, while one employee's time is split between the on-site septic system and the WTP (Stetson Engineers, 2011).

As such, a value of 3.5 employees is being assumed to represent its staffing levels for water treatment only. The corresponding value for water treatment only for the City is 2.4 employees (first row of Table 4-2). A comparison of the City to SBCWD is shown in Table 4-9. The two staffing ratios for SBCWD are lower than the City's. By these measures, SBCWD has higher levels of staffing than the City.

TABLE 4-9 STAFFING RATIO COMPARISON: CITY AND SBCWD

Ratio Type[1]	City	SBCWD
Annual Water Production (MG/employee)	130	16
Number of Connections (connections/employee)	740	210

Notes:
1. Descriptions of the ratios are provided in Section 4.1.1.

4.2.8 Union Public Utility District (UPUD)

UPUD has one WTP with production of 240 MG[11] in 2010. It has approximately 1,531 connections serving 4,300 people. Its staff oversees water treatment and distribution and does not do treat wastewater. It currently has four operators on staff for the WTP and distribution (Eltringham, 2011).

To compare to the City, the staffing levels for water treatment and distribution are used here. This corresponds to City staffing of 3.9 employees (fourth row of Table 4-2). The corresponding ratios for connections and production have been compared for the City and UPUD. A comparison of the City to SBCWD is shown in Table 4-10. The production and connection ratios indicate that UPUD has proportionally more staff than the City.

TABLE 4-10 STAFFING RATIO COMPARISON: CITY AND UPUD

Ratio Type[1]	City	UPUD
Annual Water Production (MG/employee)	80	60
Number of Connections (connections/employee)	450	380

Notes:
1. Descriptions of the ratios are provided in Section 4.1.1.

4.2.9 Summary of Staffing Comparisons to Similar Systems

A comparison of the staffing levels is presented in Table 4-11. The City's production and connection ratios are compared to the ratios for each of the other purveyors. The City's ratios are not the same for each purveyor, due to differences in organization of the other water purveyor. For each water purveyor, the major water and wastewater functions were assessed, and the most relevant staffing levels and ratios for the City were chosen from Table 4-2.

The comparison to seven water purveyors reveals that the City generally has lower staffing levels than other purveyors. The production ratio, the ratio of the total annual production to total employees, is a reasonable representation of how many employees a purveyor has for each unit of water produced. Table 4-11 shows that the City has a higher production ratio in six of seven cases. When the City ratio is expressed as a percent of the other purveyor ratio, a value above 100% indicates that the City has relatively fewer employees than the other purveyor. On average, and excluding SBCWD[12], the City ratio is 131% of the other purveyors' ratios. This

[11] 240 MG is the urban retail quantity and does not include agricultural irrigation deliveries.
[12] The values for SBCWD have been excluded from the calculation of the average in order to avoid skewing the average too high.

means that, based on the comparison to the seven purveyors in the survey, the City has fewer employees when normalized to total annual production.

When using the connection ratio to compare staffing levels, Table 4-11 shows that the City's staffing levels are lower than the other purveyors' in three of seven cases. The connection ratio is a reasonable representation of how many employees a purveyor has for each connection served. When the City ratio is expressed as a percent of the other purveyor ratio, a value above 100% indicates that the City has relatively fewer employees than the other purveyor. On average, and excluding SBCWD, the City ratio is 106% of the other purveyors' ratios.

TABLE 4-11 SUMMARY OF STAFFING COMPARISONS

	Production			Connections		
Water Purveyor	**City Ratio[1]**	**Other Purveyor Ratio**	**City as Percent of Other Purveyor[2]**	**City Ratio[1]**	**Other Purveyor Ratio**	**City as Percent of Other Purveyor[3]**
CCWD	42	33	*127%*	240	260	92%
FPUD	80	55	*145%*	450	320	*141%*
Gridley, City of	42	96	44%	240	260	92%
GCSD	42	24	*175%*	240	550	44%
Jackson, City of	80	49	*163%*	450	300	*150%*
SBCWD	130	16	*813%*	740	210	*352%*
UPUD	80	60	*133%*	450	380	*118%*
		Average[4]	131%			106%

Notes:
1. The City ratio has been chosen from Table 4-2 in order to provide the most relevant comparison to the other water purveyor. Systems have been compared on the basis of how many of three possible service functions are provided.
2. Values greater than 100% are italicized. A value above 100% means that the City ratio is higher than the other purveyor ratio, indicating that, on the basis of number of employees and total annual production, the City has lower staffing levels.
3. Values greater than 100% are italicized. A value above 100% means that the City ratio is higher than the other purveyor ratio, indicating that, on the basis of number of employees and connections, the City has lower staffing levels.
4. Average was computed using percentages for all purveyors except for SBCWD. The large percentages for SBCWD (813%, 352%) skewed the averages too high.

5.0 ASSESSMENT OF PROJECT NEEDS

Projects recommended as part of this audit are detailed in this chapter. They have been divided into four categories: Water Treatment Plant, Distribution System, Water Quality Sampling, and Administrative and Planning. Some projects have been recommended in order to correct deficiencies in compliance with laws and regulations (Chapter 3). Additional projects have been recommended based upon maintaining a reliable, safe, and secure water supply for the City. An additional recommendation has been made based on the staffing summary presented in Chapter 4.

Each project has been given a number, with options for that project labeled A, B, etc. Detailed project descriptions are given for each project. Additionally, where feasible, budgetary-level costs have been estimated. For projects expected to be completed by City staff, costs have been quantified using the total time estimated to complete the project and total labor costs obtained from the City (McHattan, pers. comm., Oct 5, 2011). Following each category, a summary table is presented. Finally, at the end of the chapter, a summary table of all projects and costs is given. Physical projects are also shown on Figure 5 and on Plate 2.

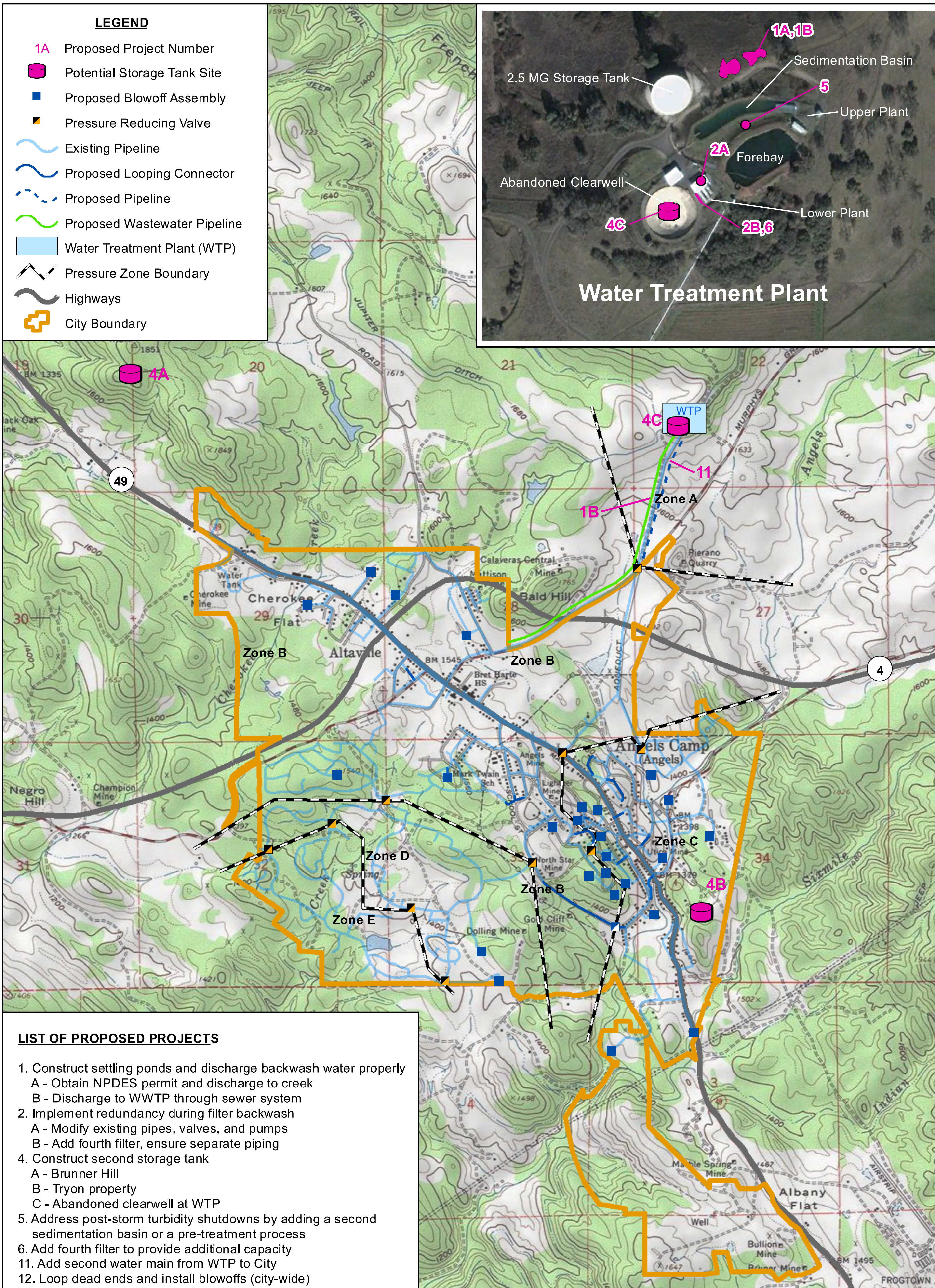
5.1 PROPOSED PROJECTS: WATER TREATMENT PLANT

Proposed projects located at the WTP are presented in this section. These include projects related to filter backwashing, increasing capacity, and turbidity shutdowns.

5.1.1 Project No. 1: Construct Settling Ponds and Discharge Backwash Water Properly

Currently, the City discharges its filter backwash into a ditch system that leads directly into a creek behind the WTP. This action is done without an NPDES permit, in violation of state laws. In order to comply with state regulations, the City should construct settling ponds to collect the backwash water and settle out solids. Settling ponds are common practice in handling backwash water in California.

Once ponds are installed, the City may work with CDPH to determine what portion of the water may be recycled through the headworks of the WTP. This has the potential to increase the efficiency of the WTP as well as promote water conservation. Backwash recycling regulations can be found in CCR 22 § 64653.5. Based on the “Filter Backwash Recycling Rule” written by the United States Environmental Protection Agency (EPA) in 2001, operational considerations, such as the percent of backwash water recycled, are site-specific. The rule requires the City to



LIST OF PROPOSED PROJECTS

1. Construct settling ponds and discharge backwash water properly
   - A - Obtain NPDES permit and discharge to creek
   - B - Discharge to WWTP through sewer system
2. Implement redundancy during filter backwash
   - A - Modify existing pipes, valves, and pumps
   - B - Add fourth filter, ensure separate piping
4. Construct second storage tank
   - A - Brunner Hill
   - B - Tryon property
   - C - Abandoned clearwell at WTP
5. Address post-storm turbidity shutdowns by adding a second sedimentation basin or a pre-treatment process
6. Add fourth filter to provide additional capacity
11. Add second water main from WTP to City
12. Loop dead ends and install blowoffs (city-wide)

PROPOSED WATER SYSTEM FACILITIES
ANGELS CAMP, CA

STETSON ENGINEERS INC.

Notes: Project numbers correspond to numbering in Chapter 5.
Only physical infrastructure projects are included on this map.
Sources: City of Angels Camp GIS data., 2011.
1:24K Topo, Angels Camp, 1973. USGS

N

0 2,500 5,000 Feet

Path: J:\jn2379\Location_ProposedFacilities.mxd

FIGURE 5

consult with the state prior to making operational changes. Pilot or full-scale testing is also recommended.

Research on common backwash water recycling practices in California indicates that the City will likely not be able to recycle all of the backwash water and will still have to discharge a portion of the water . Two options are to obtain an NPDES permit and discharge the backwash water to the creek(Option 1A) or to discharge the water to the wastewater treatment system for treatment and disposal, which does not require an NPDES (Option 1B). However, City staff indicated that the sewer pipelines in the area of the WTP are at capacity, so additional sewer pipelines or upgrades may be required to implement this option.

The cost to obtain an NPDES permit is estimated to be approximately $43,000, of which $40,000 is for preparing an application and $3,000 is for required EPA fees. The estimate is based on an annual discharge volume for all backwash cycles plus four cleanings of the sedimentation basin per year. The discharge volume may be lowered if some of the backwash water is recycled through the WTP. This cost does not include annual maintenance costs for monitoring and reporting, which may be up to $100,000 per year.

Stetson's budgetary-level cost estimate for the construction of two settling ponds is $220,000. The cost for the settling ponds includes clearing and grubbing of the site, excavation, concrete lining of the ponds, miscellaneous costs for structures, mobilization/demobilization costs (6% of construction costs), and engineering and contingency costs (25% of construction costs). This estimate assumes a relatively flat area for the project site. The ponds have been sized to hold approximately 500,000 gallons, which is enough capacity to simultaneously accommodate the draining of the sedimentation basin and a full backwash cycle of all three filters.

Stetson's budgetary-level cost estimate for the construction of a pipeline to convey water from the ponds to the wastewater treatment system is $350,000. The cost for the backwash pipeline includes approximately 7,500 feet of 4-inch PVC to connect the backwash pond to the nearest sewer system pipeline. This cost will be higher if the nearest sewer pipeline is at capacity and needs to be upgraded or replaced.

5.1.2 Project No. 2: Implement Redundancy during Filter Backwash

Currently, there is no redundancy during filter backwashing. All filters are offline during the backwashing process, so no filtered water is produced and the treatment process is stopped for up to 2.75 hours. This is a possible violation of the City's permit requirements and state regulations (See Sections 3.3.3.3 and 3.2.2.2, respectively). As stated in the engineer's report that accompanied the 2003 permit amendment, the third filter was installed so that the WTP could continue to produce filtered water while one or both filters were being backwashed.

Two options are available to comply with the regulations as well as improve reliability. The City can modify existing pipes, valves, and pumps so that each filter has separate piping (Option 2A) or ensure separate piping when an additional filter is installed (Option 2B). If separate piping is installed for each filter, the WTP can continue filtering water with at least one filter while backwashing another filter. This would provide the redundancy intended in the state regulations and permit.

Stetson's budgetary-level cost estimate for modifying the existing infrastructure to isolate each pressure filter is $50,000. The cost includes 60 feet of 6-inch steel pipe, six 6-inch butterfly valves with electronic actuators, electrical control system updating, mobilization/demobilization costs (6% of construction costs), and engineering and contingencies costs (25% of construction costs).

A budgetary-level cost estimate for ensuring separate piping when installing an additional filter (Option 2B) is not provided because it is assumed that these costs would be included in the total cost of installing an addition filter (see Section 5.1.6).

5.1.3 Project No. 3: Pursue Emergency Alternative Water Supply

The water shortage following the Darby Fire is an example of why it is important to have additional water supplies available in emergency situations. Accordingly, one of the recommendations of this audit is to pursue alternative options for providing water in the event that the flume system is damaged or the main water supply is otherwise compromised. Options include construction of one or more wells or utilization of water in abandoned mines. A budgetary-level cost estimate for constructing a municipal well pumping at 500 gpm is between $300,000 and $500,000. This estimate does not include costs associated with permitting, regulatory compliance, or infrastructure to convey water from the well to the WTP.

Additional actions can also be taken to reduce the impact of an emergency situation by reducing the City's demands. The City may explore additional use of recycled water in order to offset potable demands. A formal water rationing plan may also be developed. The City's Emergency/Disaster Response Plan (see the 2008 Operations and Maintenance Plan) covers contamination of the supply, but does not directly address rationing procedures when the water supply is threatened.

5.1.4 Project No. 4: Construct Second Storage Tank

It is recommended that the City construct a second storage tank with a volume of 2.0 MG. This will promote system reliability and security. In the event of a tank failure or water quality problem, the system's entire supply is vulnerable. As described in the City's water supply permit, the City is required to have a minimum tank volume of approximately 0.95 MG which is required for the proper chlorination contact time. Therefore, the City's existing operating capacity is 1.55 MG. If the City experiences growth in the future, an additional storage tank will likely be needed to meet MDD, as required by state regulations (see Section 3.2.1).

Three proposed locations for the storage tank are shown on Figure 5. Option 4A is on Brunner Hill, 4B is within the Tryon Property, and 4C is at the abandoned clearwell at the WTP. Options 4A and 4B were chosen based on previous recommendations by the City. Option 4A on Brunner Hill would provide redundant storage for the system and would sit at an elevation of approximately 1,800 ft MSL, providing sufficient pressure for delivery to the entire distribution system.

The Tryon Property (Option 4B) is on the eastern side of the City, and would also provide redundant storage for the system. The storage tank would sit at an elevation of approximately 1,440 ft MSL which would provide enough pressure for delivery to all zones of the distribution system

The final option, the abandoned clearwell at the WTP (4C), likely would be less expensive to construct due to minimal grading, existing access easements, and less piping required (due to its proximity to the WTP and other storage tank) than the other locations. However, this option does not provide as much redundancy as the other two options. As with the other locations, this site would provide enough pressure to supply water to the entire distribution system.

Stetson's budgetary-level cost estimate for the construction of a 2.0 MG storage tank is $2.2 million. Assumptions included in this estimate are as follows: the cost was based upon the construction cost for the existing 2.5-MG water tank provided by the City. This construction cost was adjusted to 2011 dollars using the published Consumer Cost Index (CCI) and then adjusted proportionally to the correct size tank. An engineering and contingency cost was added based on 25% of the construction cost. This cost estimate is for construction cost only, including pipelines and valves at the tank site. It does not include any heavy grading, road construction, acquisition of easements, pipelines to connect to the water system, or any environmental studies that may be required. A cost estimate of $2.2 million can be considered as a whole project cost estimate for

Option 4C. However, Options 4A and 4B will cost more due to site grading, land acquisition costs, and additional piping costs.

5.1.5 Project No. 5: Address Post-storm Turbidity Shutdowns

As discussed in Section 2.4.3.3, water quality regulations force the WTP to shut down when the turbidity of the raw surface water is above 3 NTUs. Depending on how long the WTP is shut down for and the initial water level in the storage tank, the volume of water in the storage tank may drop below the allowable minimum as described in the City's water supply permit and in 22 CCR § 64554(a). The first option for addressing this issue is to investigate whether a second sedimentation basin would eliminate shutdowns (Option A). A second option is to examine the feasibility of a pre-filtration process, such as a slow sand filter or other media filter, that would reduce the turbidity of the raw water to allowable levels (Option B). If the construction of a second sedimentation basin under Option A is feasible, it would also improve redundancy in the treatment system. Due to the low frequency of shutdowns due to high turbidity levels (on the order of two to four days per year), the pre-filtration process of Option B would likely be marginally sized and not a large-scale operation.

The approximate cost to complete a feasibility study for either of these options is $20,000.

5.1.6 Project No. 6: Add Fourth Filter

Currently, the City operates three pressure filters at its WTP. Proposed Project No. 6 is the addition of a fourth filter. Installing a fourth filter at the WTP would provide additional capacity at the WTP and accommodate future growth within the City. The fourth filter would also provide redundancy during the backwash process if separate piping from the three other filters was installed (see Section 5.1.2 on redundancy during filter backwashing).

A 2009 cost estimate for the installation of a fourth filter at the WTP was provided by the City (Walker, 2011). The current cost of installing a fourth filter is estimated to be $870,000. This includes estimates for constructing an addition to the filter building, the filter system, a needed retaining wall, mobilization, and pipe alterations.

5.1.7 Summary of Proposed Projects at the Water Treatment Plant

A summary of the proposed projects at the WTP is presented in Table 5-1. These projects would put the WTP in compliance with codes and regulations as well as improve the reliability of the water treatment system.

TABLE 5-1 SUMMARY OF PROPOSED PROJECTS AT WATER TREATMENT PLANT

No.	Project	Description	Rationale
1	Construct Settling Ponds and Discharge Backwash Water Properly	Construct settling ponds. Work with CDPH to determine how much backwash water may be recycled through headworks. For water that must be disposed of, two options are: Option A: Obtain discharge permit and discharge to creek Option B: Discharge to wastewater collection system	• Necessary to comply with 23 CCR § 2235.1. • If backwash water can be recycled, will increase efficiency of WTP. • Allows for continued operation of the WTP during cleaning of the sedimentation basin.
2	Implement Redundancy During Filter Backwash	Modify system so that during backwash, at least one filter is on-line and producing water. Option A: Modify existing pipes, valves, and pumps Option B: During the installation of an additional filter, ensure separate piping	• Improve reliability. • May be necessary to comply with the City's water supply permit and 22 CCR § 64659.
3	Pursue Emergency Alternative Water Supply	Pursue alternative options for providing emergency water supply in the event the flume system is damaged. Most likely option is one or more wells.	• Necessary to provide redundancy if flume system is compromised, particularly below Ross Reservoir.
4	Construct Second Storage Tank	Construct new 2.0 MG tank at one of three proposed locations: Option A: Brunner Hill Option B: Tryon Property Option C: Abandoned Clearwell at WTP	• Necessary for reliability and security of system. • Needed to meet future MDD, as required by 22 CCR § 64554(a).
5	Address Post-storm Turbidity Shutdowns	Option A: investigate whether second sedimentation basin would eliminate shutdowns Option B: investigate feasibility of pre-filtration or other process to make high turbidity water usable.	• Necessary to improve system reliability after storms. • If Option A is feasible, it would also improve redundancy.
6	Add Fourth Filter	Add fourth mixed-media filter to provide additional capacity at WTP.	• Provide additional redundancy. Necessary to accommodate future growth.

5.2 PROPOSED PROJECTS: DISTRIBUTION SYSTEM

Proposed projects located within the distribution system are presented in this section. Projects include an inventory of the existing infrastructure, developing and utilizing a hydraulic model, and replacing or installing new distribution infrastructure.

5.2.1 Project No. 7: Complete an Inventory of the Distribution System

Based on correspondence with the City and a review of existing GIS coverages, the City currently does not have a complete inventory of the pipes, valves and hydrants in the distribution system. The City's current GIS coverage has pipe locations and sizes, but is generally missing pipe installation dates and materials. Most of the valves are shown in the GIS coverage, but valve types are missing. The GIS coverage also does not show known fire hydrants located in Zone A.

In order to allow the City to make accurate decisions relating to infrastructure planning and construction, a complete inventory of distribution system infrastructure should be performed. A complete inventory would also be required in order to develop a hydraulic model of the system. The data that has already been collected should be checked for errors and additional data should be gathered and added to the GIS coverage.

The distribution system inventory may be handled by City staff if time is available, or this task may be contracted for as part of the Water Master Plan process. Other lower-cost alternatives to City staff may be considered, such as part-time staff. The estimated cost of completing this project in-house is $17,000. This estimate was computed using the hourly labor costs (wages plus benefits) for City public works staff, GIS staff, and the City Engineer.

5.2.2 Project No. 8: Develop a Hydraulic Pipe Network Model

A tool used by many water purveyors is a hydraulic pipe network model (hydraulic model). The goal of a hydraulic model is to determine flow rates and pressures within individual sections of the pipe network using specialized software. Infrastructure that should be included in the City's hydraulic model includes the WTP, storage tank, and components of the distribution system. The distribution system inventory (Section 5.2.1) would be a vital source of data for the hydraulic model.

The hydraulic model is a critical tool for decision making, prioritizing projects, and planning for future development. It would also provide a means to analyze whether certain codes and regulations are met, particularly minimum pressure and fire flow requirements, within all individual sections of the pipe network. The hydraulic model may be implemented as a component of the Water Master Plan Update (see Section 6.0).

Stetson's budgetary-level cost estimate for developing a hydraulic model of the City's distribution system is $60,000. This cost estimate includes data collection and review, calibration of the hydraulic model, and simulation of different water demand scenarios. In order to calibrate a hydraulic model, City staff will need to perform the hydrant flow rate and pressure tests.

5.2.3 Project No. 9: Identify and Prioritize Infrastructure Upgrades using the Hydraulic Model

Using the distribution system inventory and the resulting hydraulic model, the City can identify and prioritize infrastructure upgrades. The model provides a tool for assessing system needs, either to correct for existing deficiencies or accommodate future growth. Pressure problems, limited fire flows, and pipe replacement projects may be identified with the model. In particular, the City should use the hydraulic model as a tool to design a second storage tank and a second water main from the WTP to the distribution system.

Stetson's budgetary-level cost estimate for identifying and prioritizing infrastructure upgrades using the results from a hydraulic model is $10,000.

5.2.4 Project No. 10: Assess Distribution System Compliance using the Hydraulic Model

Using the results of the distribution system inventory and the hydraulic model, the City can determine if it is in compliance with certain codes and regulations. All codes and regulations regarding pipe flows and pressure need to be met within all sections of the distribution system. For example, the hydraulic model can identify areas where the pressure drops below 20 psi (which would not be in compliance with 22 CCR § 64602) and can simulate fire flows in order to determine if individual sections provide the fire flows required in the City's municipal code.

Stetson's budgetary-level cost estimate for assessing the City's distribution system compliance using the hydraulic model is $10,000.

5.2.5 Project No. 11: Add Second Water Main from WTP to City

Currently, the City has a single 14-inch pipeline delivering treated water from the WTP to the distribution system. The existing pipeline is old and is a major weakness in the system. If this pipeline were to be damaged or inoperable, the City would not be able to supply its customers with water. In order to eliminate this concern, the City should install a second 18-inch water main from the WTP to the distribution system. This pipeline would run parallel to the existing main and is necessary for system redundancy, reliability, and to accommodate any future growth.

Stetson's budgetary-level cost estimate for the construction of an second water main from the WTP to the distribution system is $850,000. Assumptions included in this estimate are as follows: pipeline costs were based upon construction costs for the Demerest, Raspberry, Minna, and Church Street pipeline replacement project completed by the City. These construction costs were adjusted using RS Means to obtain unit costs for various pipeline sizes. The cost estimate includes 3,300 linear feet (LF) of 18-inch PVC estimated at $200/LF, 18-inch and 14-inch gate valves to connect to the existing water main, and an engineering and contingency cost at 25% of the construction cost.

5.2.6 Project No. 12: Loop Dead Ends and Install Blowoff Assemblies

Within the existing distribution system, there are a number of dead ends that do not have blowoffs. Water quality degrades in these locations, where sediment and contaminants collect. One solution to dead ends is to loop to a nearby pipeline. If this is not possible, a blowoff assembly may be installed so that water at the dead end may be routinely flushed. Blowoffs are required for all dead ends constructed after February 8, 2008 (22 CCR § 64575). Looping existing dead ends or installing blowoffs would improve the reliability and water quality within the distribution system.

Information on some dead ends was provided by the City, and Stetson then reviewed the entire system to make recommendations. Stetson identified 14 dead ends that may be eliminated by looping to another pipeline and 29 dead ends where looping is not possible and where blowoff assemblies should be installed.

Stetson's budgetary-level cost estimate for looping 14 dead end locations is $970,000. Assumptions included in this estimate are as follows: pipeline construction costs were based on the 6-inch PVC and 8-inch PVC pipe costs provided by the City for the Demerest, Raspberry, Minna, and Church Street projects. This construction cost was adjusted using RS Means to obtain relative unit costs for pipeline sizes not included in the pipeline replacement project. The cost estimates includes pipeline to complete the looping of the dead ends, as well as pipeline replacement recommendations provided by the City. The cost estimate includes 1,560 LF of 4-inch PVC estimated at $50/LF, 3,390 LF of 6-inch PVC estimated at $85/LF, 2,020 LF of 8-inch PVC estimated at $115/LF, valves and appurtenances estimated at 30% of the pipeline cost, and an engineering and contingency cost estimated at 25% of the construction cost.

Stetson's budgetary-level cost estimate for installing 29 blowoff assemblies is $120,000. The cost for the blowoff assemblies is based upon published bid estimates for similar projects. The total includes 29 blowoff assemblies estimated at $3,000 each, mobilization and demobilization costs estimated at 6% of the construction cost, and an engineering and contingency cost estimated at 25% of the construction cost. The criteria for determining the locations for the proposed blowoff assemblies include the following: dead end pipe length and size, proximity to fire hydrants, location of dead ends within the water system, and estimated number of service connections to the dead end pipeline. Generally, a dead end pipeline with a length of less than 250 feet did not require a blowoff assembly.

5.2.7 Summary of Proposed Projects within the Distribution System

A summary of the proposed projects within the distribution system is described in Table 5-2. These projects include performing an infrastructure inventory, developing and utilizing a hydraulic model, as well as addressing dead ends. These projects would help the City to determine compliance with codes and regulations, identify system needs and concerns, and improve the reliability of the distribution system.

TABLE 5-2 SUMMARY OF PROPOSED PROJECTS WITHIN THE DISTRIBUTION SYSTEM

No.	Project	Description	Rationale
7	Complete an Inventory of the Distribution System	Complete an inventory of all pipes, valves and hydrants within the system. Check existing data for errors and gather additional data to add to the GIS coverage.	• Necessary to allow the City to make accurate decisions about infrastructure planning and construction. • Would be required in order to develop a hydraulic model of the system.
8	Develop a Hydraulic Pipe Network Model	Develop a model of the system, including the treatment plant, storage tank, and distribution system. May be implemented as a component of the Water Master Plan Update.	• Recommended tool for decision-making, prioritizing projects, and planning for future development. • Will provide a means to analyze whether certain regulations are being met.
9	Identify and Prioritize Infrastructure Upgrades using the Hydraulic Model	Use the results of the system inventory and hydraulic model to identify and prioritize infrastructure upgrades within the system.	• Hydraulic model provides a tool for assessing system needs.
10	Assess Distribution System Compliance using the Hydraulic Model	Use the results of the system inventory and hydraulic model to assess whether certain state regulations are being met.	• Hydraulic model provides a way for City to demonstrate compliance with particular regulations.
11	Add Second Water Main from WTP to City	Add a second water main from the WTP to the distribution system. An 18” line is proposed to run parallel to the existing 14” line.	• Necessary for system redundancy and reliability. The single pipe is old and is a major system weakness.
12	Loop Dead Ends and Install Blowoff Assemblies	Where possible, loop dead ends. If looping is not possible, install blowoff assembly if not already there.	• Will improve system reliability and water quality. • Blowoff assemblies are required for all dead ends constructed after February 8, 2008 (22 CCR § 64575).

5.3 PROPOSED PROJECTS: WATER QUALITY SAMPLING

Based on the City’s 2009 Consumer Confidence Report, the City’s water quality is in compliance with the CCR. The only project identified for water quality sampling is to update the bacterial sampling plan in order to be in compliance with the CCR.

5.3.1 Project No. 13: Update Bacterial Sampling Plan

The City’s bacterial sampling plan was last updated in 2002. State regulations require a minimum number of samples per month based on the number of connections in the distribution system (see Section 3.2.4). Since the City’s number of connections has increased, it is now required to complete a minimum of six samples per month, rather than the five samples per month required by the 2002 plan. Moreover, regulations require an update of the plan at least every 10 years, so the City is due for an update by 2012, regardless of changes in the number of connections.

The plan will need to be revised to reflect the new minimum number of samples per month. In addition, the locations of sampling points may be re-assessed. The City has recently installed sampling spigots in areas of new construction or pipeline replacements, so they have additional sampling sites available that may be added to the plan.

The project is expected to be completed by City staff. The cost to update the bacterial sampling plan is estimated to be approximately $4,000. In addition, the annual cost to complete the additional sampling is estimated to be $2,000 per year. This estimate was computed using the hourly labor costs (wages plus benefits) obtained from the City.

5.4 PROPOSED PROJECTS: ADMINISTRATIVE AND PLANNING

Proposed administrative and planning projects are presented in this section. These include updating or creating various planning documents as well as projects involving staffing.

5.4.1 Project No. 14: Develop City Planning Criteria in Next Water Master Plan

The most recent Water Master Plan (Weber, Ghio, and Associates, 2002) does not include a comprehensive list of City Planning Criteria pertinent to the City's water system. The water system is operated based on a number of different code documents (CCR, water supply permit, city municipal code, city improvement standards, etc.) It is suggested that the City incorporate all of these codes into one comprehensive list in its next water master plan. A compilation of all water requirements and standards would be helpful for planning future projects. In addition to including all relevant code in the planning criteria, the City should also include industry best management practices where codes are not specific. It is generally recommended that water master plans are updated every 10 years and therefore the City should update its plan in 2012.

Including a comprehensive list of City Planning Criteria in the next water master plan would be a useful tool in assessing existing criteria for future infrastructure and existing deficiencies. They would also be used in tandem with a hydraulic model (Section 5.2.2).

The project should be included as part of the Water Master Plan. The estimated cost for this portion of the work is $5,000.

5.4.2 Project No. 15: Submit Permit Amendment Following Major Upgrades at the WTP

State regulations require water supply permits to be amended following any major upgrades to the WTP (22 CCR § 64556). Therefore, if the City completes any of the projects described in Section 5.1 (Proposed Projects at the Water Treatment Plant) or any other major upgrades at the WTP, it is required to submit an application to CDPH for a permit amendment.

The project may be completed by the City Engineer or an outside consultant. The estimated cost to complete the application is $11,000. This is based upon the total estimated time required, and the hourly labor costs for the City Engineer and WTP staff.

5.4.3 Project No. 16: Update Operations and Maintenance Plan

The most recent operations and maintenance plan for the WTP was completed in April 2008 (Weber, Ghio, and Associates). Upgrades have since been completed at the WTP, and the plan should now be updated to reflect them. This is required by the City's water supply permit under Condition No. 2. These upgrades include the new slidegate at the Forebay, new meter and pipeline at the head works, new floc drive in the floc basin, as well as the SCADA system upgrade.

The project may be completed by the City Engineer or an outside consultant. The approximate cost to complete the application is $14,000. This is based upon the total estimated time required, and the hourly labor costs for the City Engineer and WTP staff.

5.4.4 Project No. 17: Pursue Shortage Plan with UPA

As described in Section 2.3.3, there is no shortage plan in place to determine how much water each entity of UPA would receive if a reduction in water delivery occurs. In the event that deliveries are curtailed during very dry conditions, the City currently has no way of determining what its water allocation would be. Accordingly, it is recommended that the City pursue a shortage plan with UPA so that water deliveries to the City during drought conditions may be determined. This is essential to securing a reliable water supply for the City and will improve the City's ability to always meet the MDD as required by 22 CCR § 64554(a).

The level of effort required for this project is unknown and therefore no costs have been assigned.

5.4.5 Project No. 18: Develop an Alternative Supply for the Greenhorn Creek Development

As discussed in Section 2.2.3, the Greenhorn Creek development diverts water from Angels Creek in order to meet a portion of its golf course irrigation demand. Since these diversions are within City limits, the diverted water counts as part of the City's annual contractual 1,600 AF allocation thus decreasing the total amount of water available at the WTP. In order to ensure that the City would be able to receive its entire 1,600 AF when necessary, the City should explore alternative supplies for the Greenhorn Creek Golf Resort. Several options are possible: (1) have the development negotiate a separate contract with UPA to purchase water from Angels Creek, (2) increase the City's allocation to include additional water for the golf course on top of the current allocation, or (3) satisfy the golf course demand with all tertiary treated water.

The level of effort required for this project is unknown and therefore no costs have been assigned.

5.4.6 Project No. 19: Staffing Level Recommendation

As discussed in Section 4.0, the City's current staffing levels are lower than other comparable water purveyors. In order for the City's staffing levels to be more in line with other purveyors, a 20% increase in staff is proposed. Based on current staffing of six employees, a 20% increase would mean an additional 1.2 employees. This may be done by hiring one additional full-time employee plus one part-time staff member.

An additional recommendation based on the survey results is that the City should consider 8-hour shifts for their treatment personnel. Such a change would mean that more employees are present during a shorter shift time. A shorter shift time with more personnel present may lead to more efficient operation of the treatment plants.

The estimated annual cost to hire additional staff is $90,000 per year. This is based upon the hourly labor costs for operators, assuming one new full-time employee and one new part-time employee at 20% utilization. This assumes mid-level operators, not entry-level.

5.4.7 Summary of Proposed Administrative and Planning Projects

The proposed administrative and planning projects are summarized in Table 5-3. These projects include updating planning documents, developing new agreements, and making changes to staffing.

TABLE 5-3 SUMMARY OF PROPOSED ADMINISTRATIVE AND PLANNING PROJECTS

No.	Project	Description	Rationale
14	Develop City Planning Criteria in Next Water Master Plan	Develop list of City criteria for future planning.	• Useful planning tool for assessing criteria for future infrastructure and existing deficiencies. • To be used in tandem with hydraulic model.
15	Submit Permit Amendment Following Major Upgrades at the WTP	Submit application for permit amendment following any major upgrades at the WTP.	• Necessary to comply with 22 CCR § 64556.
16	Update Operations and Maintenance Plan	Update operations and maintenance plan to reflect recent upgrades at WTP.	• Required by Condition No. 2 in the Water Supply Permit.
17	Pursue Shortage Plan with UPA	The City should work with UPA to develop a shortage plan to allocate water to all users during drought.	• Essential to securing a reliable water supply for the City. • Securing a shortage plan will improve City's ability to always meet MDD as required by 22 CCR § 64554(a).
18	Develop an Alternative Supply for the Greenhorn Creek Development	Explore options for alternative supplies for Greenhorn Creek.	• Necessary to ensure that the entire 1,600 AF allocation is available to the City.
19	Staffing Level Recommendation	Hire one full-time employee and one part-time staff member.	• Current staffing levels are below other comparable water purveyors by approximately 20%.

5.5 ESTIMATED BUDGETARY-LEVEL COST SUMMARY

Estimated budgetary-level costs for the proposed projects are presented in Table 5-4.

TABLE 5-4 LIST OF PROPOSED PROJECTS AND ESTIMATED COSTS

No.	Project	Estimated Cost[1]
Proposed Projects at the Water Treatment Plant		
1	Construct Settling Ponds and Discharge Backwash Water Properly	
	Construct settling ponds	$220,000
	Discharge Option A: Obtain NPDES permit and discharge to creek	$43,000 [2]
	Discharge Option B: Discharge to wastewater collection system	$350,000
2	Implement Redundancy During Filter Backwash	
	Option A: Modifying existing pipes, valves, and pumps	$50,000
	Option B: During the installation of additional filter, ensure separate piping	Included in No. 6
3	Pursue Emergency Alternative Water Supply	$300,000 - $500,000
4	Construct Second Storage Tank	
	Option A: Brunner Hill	$2,200,000[3]
	Option B: Tryon Property	$2,200,000[3]
	Option C: Abandoned Clearwell at WTP	$2,200,000
5	Address Post-storm Turbidity Shutdowns: Feasibility Study	
	Option A: Investigate sedimentation basin	$20,000
	Option B: Investigate feasibility of pre-filtration or other process	$20,000
6	Add Fourth Filter	$870,000
Proposed Projects within the Distribution System		
7	Complete an Inventory of the Distribution System	$17,000 [4]
8	Develop a Hydraulic Pipe Network Model	$60,000
9	Identify and Prioritize Infrastructure Upgrades using the Hydraulic Model	$10,000
10	Assess Distribution System Compliance using the Hydraulic Model	$10,000
11	Add Second Water Main from WTP to City	$850,000
12	Address Dead Ends	
	A. Loop Dead Ends (14)	$970,000
	B. Install Blowoff Assemblies (29)	$120,000
Water Quality Sampling Proposed Projects		
13	Update Bacterial Sampling Plan	$4,000 [4, 5]
Proposed Administrative and Planning Projects		
14	Develop City Planning Criteria in Next Water Master Plan	$5,000 [4]
15	Submit Permit Amendment Following Major Upgrades at the WTP	$11,000 [4]
16	Update Operations and Maintenance Plan	$14,000 [4]
17	Pursue Shortage Plan with UPA	n/a
18	Develop an Alternative Supply for the Greenhorn Creek Development	n/a
19	Staffing Level Recommendation	$90,000 [4]

1. An 'n/a' indicates that the level of effort required to complete this project is unknown and a cost has not been assigned.
2. Includes initial cost to prepare permit application. Does not include annual costs for reporting and monitoring which may be up to $100,000 per year.
3. Does not include additional costs for site grading and additional pipe infrastructure to connect the storage tank to the existing distribution system.
4. Project may be completed by City staff. Cost is based upon hourly total labor costs of City staff and estimated time required.
5. Cost shown is for initial work to update sampling plan. Annual costs to sample one additional site per month are estimated to be $2,000 per year.

6.0 PROPOSED SCHEDULE FOR WATER MASTER PLAN AND CIP PROGRAM IMPLEMENTATION

A water master plan is a comprehensive assessment of a water purveyor's existing system and future needs. Water master plans are not required by regulations but are best practice planning documents used by water purveyors. In general, a water master plan is prepared every ten to twenty years. A water master plan is intended guide a purveyor in making strategic decisions to handle existing deficiencies and plan for the future. A master plan includes information about various aspects of a water system including:

- Background information such as service area, population, and climate
- Existing and future supply and demand
- Relevant codes and regulations governing the water system
- Planning criteria
- Water quality issues and requirements
- Hydraulic model preparation and analysis
- Recommended CIPs
- Funding sources and scheduling for recommended CIPs

6.1 REVIEW OF THE CITY'S 2002 WATER MASTER PLAN

The most recent water master plan for the City was completed in 2002. Based on the introductory paragraph, it was intended to reflect an Urban Water Management Plan (UWMP) as defined in Section 10631 of the California Water Code. Review of the 2002 Water Master Plan and the California Water Code indicates that the 2002 document includes limited elements of both an UWMP and a water master plan. These documents are defined differently and are generally prepared separately.

An UWMP is a mandatory document for water purveyors who service at least 3,000 customers or deliver more than 3,000 AFY of water. The City does not fall into either requirement and thus does not have to produce an UWMP. The main purpose of an UWMP is to ensure that a water purveyor is able to meet demands within its service area during normal, dry, and multiple dry years. It is mainly focused on a supply-demand analysis. A water master plan is not mandatory and its components are more system-specific. A water master plan includes a thorough technical analysis of the water system infrastructure, with a final goal of determining existing deficiencies and projects necessary to accommodate future growth.

6.2 PROPOSED SCHEDULE FOR DEVELOPING A WATER MASTER PLAN AND CIP PROGRAM

Key milestones for developing a water master plan (including developing a CIP program), their suggested completion dates, and durations are shown in Table 6-1. The schedule was designed so that the water master plan would be completed when the current water master plan projections conclude in 2015. Key milestones include completing an inventory of the distribution system infrastructure (Proposed Project No. 7), preparing a hydraulic model (Proposed Project No. 8), analyzing the results of the hydraulic model (Proposed Project No. 9 and No. 10), and finally, drafting and approving the water master plan.

TABLE 6-1 SUGGESTED COMPLETION DATES FOR KEY MILESTONES

Milestone	Completion Date	Duration (months)
Complete Infrastructure Inventory	June 2012	6-10
Issue an RFP for the Hydraulic Model and go through Bidding Process	June 2012	3
Prepare Hydraulic Model	February 2013	8
Analyze Results of Hydraulic Model	July 2013	5
Issue an RFP for the Water Master Plan and go through Bidding Process	September 2013	3
Develop and Prepare a Draft Water Master Plan (Including a CIP Program)	July 2014	10
Hold a Comment Period on the Draft Water Master Plan	September 2014	1
Incorporate Comments in the Plan and Prepare a Final Water Master Plan	October 2014	1
Approve Final Water Master Plan	November 2014	1

6.2.1 Schedule Summary

If completed by City staff, the inventory is expected to take several months to complete, given that staff hours are limited. Six to ten months was estimated to complete the infrastructure inventory.

Preparing and issuing a “Request for Proposals” (RFP) as well as going through the bidding process usually take up to three months to complete. The schedule was prepared assuming separate RFPs would be issued for the hydraulic modeling and for the water master plan preparation. It is estimated that it would take 13 months to prepare and analyze a hydraulic model of the City’s water system and one year to prepare a draft water master plan. Holding a comment period, preparing a final water master plan and getting approval from the City would each take up to a month to complete.

6.2.2 Description of Water Master Plan Process

Before a water master plan is drafted, a hydraulic model of the City's water system should be prepared and reviewed. The first step in preparing a hydraulic model is to advertise the job through a RFP. Once all bids are received and reviewed, the City selects the best bidder to prepare the hydraulic model.

A goal of a hydraulic model is to accurately represent the City's water system by determining flows and pressures within individual sections of the network for a series of scenarios such as average day demand, MDD, and fire flows. The distribution system inventory is a vital source of data for the hydraulic model. After the hydraulic model is prepared and results are available, an analysis should be prepared in order to identify and prioritize infrastructure upgrades (Proposed Project No. 9) as well as assess the system's compliance with relevant codes and regulations (Proposed Project No. 10).

Once a model is prepared and its results are analyzed, the City's water master plan can be completed. The City should issue a new RFP. Once all bids are received and reviewed, the City selects the best bidder to write the water master plan. The bidder (selected consultant) will then address all relevant components of a water master plan (a number of them are listed as bullets above) and develop them into a water master plan. Similar to the 2002 water master plan, the new plan may include projections for the next 15-year period.

After a draft water master plan is completed, the consultant will release the draft to the City for comments. Once the City reviews the draft water master plan and prepares its comments, the comments are incorporated into the plan and a final water master plan is prepared and submitted for City approval.

An important component of a water master plan is a review of the results from the hydraulic model and prioritizing what areas of the water system should be upgraded or reviewed more in depth. A number of suggested projects are proposed in Section 5.0. Once the City decides on what projects it would like to implement and a construction timeframe, funding should be assessed and a CIP program for the City's water system can be finalized. The CIP program should be included as a component of the water master plan.

A CIP program is a five to ten year plan that identifies prioritized capital projects (such as infrastructure replacements) and provides a schedule and funding opportunities for the plan. The CIP program is intended to provide a link between the recommended projects in the water master plan and the City's annual budget. A major benefit of a CIP program is the ability to evaluate all potential projects at the same time, ensuring that the City's funds are used efficiently.

6.3 PRIORITIZED LIST OF PROPOSED CIPS

The proposed recommendations described in Section 5.0 that may be considered as CIPs are prioritized by importance and time sensitivity in Table 6-2. The CIPs with the highest priority are those which would put the City in compliance with a certain code or regulation. These CIPs include filtering backwashing procedures and the updating of planning documents. Next in priority are those CIPs that are necessary for the reliability and security of the City's water system. These include CIPs within the City's water system as well as within the greater UPA diversion system. Lowest in priority are projects whose current state is in compliance with codes and regulations. These include adding capacity to the WTP as well as new staffing. It should be noted that Proposed Project No 15 (submitting a permit amendment following major upgrades at the WTP) should be completed following any completed CIP at the WTP.

TABLE 6-2 PRIORITIZED LIST OF PROPOSED CIPS

Priority Rank	Proposed CIP	Type of Project
1	Construct Settling Ponds and Discharge Backwash Water Properly	Treatment
2	Implement Redundancy During Filter Backwash	Treatment
3	Update Operations and Maintenance Plan	Admin and Planning
4	Update Bacterial Sampling Plan	Water Quality
5	Add Second Water Main from WTP to City	Distribution
6	Pursue Emergency Alternative Water Supply	Treatment
7	Construct Second Storage Tank	Treatment
8	Address Post-storm Turbidity Shutdowns	Treatment
9	Address Dead Ends	Distribution
10	Pursue Shortage Plan with UPA	Admin and Planning
11	Develop an Alternative Supply for the Greenhorn Creek Development	Admin and Planning
12	Add Fourth Filter[1]	Treatment
13	Staffing Level Recommendation	Admin and Planning

Notes:
1. If installing a fourth filter is chosen to address redundancy during backwash, it is of higher priority (rank no. 2).

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