City of FRESNO

CITYWIDE RECYCLED WATER DEMAND AND SOUTHWEST RECYCLED WATER SYSTEM ANALYSIS

FINAL | October 2019

Blair, Church & Flynn
CONSULTING ENGINEERS

carollo

CITYWIDE RECYCLED WATER DEMAND AND SOUTHWEST RECYCLED WATER SYSTEM ANALYSIS

FINAL | October 2019

Contents

Appendices

Tables

Figures

Abbreviations

ac-ft	acre-feet
ADD	average day demand
AFY	acre-feet per year
AWWA	American Water Works Association
Bakman	Bakman Water Company
Beacon®	Beacon® Advanced Metering Analytics Data Management System
Carollo	Carollo Engineers, Inc.
City	City of Fresno
CUSD	Clovis Unified School District
DPU	Department of Public Utilities
EPA	Environmental Protection Agency
ET_L	landscape evapotranspiration
ET_o	Reference Evapotranspiration
FID	Fresno Irrigation District
FMFCD	Fresno Metropolitan Flood Control District
Fresno State	California State University Fresno
ft	feet
ft/kft	feet per 1,000 feet
FUSD	Fresno Unified School District
GIS	Geographic Information System
gpm	gallons per minute
GRRP	groundwater recharge reuse project
MBR	membrane bioreactor
MDD	maximum day demand
MG	million gallons
mgd	million gallons per day
PHD	peak hour demand
RWMP	Recycled Water Master Plan
RWPS	Recycled Water Pump Station
RWRF	Regional Wastewater Reclamation Facilities
SW1A	Southwest 1A
TTDF	Tertiary Treatment and Disinfection Facility
USBR	United States Bureau of Reclamation
UV	ultraviolet
WRF	wastewater reclamation facility

Section 1

INTRODUCTION

1.1 Existing Recycled Water Facilities and Current Users

The Fresno-Clovis Regional Wastewater Reclamation Facility (RWRF) is a secondary treatment plant with a rated capacity of 88 million gallons per day (mgd). The RWRF is owned by the Cities of Fresno and Clovis, and is operated by the City of Fresno (City) Department of Public Utilities (DPU) Wastewater Division. The RWRF service area includes both the Fresno and Clovis metropolitan areas, Pinedale, and some areas of Fresno County not within the City limits.

The City completed the construction of the Tertiary Treatment and Disinfection Facility (TTDF) at the RWRF in 2017. The TTDF is membrane bioreactor (MBR) treatment facility capable of producing 5 mgd of recycled water that meets Title 22 of the California Code of Regulations and the recycled water is currently distributed to users in southwest Fresno through a network of large-diameter pipelines. The TTDF sends flow to a 3.2 million gallon (MG) reservoir at the RWRF that stores and equalizes recycled water flows before being pumped into the pipelines by the Recycled Water Pump Station (RWPS). The reservoir and RWPS are also located at the RWRF.

The City currently provides recycled water from the TTDF to three sites for irrigation: Quist Farms, Fresno Memorial Gardens, and Roeding Park. When recycled water demands are low, the tertiary-treated water overflows the reservoir and is discharged into the RWRF percolation ponds.

The City also owns and operates the North Fresno Wastewater Reclamation Facility (North Fresno WRF). The North Fresno WRF was constructed to provide recycled water for landscape irrigation at the Copper River Golf Course and the surrounding development.

1.2 History of the Recycled Water Transmission Main System Development

The City completed the development of a Recycled Water Master Plan (RWMP) in 2010. The RWMP projected citywide recycled water demands and the recommended alternative included construction of a tertiary treatment/disinfection facility at the RWRF and a recycled water transmission main (RWTM) system that would serve large open spaces (parks, cemeteries, and golf courses) in the southwest, northwest, and northeast quadrants of the city. The RWMP recommended phasing construction of the system to initially serve the southwest quadrant, with expansion into the northwest and northeast quadrants to follow. It envisioned that the Title 22 recycled water would be produced by filtering secondary effluent with cloth filters and disinfecting using an ultraviolet (UV) disinfection system. However, the City concluded during TTDF project initiation that an additional benefit could be gained by producing recycled water using MBR technology and replacing the oldest treatment train at the RWRF (referred to as the "A Side" of the RWRF). The City planned at that time to eventually replace the entire A Side with MBRs as the RWTM system expanded and recycled water demand increased.

The City completed construction of RWTM Segments Southwest 1A (SW1A), SW1B, and SW1C and began serving Quist Farms in 2017 and Fresno Memorial Gardens and Roeding Park in 2018.

RWTM SW1C2 was completed in late summer 2018. RWTM Segments SW4, SW1D, and Madison-Whitesbridge are currently being constructed and will be completed in 2020.

In 2016, the DPU selected three consultants to design the Northeast and Northwest quadrant RWTM systems, and associated booster pumping and storage facilities. Carollo Engineers, Inc. (Carollo) was tasked with developing a hydraulic model of the Southwest, Northwest, and Northeast RWTM systems as a part of this design effort, and the model was progressed to include existing and proposed pipelines and some of the users identified in the 2010 RWMP. As the modeling effort progressed, it became evident to the City that a more thorough analysis of user demand patterns was needed to accurately model the system to support the overall design. The DPU completed installation of an advanced metering infrastructure (AMI) system for residential and commercial water meters in 2014 that includes a data management system that stores metered consumption data in 15-minute intervals, so this data could be used to analyze user demand patterns and calculate potential citywide recycled water irrigation demand. Consequently, the DPU temporarily suspended work on the detailed design effort until the demand analysis could be completed.

Additionally, the DPU also needed to better understand the operational parameters of the Southwest RWTM system as the system came online and users were connected. Consequently, the DPU redirected the modeling task to model Southwest system operations and to analyze the metered consumption data to calculate potential citywide recycled water irrigation demand. This report presents the results of these two analyses and Figure 1 shows the RWTM system that was included in the model with the future RWTM pipeline alignments included in the design contracts.

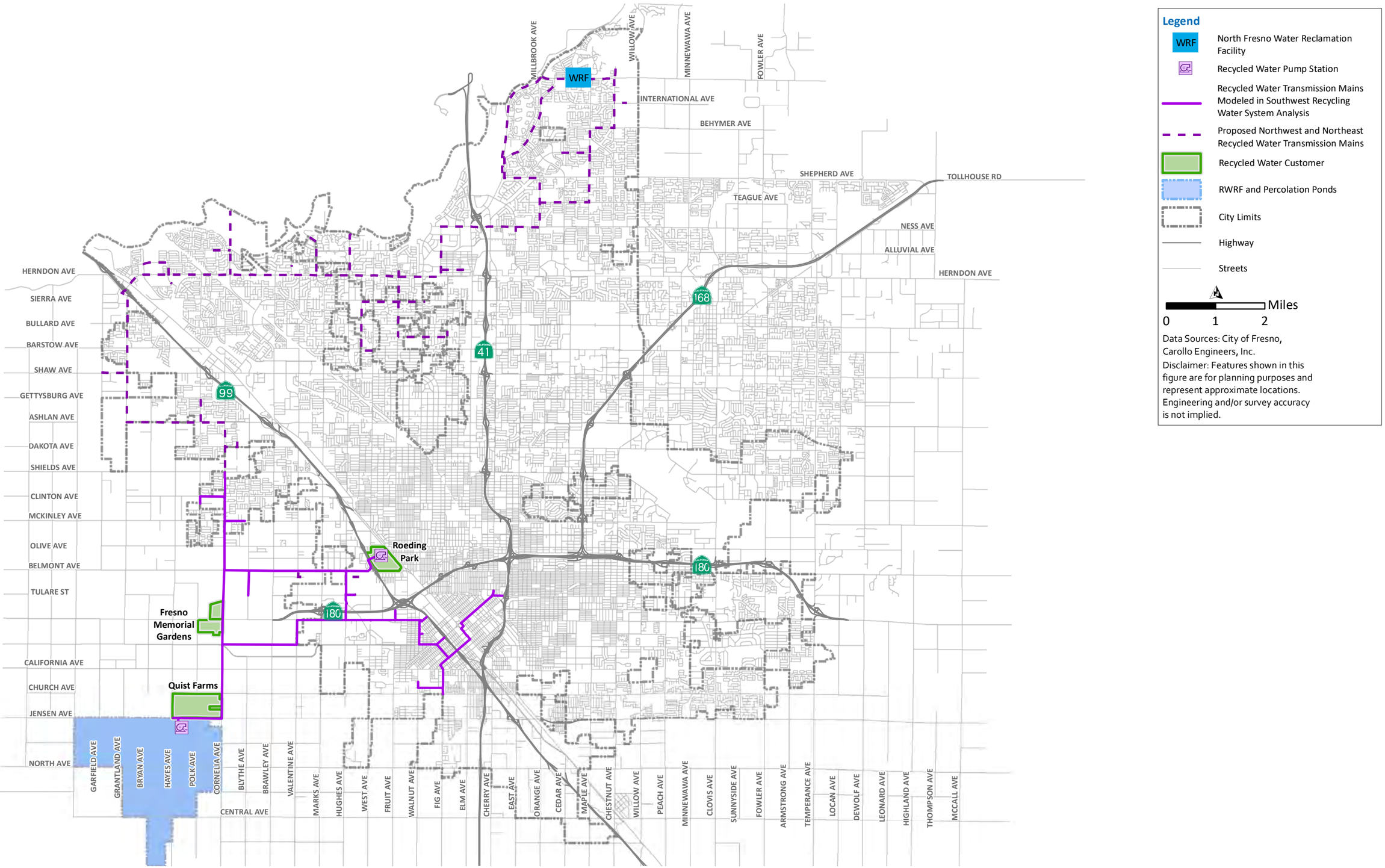
1.3 Analysis Objectives

The City identified the following objectives for this analysis:

1. Update projections of citywide recycled water irrigation demands using the City's metered water consumption data, focusing on public open spaces (i.e. parks, schools, etc.).
2. Develop a Geographic Information System (GIS) database of recycled water demand sites.
3. Use the recycled water hydraulic model to simulate daily and seasonal usage patterns to develop the Southwest recycled water system operational approach and inform the development of the level of service.
4. Update costs for continuing to develop the recycled water system to understand future investment needed to continue expanding the Northwest and Northeast quadrant RWTM systems.

The report contains the following sections:

1. Background and purpose.
2. Description of the analysis conducted to project potential citywide recycled water irrigation demands.
3. Development of the RWTM hydraulic model, description of the scenarios considered to complete the Southwest hydraulic analysis, and the analysis results.



Legend

- WRF — North Fresno Water Reclamation Facility
- Recycled Water Pump Station
- Recycled Water Transmission Mains Modeled in Southwest Recycling Water System Analysis
- Proposed Northwest and Northeast Recycled Water Transmission Mains
- Recycled Water Customer
- RWRF and Percolation Ponds
- City Limits
- Highway
- Streets

Miles

0 1 2

Data Sources: City of Fresno, Carollo Engineers, Inc.

Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

Figure 1 Demand Study Area and RWTM System

Section 2

CITYWIDE RECYCLED WATER DEMAND ANALYSIS

This section summarizes the results of the 2010 RWMP demand analysis and describes the analysis performed to update the citywide recycled water demand projections.

2.1 Background

2.1.1 Summary of 2010 RWMP Demand Projections

The 2010 RWMP considered four types of reuse opportunities:

- Urban reuse (includes irrigation and industrial uses).
- Agricultural reuse.
- Groundwater recharge.
- Fisheries enhancement.

The potential urban reuse was developed before the City completed installation of the residential and commercial water meters, so citywide recycled water demands were projected by using GIS to estimate irrigable green spaces at parks, schools, golf courses, and cemeteries and calculating irrigation demands based on evapotranspiration and rainfall data.

Agricultural reuse potential was projected by considering the direct deliveries of reclaimed water that the City currently provides to nearby farms and to the Fresno Irrigation District (FID) and further expanding deliveries of undisinfected effluent by constructing new pipelines to serve additional users. The City eliminated from consideration upgrading the RWRF to supply tertiary-treated water to nearby farms or to FID canals, choosing instead to focus on distributing tertiary-treated water to urban users.

Title 22 requires recycled water used for groundwater recharge to be diluted with non-recycled water, or diluent water. Groundwater recharge reuse potential was projected by considering availability of diluent water and siting groundwater recharge reuse project (GRRP) basins adjacent to either Fresno Metropolitan Flood Control District (FMFCD) conveyance facilities or FID canals. Reuse potential was calculated using an average percolation rate for the area and multiplying it to the land available for GRRP basins.

Fisheries enhancement wasn't explored beyond initial discussions with the United States Bureau of Reclamation (USBR) because recycled water could only supply a negligible amount compared to the large volume of water needed to enhance deliveries for fisheries on the San Joaquin River.

A summary of the calculated potential reuse volumes were presented in Table 5.1 and Figure 5.1 in the 2010 RWMP. That information is included below as Table 1 and Figure 2, respectively.

Table 1 Summary of Potential Reuse Volumes from Table 5.1 of the 2010 RWMP

	Recycled Water Use (AFY)
Urban Irrigation and Industrial Reuse by Existing Large Users	9,800[(a)]
Irrigation of Existing and Future Commercial and Residential Users	>4,000
Groundwater Reuse Recharge	Up to 31,000(1)
Expand Direct Agricultural Reuse with Secondary Effluent	4,200
Expand Delivery to FID for Agricultural Reuse	>20,000(2)
Total	**>69,000**

Notes:
(1) Recycled water for groundwater reuse recharge will be limited by the land available for recharge basins and the availability of diluent water.
(2) Delivery of recycled water to FID is unlimited by potential demand, rather it will be limited by remaining available supply once urban reuse and GRRPs are fully implemented

Correction:
(a) The projected urban irrigation and industrial reuse demand listed in Table 5.1 in the 2010 RWMP was incorrectly stated to be 14,700 AFY. The correct projected demand is 9,800 AFY.

Table 5.4 in the RWMP, which is included below as Table 2, showed that approximately 9,800 AFY projected for urban irrigation and industrial reuse was possible if the City constructed the entire recycled water system shown in Figure 5.3 of the RWMP, which is included as Figure 3. The 9,800 AFY included approximately 2,600 AFY of indoor, or non-irrigation, industrial uses, so the recycled water irrigation demand projected at that time was approximately 7,200 AFY. The additional 4,000 AFY for commercial and residential irrigation noted in Table 1 and in Figure 2 would be possible if the City extended laterals off of the main transmission system that would serve the larger users. Consequently, the total recycled water irrigation demand projected in the 2010 RWMP was approximately 11,200 AFY. The treatment capacity included in Table 5.4 was determined to be what would be required to serve the maximum day demand for the uses listed.

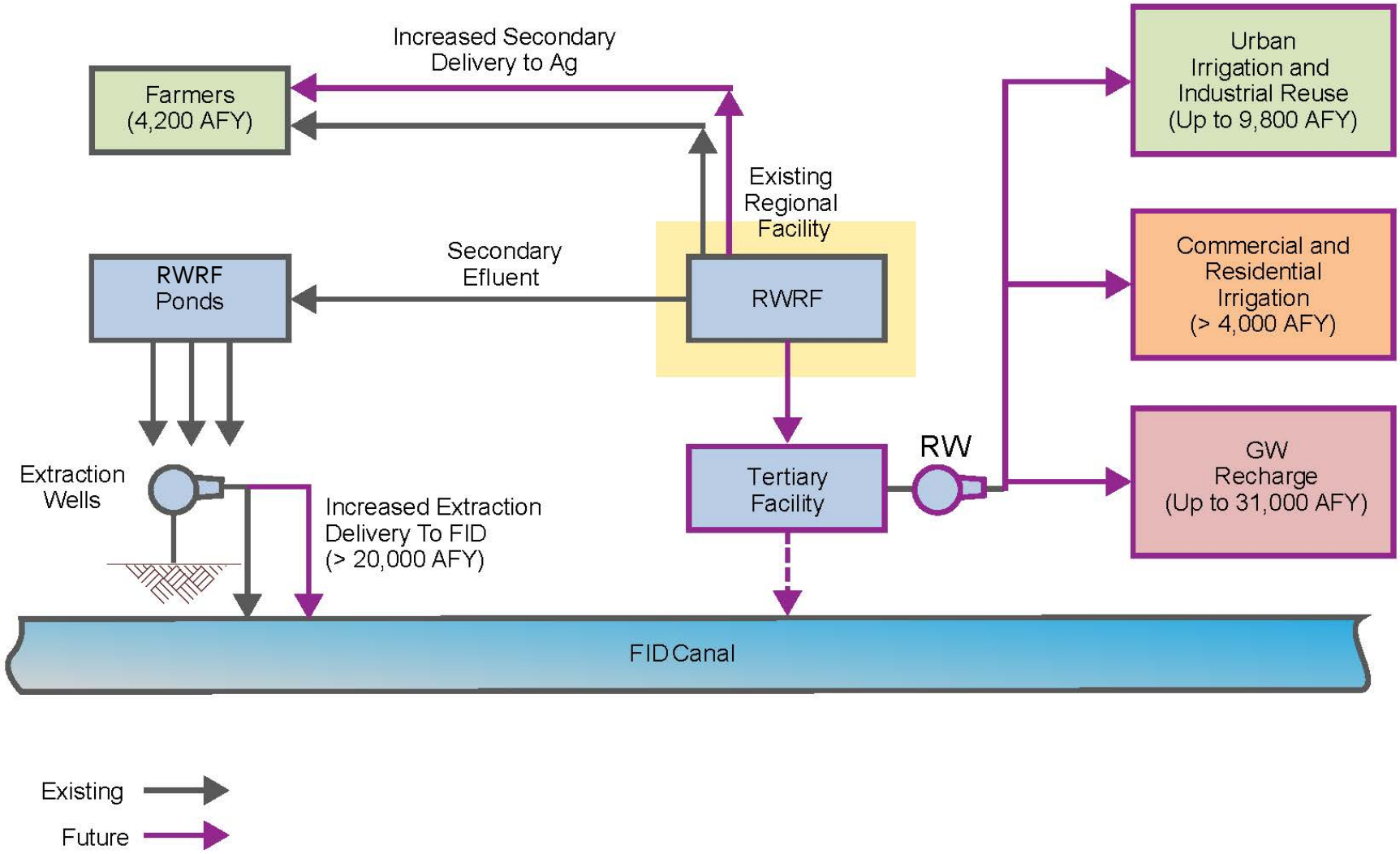
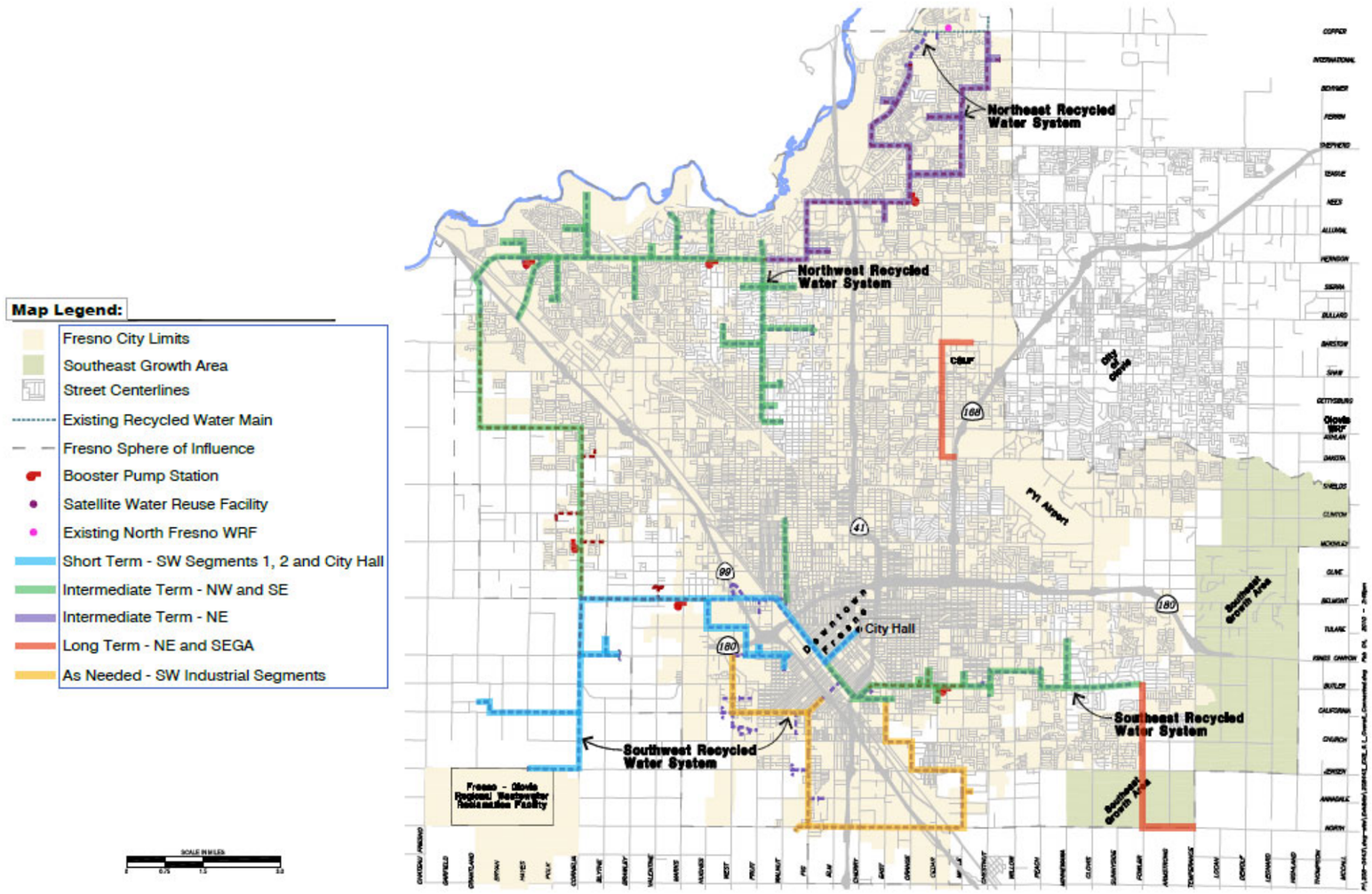


Figure 2 Summary of Recommended Alternatives from Figure 5.1 of the 2010 RWMP

Table 2 Recommendations for Urban Reuse from Table 5.4 of the 2010 RWMP

City Quadrant	Pipe Segments and Lengths	Major Users Served	Demand, AFY	Treatment Facilities Required, mgd
Southwest	Pipe segments 1 and 2 – 15.32 miles	Roeding Park Kearney Park 3 cemeteries Chandler Airport 3 industries (laundries) Highway 180 and 99 3 schools	1,800	2.4
	Spur to City Center (part of pipe segment 4) – 2.5 miles	City Hall/courthouse Grizzlies stadium 1 hospital	170	0.2
	Pipe segment 3 – 1.44 miles	3 schools	95	0.1
	Industrial users as possible (pipe segments 5 to 9 and remainder of 4) – 17.0 miles	14 industries 7 parks 10 schools	2,100	2.8
Northwest	All identified pipe segments 28.1 miles	Golf Courses: Riverside Golf Course, Islewood Golf Course, San Joaquin Country Club, Fig Garden Golf Course Lake Van Ness Highway 99 24 schools 4 parks	1,900	5.3
Northeast	All identified pipe segments - 16.17 miles	Woodward Park, Fort Washington Country Club Woodward Lake 14 schools 2 parks	2,720	3.9
	Pipe segment for Granite Park and CSUF – 3 miles	Granite Park CSUF Schools Parks	4,900	4.0
Southeast	All identified pipe segments 7.35 miles	Fairgrounds, Fresno Pacific University Sunnyside Country Club Village Green Golf Course 9 schools 4 parks	995	2.8
Total Demand			**9,780**	



Note:
Distribution is primarily to serve urban users.
GRRP opportunities will be served from urban distribution system.
System does not accommodate agricultural reuse of exchange projects.

Figure 3 Existing and Proposed Recycled Water System

2.1.2 Total Citywide Water Demand

The City's metered water consumption data is collected and managed through the Beacon® Advanced Metering Analytics Data Management System (Beacon®). It is available in quarter-hour increments and meter attributes include location, meter size, account class, type of use, and several other attributes that are used for billing and analysis.

Location data includes the customer address, city council district, and zip code. The Account Class attribute in Beacon® categorizes each customer into one of the following:

- Single-family residential.
- Multi-family residential.
- Municipal.
- Educational.
- Commercial.
- Industrial.
- Vacant.

The Water Type attribute in Beacon® categorizes each water meter into one of the following use types:

- Water.
- Irrigation.
- Recycled water.

Carollo analyzed data exported from Beacon® to calculate demands for the different account classes in calendar years 2017 and 2018. The citywide total water demand during this period averaged approximately 105,400 acre-feet per year (AFY). Tables 3 and 4 list monthly water consumption for the different account classes in 2017 and 2018, respectively, and Figure 4 shows the relationship between consumption and precipitation for different uses during this same period. Tables 5 and 6 list the consumption for each use type in 2017 and 2018, respectively, for the different account classes.

Table 3 2017 Metered Water Consumption

Month	Precipitation (in)	Total Consumption (ac-ft)	Metered Irrigation (ac-ft)	Metered Recycled Water (ac-ft)	All Other Uses[1] (ac-ft)
January	5.50	4,621	104	0	4,517
February	2.52	4,068	64	0	4,003
March	1.08	5,433	210	0	5,223
April	3.42[2]	6,331	387	0	5,944
May	0.12	9,873	851	0	9,022
June	0.00	11,883	1,148	0	10,735
July	0.00	13,577	1,391	0	12,186
August	0.00	13,421	1,409	0	12,012
September	0.16	11,446	1,151	0	10,295
October	0.09	9,949	890	49	9,010
November	0.28	7,287	488	7	6,792
December	0.04	6,314	279	64	5,972
Total	**13.21**	**104,204**	**8,371**	**120**	**95,713**

Notes:
(1) These quantities include indoor water uses and irrigation uses that are not measured using a dedicated irrigation meter.
(2) Estimated.

Table 4 2018 Metered Water Consumption

Month	Precipitation (in)	Total Consumption (ac-ft)	Metered Irrigation (ac-ft)	Metered Recycled Water (ac-ft)	All Other Uses[(1)] (ac-ft)
January	1.23	5,611	192	11	5,408
February	0.26	5,635	269	35	5,331
March	4.19	5,635	265	3	5,367
April	0.64	7,247	507	44	6,695
May	0.00	10,277	1,029	41	9,208
June	0.00	12,136	1,278	95	10,763
July	0.00	13,560	1,443	97	12,019
August	0.00	13,288	1,532	99	11,658
September	0.00	11,330	1,225	60	10,045
October	0.10	9,506	940	42	8,523
November	1.67	7,024	548	24	6,452
December	1.67	5,379	227	3	5,149
Total	**9.76**	**106,628**	**9,455**	**555**	**96,619**

Notes:
(1) These quantities include indoor water uses and irrigation uses that are not measured using a dedicated irrigation meter.

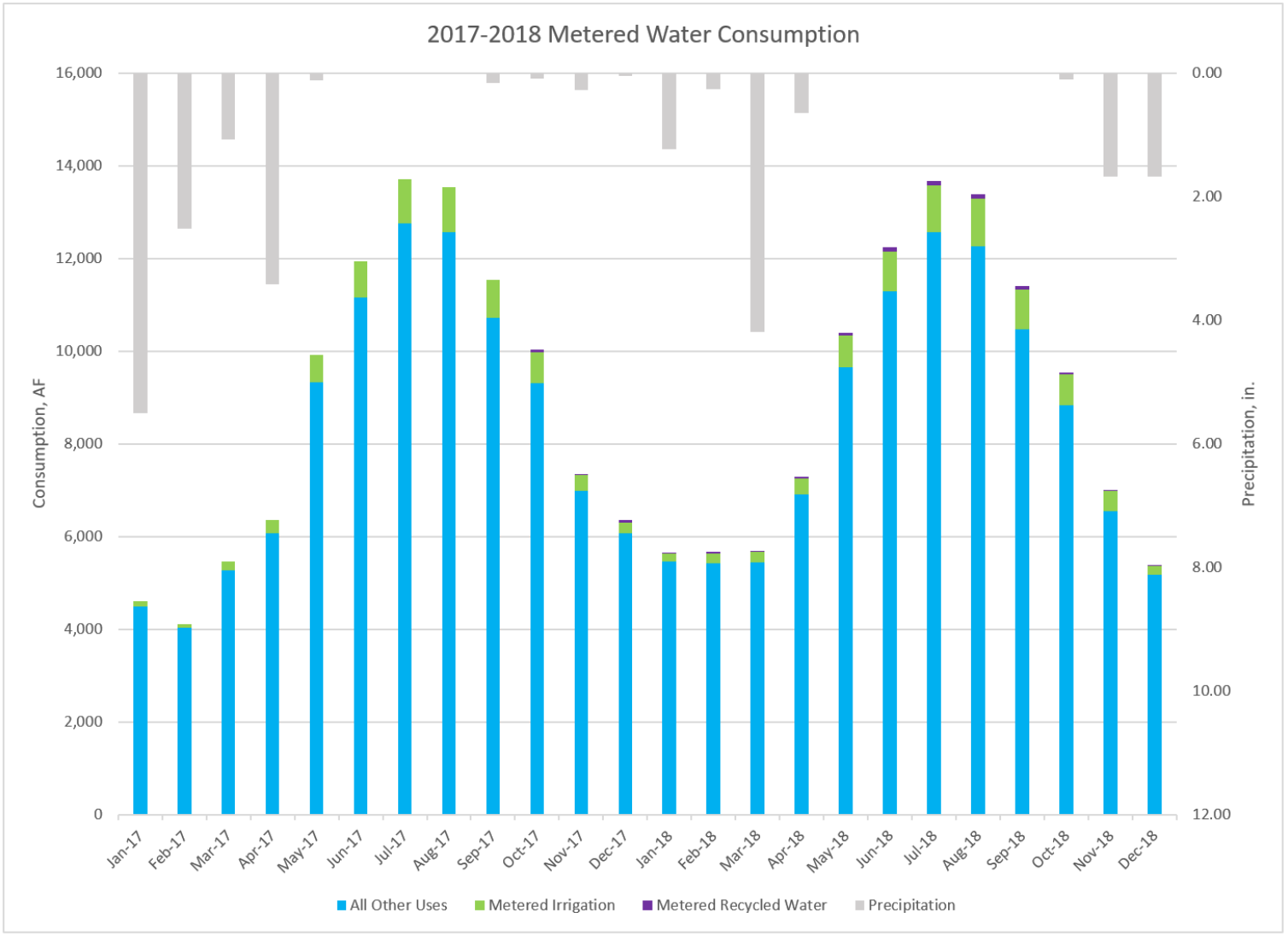


Figure 4 2017-2018 Metered Water Consumption

Table 5 2017 Metered Water Consumption by Meter Class and Type of Use

Meter Class	Total Consumption		Metered Irrigation			Metered Recycled Water	All Other Uses[1]
	(ac-ft)	Percent of Total Consumption (%)	(ac-ft)	Percent of Total Consumption (%)	Percent of Irrigation Consumption (%)	(ac-ft)	(ac-ft)
Commercial	18,002	17.3	3,683	3.5	44.0	120	14,199
Educational	3,769	3.6	1,634	1.6	19.5	0	2,135
Industrial	4,990	4.8	9	0.0	0.1	0	4,981
Municipal	4,115	3.9	2,474	2.4	29.6	0	1,641
Multi-Family Residential	17,985	17.3	561	0.5	6.7	0	17,424
Single-Family Residential	55,343	53.1	9	0.0	0.1	0	55,334
Total	**104,204**	**100.0**	**8,370**	**8.0**	**100.0**	**120**	**95,714**

Notes:
(1) These quantities include indoor water uses and irrigation uses that are not measured using a dedicated irrigation meter.

Table 6 2018 Metered Water Consumption by Account Class and Type of Use

Account Class	Total Consumption		Metered Irrigation			Metered Recycled Water	All Other Uses[1]
	(ac-ft)	Percent of Total Consumption (%)	(ac-ft)	Percent of Total Consumption (%)	Percent of Irrigation Consumption (%)	(ac-ft)	(ac-ft)
Commercial	19,286	18.1	4,220	4.0	44.6	479	14,587
Educational	4,177	3.9	2,065	1.9	21.8	0	2,112
Industrial	5,170	4.8	10	0.0	0.1	0	5,160
Municipal	4,207	3.9	2,551	2.4	27.0	76	1,580
Multi-Family Residential	18,707	17.5	598	0.6	6.3	0	18,109
Single-Family Residential	55,081	51.7	11	0.0	0.1	0	55,070
Total	**106,628**	**100.0**	**9,455**	**8.9**	**100.0**	**555**	**96,619**

Notes:
(1) These quantities include indoor water uses and irrigation uses that are not measured using a dedicated irrigation meter.

2.1.2.1 Observations Regarding Metered Consumption Data

The following observations can be made in reference to the 2017-2018 metered consumption data presented above:

1. Citywide demand increased by approximately 2.3 percent from 2017 to 2018.
2. Measured irrigation demand accounted for 8.0 percent of total citywide water demand in 2017 and 8.8 percent 2018 as shown in Tables 5 and 6, respectively.
3. In 2018, citywide measured irrigation demands increased by approximately 13 percent over 2017, likely driven by a drier 2018. Table 7 shows the annual changes for each account class and type of use.
4. Measured irrigation demand from the commercial account class accounted for nearly 45 percent of total citywide metered irrigation demand in 2018, even though total demand from the commercial account class accounted for less than 20 percent of total citywide consumption demand.
5. Measured irrigation from the educational and municipal account classes accounted for nearly 49 percent of total citywide metered irrigation demand in 2018, even though total demand from these two account classes accounted for only 7.8 percent of total citywide consumption demand.
6. Measured irrigation from the commercial and educational account classes accounted for nearly 90 percent of the increase in irrigation demand from 2017 to 2018.
7. Within the educational account class, in 2018 total consumption increased by 408 acre feet, and irrigation consumption increased by 431 acre feet.

Table 7 Change in Metered Water Consumption by Account Class and Type of Use from 2017 to 2018

Account Class	Total Consumption (%)	Metered Irrigation (%)	Metered Recycled Water (%)	All Other Uses[(1)] (%)
Commercial	7.1	14.6	298.8	2.7
Educational	10.9	26.4		-1.0
Industrial	3.6	11.1		3.6
Municipal	2.2	3.1	New	-3.7
Multi-Family Residential	4.0	6.6		3.9
Single-Family Residential	0.0	21.1		0.0
Total	**2.6**	**13.0**	**362.4**	**1.2**

Notes:
(1) These quantities include indoor water uses and irrigation uses that are not measured using a dedicated irrigation meter.

2.2 Potential Citywide Recycled Water Demand

This section describes the process used to calculate potential citywide recycled water demand. It provides an overview of the data used in the calculations, and the process used to calculate demands for each class of user (commercial, industrial, etc.).

2.2.1 General Approach

Potential citywide recycled water irrigation demands were calculated using the following general approach:

1. Extract irrigation consumption from Beacon® for all account classes, assuming that all current irrigation demand could be provided by recycled water.
2. Analyze the educational and municipal irrigation usage data and determine whether further analysis was needed to accurately calculate potential future recycled water irrigation demand.
3. Coordinate with the large educational and municipal users (Fresno Unified School District (FUSD), Clovis Unified School District (CUSD), California State University, Fresno (Fresno State), and Caltrans) to gather additional irrigation information and data. Validate that the Beacon® data represents their long-term irrigation strategies if recycled water were made available.
4. Identify large parks, golf courses, and cemeteries that do not currently utilize Fresno's water system as a source of irrigation water. Use GIS to estimate irrigable land and calculate demand using evapotranspiration and precipitation data.

The following sections describe each of the demand calculations in detail.

2.2.2 Measured Irrigation Consumption

As shown in Tables 3 and 4 above, total irrigation consumption in 2017 and 2018 across all account classes was 8,371 and 9,455 acre feet, respectively. The following sections discuss the potential citywide recycled water irrigation demand for the different account classes.

2.2.2.1 Commercial, Industrial, and Residential Account Classes

Table 8 lists the measured irrigation consumption for the commercial, industrial, and residential account classes in 2018. This consumption accounted for approximately 51 percent of total metered irrigation demand in 2018, which corresponds to approximately 4.5 percent of total citywide consumption demand. The potential future recycled water irrigation demand from these account classes is considered to be a minimum of 5,318 acre feet, which is the consumption measured in 2018. This potential future demand includes the recycled water that was delivered to Quist Farms, and could potentially grow as the city grows. Because the City is most interested in focusing on the potential to serve public land uses, no additional analysis of the commercial, industrial, or residential account classes was performed.

Table 8 Metered Irrigation Consumption for Commercial, Industrial, and Residential Account Classes

Account Class	Metered Consumption (ac-ft)		
	Irrigation	Recycled Water	Total
Commercial	4,220	479	4,699
Industrial	10	0	10
Multi-Family Residential	598	0	598
Single-Family Residential	11	0	11
Total	**4,839**	**479**	**5,318**

2.2.2.2 Municipal Account Class

The total metered irrigation demand for the municipal account class was 2,474 acre-feet (ac-ft) in 2017 and 2,587 ac-ft in 2018, including the recycled water that was delivered to Roeding Park in 2018. Table 9 lists the 2017 and 2018 metered consumption by month for each type of use.

Caltrans and Roeding Park were removed from the municipal analysis and analyzed separately for the following reasons:

- The City is currently planning on serving Caltrans with recycled water as a part of the Southwest RWTM system, and in initial discussions Caltrans indicated that they would increase water consumption for irrigation if the City made recycled water available. The analysis of Caltrans' potential future recycled water demand is described in Section 2.2.5.
- Roeding Park began receiving recycled water for irrigation in August 2018, so only five months of recycled water consumption data were available for analysis. Consequently, Carollo calculated the potential future recycled water irrigation demand using GIS and assumed evapotranspiration rates. The calculation of future Roeding Park recycled water demand is included in Section 2.2.7.

Results

The total potential future water demand for the remaining users in the municipal account class was calculated to be 2,268 AFY based on 2018 metered consumption, after removing 243 ac-ft of Caltrans irrigation consumption and 76 ac-ft of Roeding Park recycled water consumption.

2.2.3 Educational Account Class Calculation

This section describes the analysis performed to calculate potential recycled water irrigation demand from the educational account class. This analysis did not include California State University, Fresno (Fresno State) because Fresno State owns and operates production wells and a water distribution system for indoor water use and landscape irrigation on the main campus, and for irrigation of its farm crops. The analysis performed to calculate Fresno State's potential recycled water irrigation demand and the results can be found in Section 2.2.4.

2.2.3.1 Process

The following process was used to calculate the potential recycled water irrigation demand for educational accounts:

1. Extract 2017 and 2018 water consumption data from Beacon® for the entire educational account class.
2. Cross tabulate consumption with type of use to identify the irrigation and indoor water consumption at individual school sites.
3. Meet with Fresno Unified School District (FUSD) and Clovis Unified School District (CUSD) to review meter inventories, discuss irrigation practices, and discuss the use of recycled water for irrigation if the City made it available.
4. Calculate irrigation consumption as a percentage of total water consumption at school sites with dedicated irrigation meters.
5. Calculate potential future demand at sites without dedicated irrigation meters, assuming that the average percentage of irrigation consumption applies uniformly across the entire educational account class.
6. Finalize the projection of potential recycled water irrigation demand for the educational account class.

Table 9 2017-2018 Monthly Municipal Account Class Consumption

Month	2017 Metered Consumption (ac-ft)				2018 Metered Consumption (ac-ft)				Change from 2017 to 1018 (%)			
	Water	Irrigation	Recycled Water	Total	Water	Irrigation	Recycled Water	Total	Water	Irrigation	Recycled Water	Total
January	78.3	32.2		110.5	83.7	56.8		140.5	6.9	76.4		27.1
February	59.1	23.5		82.6	81.4	78.2		159.6	37.6	232.8		93.1
March	73.6	51.3		125.0	93.0	83.5		176.5	26.3	62.7		41.3
April	83.5	100.3		183.7	108.5	132.2		240.7	29.9	31.9		31.0
May	162.2	240.1		402.2	157.1	262.7		419.8	-3.1	9.4		4.4
June	187.9	330.3		518.2	188.4	337.6		526.0	0.3	2.2		1.5
July	220.6	395.3		615.9	207.8	381.1		588.9	-5.8	-3.6		-4.4
August	231.0	428.3		659.3	211.4	400.3	24.7	636.4	-8.5	-6.5		-3.5
September	201.1	375.6		576.8	171.5	319.3	25.2	516.0	-14.7	-15.0		-10.5
October	158.7	293.1		451.8	127.9	252.6	14.9	395.4	-19.4	-13.8		-12.5
November	100.4	127.3		227.7	93.6	158.2	8.6	260.3	-6.8	24.3		14.3
December	84.5	77.0		161.5	55.9	88.1	2.9	146.9	-33.8	14.4		-9.0
Total	**1,640.9**	**2,474.3**	**0.0**	**4,115.2**	**1,580.1**	**2,550.7**	**76.3**	**4,207.0**	**-3.7**	**3.1**		**2.2**

2.2.3.2 Results

Table 10 lists the monthly consumption by type of use in 2017 and 2018 and the percentage change in consumption from 2017 to 2018 across the entire educational account class.

Table A-1 in Appendix A lists the consumption by type of use in 2017 and 2018 for each customer in the educational account class and the percentage change from 2017 to 2018.

FUSD and CUSD confirmed in discussions that both districts are in the process of installing dedicated irrigation meters at school sites where it will be practical and feasible. Table A-1 in Appendix A also shows that several educational customers have multiple school sites that aren't specifically identified in the "Account Full Name" field and are consequently lumped together as a single account. This includes 20 FUSD sites, 7 CUSD sites, 16 Central Unified School District sites, and the State Center Community College District (SCCCD) sites.

Because there are a number of school sites that do not have dedicated irrigation meters, calculating potential recycled water irrigation demand for the educational account class required Carollo to estimate the percentage of total consumption attributable to irrigation and apply that percentage to the sites without dedicated irrigation meters. After review of the Beacon® data, irrigation consumption in 2017 and 2018 at sites with dedicated irrigation meters averaged 75 percent of total consumption, and ranged between 98 percent and 19 percent of total consumption. However, examination of individual districts' consumption showed that Central Unified School District had dedicated irrigation meters at most of their sites, and irrigation consumption averaged approximately 87 percent across that district. A reasonable assumption to calculate potential future recycled water irrigation demand would be to use a value of 80 percent of total consumption in the calculation. Table A-2 in Appendix A lists the school sites with the measured and calculated irrigation demand in 2018 using 80 percent of total demand for irrigation.

2.2.3.3 Conclusion

Based on the analysis of Beacon® data and discussions with FUSD and CUSD, the total potential future recycled water irrigation demand for the educational account class is projected to be 3,000 AFY, using metered consumption data where it was available and calculating potential recycled water irrigation demand by assuming 80 percent of total consumption.

Table 10 2017-2018 Monthly Educational Account Class Consumption

Month	2017 Metered Consumption (ac-ft)			2018 Metered Consumption (ac-ft)			Change from 2017 to 1018 (%)		
	Water	Irrigation	Total	Water	Irrigation	Total	Water	Irrigation	Total
January	52	16	69	75	26	101	43.1	57.4	46.5
February	50	3	53	83	47	130	66.0	1279.3	143.0
March	98	37	135	67	35	102	-31.1	-5.9	-24.2
April	115	67	182	120	121	241	4.8	80.6	32.7
May	218	166	384	237	250	487	8.7	51.1	27.0
June	263	243	506	265	285	550	0.9	17.1	8.7
July	304	310	614	331	319	650	8.9	2.8	5.8
August	322	293	614	298	365	663	-7.4	24.9	8.0
September	270	218	488	263	298	560	-2.8	36.9	14.9
October	231	145	376	197	197	394	-14.8	36.3	4.9
November	128	89	217	118	93	211	-8.4	4.6	-3.1
December	83	48	131	59	30	88	-29.6	-38.2	-32.8
Total	**2,134**	**1,634**	**3,769**	**2,112**	**2,065**	**4,177**	**-1.0**	**26.4**	**10.8**

2.2.4 Fresno State Calculation

This section describes the analysis conducted to calculate potential recycled water irrigation demand for Fresno State. The following process was used:

1. Obtain well production and metered wastewater data to calculate irrigation demands for the academic campus, which will be the difference between well production and wastewater generation.
2. Calculate irrigation demands for Fresno State's farm using GIS, evapotranspiration, and precipitation data for the mix of crops grown, since Fresno State does not meter the agricultural irrigation wells, and because Fresno State also receives a surface water allocation from FID.

2.2.4.1 Academic Campus Calculation

On-campus wells provide water supply for the campus, and irrigation is not measured. Fresno State discharges its wastewater to the City's sewer system and wastewater flows are measured in two locations.

Fresno State provided well production data from January 2013 to December 2017, and the City provided the metered wastewater data for the same period. The difference between the well production data and the metered sanitary sewer flows was assumed to be the total landscape irrigation volume. Table 11 lists the annual monthly well production and metered wastewater flows and the average estimated irrigation demand.

Table 11 Estimated Annual Irrigation Demand for the Academic Campus

Year	Total Annual Groundwater Volume (acre-foot)	Total Annual Wastewater Volume (acre-foot)
2013	1116	269
2014	1093	269
2015	771	303
2016	776	274
2017	854	298
Average	922	283

Based on the data above, the annual irrigation demand for the academic campus is estimated to be 639 AF.

2.2.4.2 Fresno State Farm Calculation

Fresno State operates a 1,000 acre research farm adjacent to the academic campus that is irrigated with a combination of surface water allocated by FID when it is available and groundwater from its agricultural wells. Fresno State receives approximately 0.39 ac-ft per acre per month from FID during the irrigation season, which generally runs May through September. This amounts to roughly 1,542 acre-feet per year with the assumed crop mix and acreage listed in Table 12. Each crop type grown at Fresno State requires a different volume of irrigation based on its crop coefficient, K_c and the FID allocation does not fully cover the net irrigation demand for the current crops so the remaining irrigation volume is provided by the agricultural wells. This difference in supply could be provided by recycled water, up to the entire irrigation volume if no surface water is available from FID. Consequently, the potential future recycled water irrigation demand could range from 2,339 to 797 AFY.

Table 12 Fresno State Crop Irrigation Requirements

Crop Type	K_c	Net Irrigation Required (ft)	Area (acres)	Irrigation Volume (ac-ft)
Tree Crop	0.97	3.54	198	701
Grapes	0.8	2.84	129	366
Corn	1.15	4.31	171	737
Pasture	0.6	2.03	293	595
Total Agricultural Irrigation Required, Estimated by ET Calculation				**2,339**
FID Allocation				**1,542**
Annual Agricultural Irrigation Demand Met By Groundwater				**797**

2.2.4.3 Total Irrigation Demand

Total future potential recycled water irrigation demand for Fresno State is calculated to be between 1,436 and 2,978 AFY, depending on the availability of surface water from FID.

2.2.5 Caltrans Calculation

Caltrans currently irrigates its right-of-way within the city limits using dedicated irrigation meters located at or near freeway interchanges. At each connection point, Caltrans operates and maintains a booster pump or multiple booster pumps to maintain irrigation system pressures due to the long distances between connection points. The City and Carollo met with Caltrans to discuss the use of recycled water for right-of-way irrigation and to understand the anticipated seasonal and daily demand patterns. Caltrans provided the City with its plans to increase its use of water for irrigation in areas where recycled water connection points will be made available, which are currently on the Southwest RWTM alignment along Highway 99 and Highway 41 downtown. Caltrans stated that it would increase irrigation along the right of way if the City made recycled water available, but would continue to implement strict conservation measures if only potable water was provided.

2.2.5.1 Process

Caltrans provided a list of locations in the Southwest RWTM system where the existing dedicated irrigation meters will be converted to recycled water meters and connected to existing booster pumps. The list of locations and calculated irrigation demand is included in Appendix B.

Caltrans calculated the potential irrigation flows at each connection point using the following assumptions:

1. Each booster pump has a pumping capacity of 50 gallons per minute (gpm).
2. Caltrans will simultaneously run up to five booster pumps per connection point for 24 hours, two days per week
3. Caltrans will plan for six active irrigation days, reserving Sunday for operating any pumps, controllers, or stations that may have been out of service during the weekly irrigation rotation.
4. One-third of the connection points will be operated on each day of active irrigation.

The list provided in Appendix B identified an additional 37 booster pumps at up to 22 connection points that were not included in the calculation, but could be included in the future if the City extended the recycled water system to serve all of the Caltrans right of way within the City limits. Caltrans also included two connection points currently served by Bakman Water Company (Bakman), which were excluded from the calculation. Taking the future proposed connections into account and removing the Bakman connections results in a total of 108 booster pumps at up to 42 connection points.

2.2.5.2 Results

Using the assumptions listed above, a maximum day demand of 7,776,000 gallons at 5,400 gpm would be needed during the summer if all of the locations were running simultaneously. Caltrans plans to run each booster for two days and irrigate six days per week. Using this approach, the maximum day demand will be approximately a third of the calculated demand, or approximately 2,592,000 gallons per day during the summer. Caltrans also indicated in discussions that irrigation durations would be reduced by 50 percent in the spring and fall and by 90 percent in the winter, so the reduction in maximum day demand will only apply to the summer demand. This takes into account the additional 37 booster pumps identified in Appendix B.

Table 13 shows the calculation of annual demand using the Caltrans calculation, the seasonal assumptions, and the potential increase for covering the entire Caltrans right of way. Appendix B includes the calculation assumptions.

Table 13 Caltrans Calculations for Recycled Water Consumption

Season	Maximum	Months	Days in Period	Total Demand (gallons)	Total Demand (ac-ft)	Peak Hour (gpm)
Summer	2,592,000	June to September	122	316,224,000	971	4,700
Spring and Fall	1,296,000	April, May, October, November	122	158,112,000	485	2,350
Winter	259,200	January, February, March, and December	121	31,363,200	96	470
Total				**505,699,200**	**1,552**	

2.2.6 Golf Courses and Cemeteries

Golf course and cemetery irrigation demand was calculated by using the landscape coefficient method developed in the Guide to Estimating Irrigation Water Needs of Landscape Plantings in California by the California Department of Water Resources. The landscape coefficient method takes into consideration the amount of irrigation water required per type of landscape given its location. Ultimately, the landscape coefficient is used to estimate the water loss by evapotranspiration for various plant species. The landscape coefficient formula is shown below in Table 14. The monthly ET_o and landscape coefficient are then used to determine the landscape evapotranspiration (ET_L), as shown in Table 14, using Reference Evapotranspiration (ET_o) Zone 12 for Fresno.

Table 14 Landscape Coefficient Formula

Variable	Description	Value
K_L	Landscape Coefficient	$K_L = k_s k_d k_{mc}$
k_s	Species Factor(1)	0.6
k_d	Density Factor (Average)(2)	1.0
k_{mc}	Microclimate Factor (Average)(3)	1.0
ET_o	Reference Evapotranspiration	(See Table 15)
ET_L	Landscape Evapotranspiration	$ET_L = ET_o K_L$

Notes:
(1) Species factor set at 0.6 for multiple-species planting. Assumed variety of grasses and trees mixed together as golf course landscaping.
(2) Density Factor set at 1.0 for mix of trees and open land at golf course. Assume to be average.
(3) Microclimate Factor set at 1.0 since golf course landscape is not surrounded by high evapotranspiration objects or groundcover.

The monthly estimated evapotranspiration rates listed in Table 15 are derived from field experiments and models. Subtracting precipitation from landscape evapotranspiration determines the net irrigation requirement. The total depth of irrigation water needed for golf courses and cemetery landscaping in the Fresno area is just over two feet annually. Multiplying the net irrigation depth by the potential recycled water use areas determines the total volume of irrigation demand.

Table 15 Required Irrigation for Golf Courses and Cemeteries

Month	Zone 12 ET_O	ET_L (inches)	Average Rainfall 1948-2016 (inches)	Net Irrigation Required (inches)	Percent of Annual Net Irrigation Requirement
January	1.24	0.74	2.09	0.0	0
February	1.96	1.18	1.9	0.0	0
March	3.41	2.05	1.89	0.2	1
April	5.1	3.06	1.03	2.0	8
May	6.82	4.09	0.36	3.7	15
June	7.8	4.68	0.16	4.5	19
July	8.06	4.84	0.01	4.8	20
August	7.13	4.28	0.01	4.3	18
September	5.4	3.24	0.15	3.1	13
October	3.72	2.23	0.53	1.7	7
November	1.8	1.08	1.13	0.0	0
December	0.93	0.56	1.64	0.0	0
Total Rainfall			**10.90**		
Total Required Irrigation				**2.03 feet**	

Table 16 lists the golf courses and cemeteries considered in this analysis and their net irrigation demand.

Table 16 Golf Course and Cemetery Total Annual Irrigation Demand

Golf Course/Cemetery Irrigation Users	Measured Area (acres)	Net Annual Demand (ac-ft)
Fort Washington Country Club	123	249
Copper River Country Club	325	659
Fig Garden Golf Course	115	233
Islewood Golf Course	27	55
San Joaquin Country Club	157	318
Riverside Golf Course	117	237
Belmont Country Club	106	215
Hanks Par 3 Golf Course	23	47
Sunnyside Country Club	123	249
Airways	88	178
Fresno County Cemetery	188	381
St. Peter's Cemetery	17	35
Fresno Memorial Gardens	37	74
Total	**1,446**	**2,930**

2.2.7 Large Parks

The potential future recycled water irrigation demand for Woodward Park and Roeding Park was calculated using the same process as the golf courses and cemetery customers. The irrigable acreage of Woodward Park was estimated by using Google Earth aerial imagery. Using the developed depth of irrigation shown in Table 15, the total volume of irrigation water can be calculated. Table 17 shows the total annual irrigation demand for both Woodward and Roeding Parks.

Table 17 Large Parks Total Annual Irrigation Demand

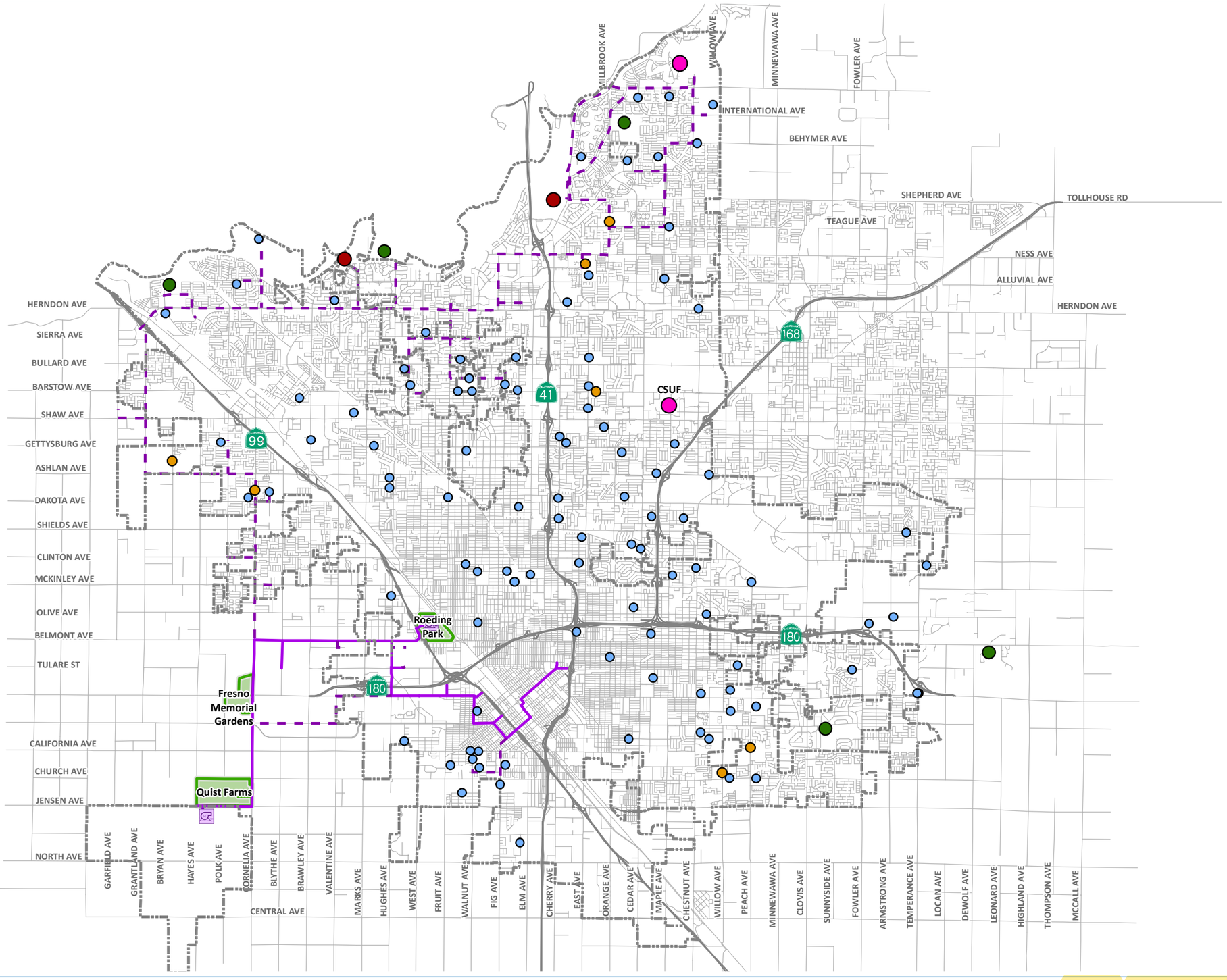
Park	Total Acreage (acres)	Total Annual Demand (ac-ft)
Woodward Park	272	551
Roeding Park	132	268
Total Large Park Annual Irrigation Demand		**819**

2.3 Total Annual Potential Recycled Water Irrigation Demand

Table 18 summarizes the results of the analysis conducted in Section 2.2, including whether the projection was developed using measured consumption data alone, a combination of measured consumption data and ET calculations, or ET calculations alone. Figure 5 shows the locations of potential recycled water irrigation users with demands greater than 15 AFY, or 20 million gallons per year.

Table 18 Total Calculated Potential Recycled Water Irrigation Demand

Account Class or User	Potential Irrigation Demand (ac-ft)	Percent of Projected Annual Irrigation Demand (%)	Basis for Projecting Future Demand
Commercial	4,699	25.1	Measured
Industrial	10	0.1	Measured
Multi-Family Residential	598	3.2	Measured
Single-Family Residential	11	0.1	Measured
Municipal	2,231	11.9	Measured
Educational	3,000	16.0	Measured and Calculated
Fresno State	2,978	15.4	Measured and Calculated
Caltrans	1,552	8.3	Calculated
Golf Courses and Cemeteries	2,932	15.6	Calculated
Large Parks	819	4.4	Calculated
Total	**18,747**	**100.0**	



Legend

Total Annual Demand (AC-ft)

- 15 - 61
- 61 - 153
- 153 - 307
- 307 - 614
- 614 and Greater
- Recycled Water Pump Station
- Recycled Water Pipelines
- Future/Proposed Recycled Water Pipelines

Recycled Water Customer

- Recycled Water Customer
- City Limit
- Highway
- Streets

N

0 1 2 Miles

Data Sources: City of Fresno

Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

Figure 5 **Potential Annual Recycled Water Irrigation Demand Volume**

Section 3

SOUTHWEST RECYCLED WATER SYSTEM ANALYSIS

This section presents the analysis of the Southwest recycled water system. The City requested that this analysis be conducted to support startup and initial operation of the Southwest system, to better understand how user demands impact the system and to determine whether and when booster pumping will be needed to meet peak demand pressures.

3.1 Recycled Water Hydraulic Model

The City's recycled water hydraulic model was developed in InfoWater software. InfoWater is a comprehensive hydraulic and dynamic water quality modeling software application that utilizes the same computational engine as H_2OMap Water. InfoWater uses the Environmental Protection Agency's (EPA) EPANET model simulation engine, which is widely used throughout the world for planning, analysis, and design related to water distribution systems. The InfoWater package can run directly within the ArcGIS environment and therefore offers an enhanced graphical user interface.

The City's hydraulic model combines information on the physical and operational characteristics of the distribution system, and performs calculations to solve a series of mathematical equations to simulate flow in pipes. The primary source for development of the hydraulic model were as-built drawings for existing pipelines and drawings for planned pipeline projects.

The purpose of a water system hydraulic model is to estimate, or predict, how the water distribution system will respond under a given set of conditions. The hydraulic model was used to evaluate the southwest segment of the recycled water system under existing and buildout conditions. The following sections summarize the characteristics and results of the hydraulic model.

3.1.1 Existing Recycled Water System

This section provides an overview of the City's existing recycled water distribution system, storage, and pumping facilities that are included in the model. Figure 6 shows the modeled existing and buildout of the Southwest recycled water system.

3.1.1.1 TTDF

The TTDF is currently producing 5 mgd with the ability for future expansion up to 30 mgd. The RWPS has four pumps with a total capacity of 6,000 gpm (8.64 mgd) and a reservoir with a capacity of 3.2 MG. There is also a booster pumping station at Roeding Park to boost pressure in the Roeding Park irrigation system. Tables 19 and 20 summarize the TTDF facilities.

Table 19 Existing Pump Station Summary

Nomenclature	Pump Number	Power (hp)	Pump Capacity (gpm)	Design Head (ft)
TTDF Pump Station	1	113	2,000	181
	2	113	2,000	181
	3	57	1,000	180
	4	57	1,000	180
Roeding Park Booster	1	25	640	125

Table 20 Existing Reservoir Summary

Name	Volume (MG)	Dimensions (ft)	Height (ft)	High Water Elevation (ft)
TTDF Storage Reservoir	3.2	90x90	16.2	256.6

3.1.1.2 Recycled Water Distribution System

The City's existing recycled water distribution system consists of approximately 8.5 miles of pipeline, ranging in diameter from 10-inches to 54-inches. Figure 3 shows the existing and buildout pipeline alignment with diameters. Table 21 provides a breakdown of the distribution system by diameter, excluding laterals. As shown, approximately 46-percent of the distribution system is comprised of 48-inch diameter pipeline.

Table 21 Existing Recycled Water Pipelines

Diameter (inches)	Length (ft)	Length (miles)	Percent of System
10	3,900	0.7	8.7
24	1,100	0.2	2.5
30	4,800	0.9	10.7
36	13,100	2.5	29.2
48	20,600	3.9	46.0
54	1,300	0.3	2.9
Total	**44,800**	**8.5**	**100**

3.1.2 Existing Recycled Water Users

The City requested that Carollo run a model simulation of the summer of 2018 with five users and a PHD of 5.36 mgd to identify whether any operational issues would occur with the TTDF producing 4 mgd. The study concluded that the current output of 4 mgd is adequate to serve existing users and recommended that additional storage be added as future users come online.

3.1.3 Potential Future Recycled Water Users

Determining the recycled water demand patterns and how the demand is distributed throughout the system is a critical component of the hydraulic modeling process. The City provided the list of potential customers along with their estimated PHD. In addition, future users were added to include surrounding schools, parks, universities, Caltrans and Fresno State. Figure 7 shows the potential future users for the Southwest Recycled Water System.

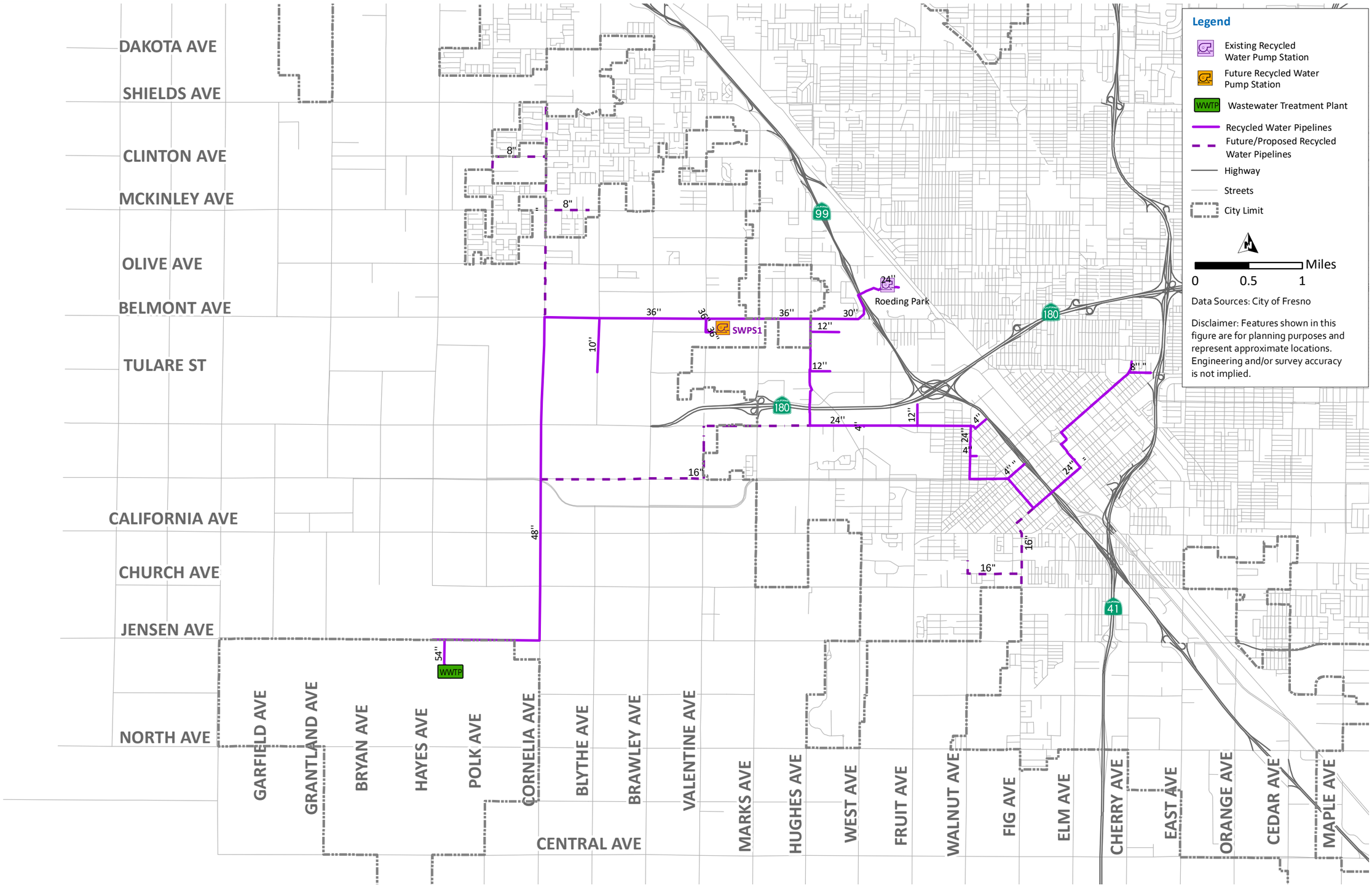


Figure 6 Existing and Proposed Buildout of Southwest Segment

Customer ID	Customer Name
1	Quist Farms
2	Fresno Memorial Gardens
3	Roeding Park
4	Peelman Farms
5	Peelman Farms
6	St Peter's Cemetery
7	Westside Auto
8-10	Multiple Cemeteries
11-12	Caltrans - 99
13-16	Multiple Cemeteries
17	Masis Ararat Cemetery
18	Belmont Memorial Park
19	Caltrans 180/Hughes
20	Caltrans 180/Fruit
21	Fink-White Park
22	Caltrans 99/Amador
23	Columbia Elem
24	Frank Ball Park
25	Kearney Triangle
26	Eaton Plaza
27	Venteran's Memorial
28	City Hall
29	AmeriPride
30	Courthouse Park
31	Community Regional
32	Chukchansi Park
33	Caltrans 41/H
34	McKinley Elem
35	El Capitan Middle
36	Polk Elem
37	Madison Elem
38	King Elem
39	Gaston Middle School
40	Computech
41	Edison High
42	Fresno City College
43	Hinton Park
44	Oasis Residential Development

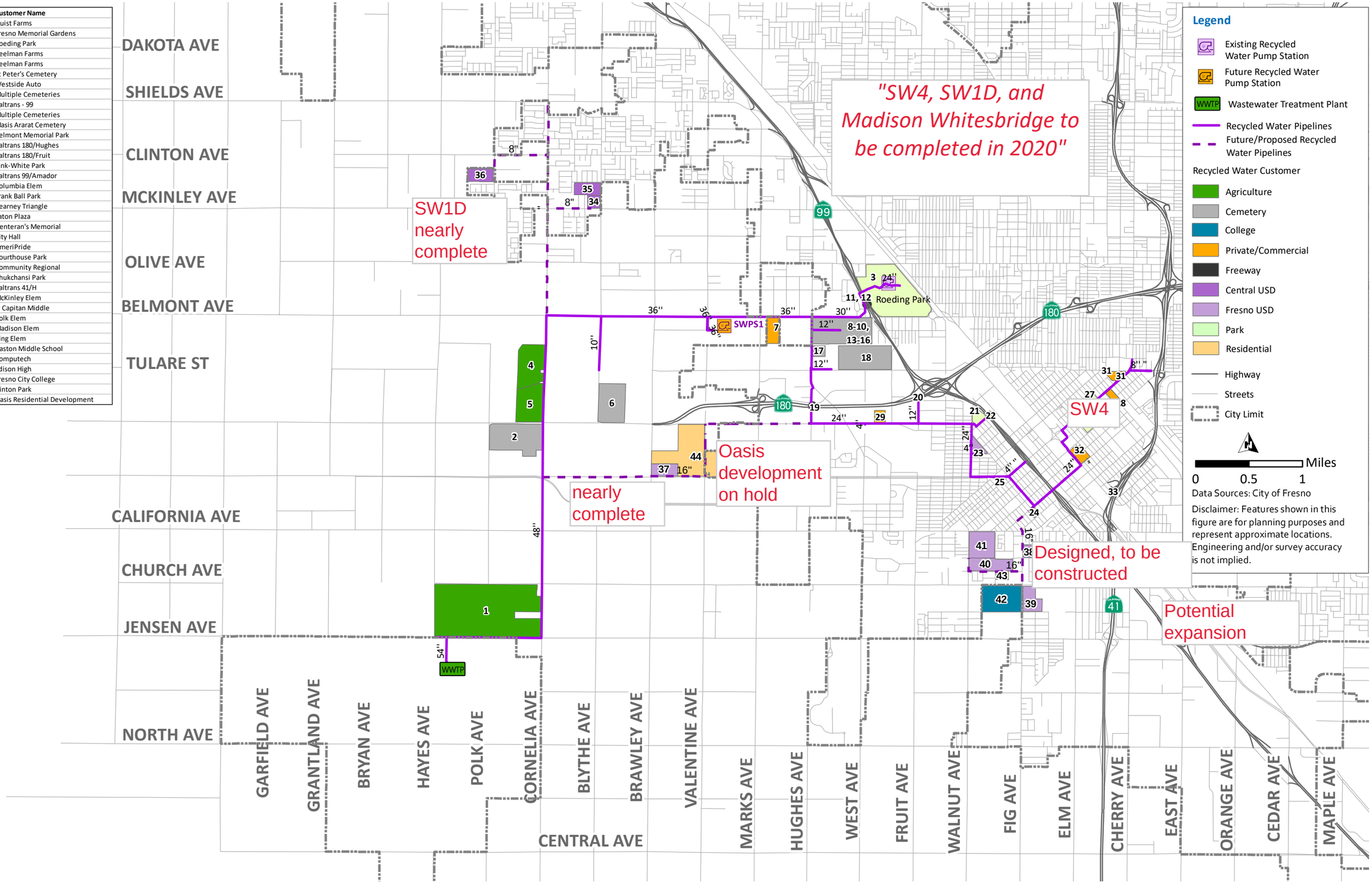


Figure 7 Potential Southwest Recycled Water Users

Table 22 summarizes the demands for the buildout of the Southwest system. Appendix C is a detailed list of users and associated recycled water demands.

Table 22 Existing and Future Recycled Water Customers and Demands

User Classification	MDD		PHD	
	(gpm)	(mgd)	(gpm)	(mgd)
Existing	3,005	4.3	3,720	5.4
Buildout				
Cemetery	1,023	1.5	3,070	4.4
School	1,174	1.7	2,709	4
Caltrans	2,600	3.7	2,600	3.7
Park	283	0.4	850	1.2
Private/Commercial	327	0.5	982	1.4
Residential	210	0.3	631	0.9
Buildout Subtotal	**5,618**	**8.1**	**10,842**	**15.6**
Total	**8,624**	**12.4**	**14,562**	**21.0**

3.1.4 Evaluation Criteria

This section presents the evaluation criteria that was used to analyze the Southwest recycled water system and to size facilities. The criteria includes system pressures, pipelines velocities, storage reservoirs volumes, and pump station capacities. A list of criteria used in the evaluation of the Southwest recycled water system is presented in Table 23.

Table 23 Evaluation Criteria

Description	Value	Units
Pipeline Criteria		
Maximum Pressure	120	psi
Minimum Pressure Under PHD	40	psi
Maximum Velocity with PHD	6	fps
Hazen Williams C-factor	120	n/a
Head loss		
Head loss for existing pipelines	10	ft/kft
Head loss for new pipelines	5	ft/kft
Storage Volume		
Operational	Difference Between PHD and MDD	MG
Pump Station Capacity		
Normal Conditions	Meet PHD with largest unit out of service	gpm
Water Use Peaking Factor		
Average Day Demand (ADD)	1.0	
Maximum Day Demand (MDD)	2.4x ADD	
Peak Hour demand (PHD)	9.3 x ADD	

The American Water Works Association (AWWA) Manual M32 indicates that velocities greater that 6 ft/s are an indication of a pipeline capacity deficiency. In addition, head loss within small diameter pipelines (less than 16-in) should not exceed 5 to 7 feet per 1,000 feet (ft/kft) and head loss in large diameter pipelines (16-in and greater) remain under 2 to 3 ft/kft. Provided that the maximum velocity criteria and the pressure criteria are not exceeded, high head loss by itself is not a controlling factor. However, it may be an indication that the pipe is nearing the limit of its carrying capacity, and may not have sufficient capacity to perform under stringent conditions. Therefore, it is recommended that maximum head loss should not exceed 10 ft/kft in existing pipelines under normal PHD conditions. New pipelines should be sized for a maximum head loss of 5 ft/kft under normal PHD conditions.

3.1.5 Diurnal Patterns

Appendix C shows the irrigation hours for each user. A majority of the users were assumed to have a constant rate of flow with irrigation hours varying from 6 hours to 24 hours. For demands not provided by the City, Beacon® was used to determine their MDD. The diurnal patterns for these users followed real-time irrigation patterns.

3.2 Recycled Water Hydraulic Model Scenarios

Carollo evaluated buildout of the Southwest Recycled Water System to identify future supply, storage, or booster pumping needs as users are added and demands increase. The following sections describe the scenarios.

3.2.1 Scenario 3 – Buildout of Southwest with Booster Pump Station and Storage

This scenario evaluated the addition of a booster pump station and storage tank on Belmont Avenue between Valentine Avenue and Marks Avenue. System pressures would be maintained during peak demand periods, and storage capacity would be added in order to maintain a pumping capacity equal to the MDD at the RWPS.

3.2.2 Scenario 2 – Buildout of Southwest with Booster Pump Station Only

This scenario evaluated the system impacts if storage is located only at the RWRF. The PHD is met by the RWPS, but an increase of pumping capacity and storage is needed at the RWRF. However, the minimum pressure criteria is met throughout the system.

3.2.3 Scenario 1 – Buildout of Southwest with No Booster Pumping or System Storage

In this scenario, PHD is met entirely by the RWPS and no additional booster pumping or storage capacity is added in the system. This would require expansion of the TTDF, the addition of storage at the WWTP, and an increase in pumping capacity to meet the PHD of 21.0 mgd. Based on the hydraulic modeling results, there are a number of areas which fall below the minimum pressure criteria, so buildout of the system isn't feasible without adding booster pumping, storage, and additional TTDF capacity.

3.2.4 Hydraulic Modeling Conclusions

The results of the modeling analysis were discussed at a progress meeting with the City in May 2018. The presentation discussed at the meeting is included in Appendix D, and the results are summarized as follows:

1. The City will need to add recycled water supply capacity to meet the maximum day demand if the recycled water customers currently identified all connect to the Southwest system.
2. Booster pumping will be needed to maintain minimum service pressures during peak demand periods, and customers in the most distant locations in the system may need to add booster pumps on their properties to achieve the pressures needed for their specific irrigation systems.
3. Additional storage capacity will need to be constructed in the system to meet peak hour demands.

Based on the above conclusions, the City would need to construct additional supply, a booster pumping station, and additional storage (Scenario 3 described above) if all customers currently identified connect to the Southwest Recycled Water System.

Section 4

OVERALL OBSERVATIONS AND CONCLUSIONS

4.1 Observations

The following observations were made after completing the potential citywide recycled water irrigation demand analysis and evaluation of the Southwest recycled water system:

1. The 14,000 AFY of potential urban reuse projected in the 2010 RWMP was determined by developing pipeline alignments that prioritized capturing demands greater than 100 AFY, so the projection only included demands along the main alignments and if laterals were extended off of the main alignments to capture larger commercial and residential users. The other demands are distributed across the city and aren't included in the overall projection.
2. The nearly 19,000 AFY of potential recycled water irrigation demand projected in this analysis is distributed citywide and serving those demands with recycled water would require an extensive distribution system, and major expansion of supply, booster pumping, and storage beyond what was projected in the 2010 RWMP.
3. Continuing with the expansion of the RWTM system into the Northwest and Northeast quadrants would allow the City to serve the majority of the large irrigation users, with the exception of Fresno State.
4. The projected demand in the 2010 RWMP for the Southwest recycled water system of approximately 4,000 AFY with an accompanying supply requirement of 5.5 MGD is lower than the 12.1 MGD of supply that was calculated in Section 3 of this report. Much of this difference is attributed to the City serving agricultural users near the RWRF and along the RWTM alignment, and increased demand from Caltrans for recycled water if it is available for irrigation.

4.2 Conclusions

The City began initiating RWMP projects in 2013 by proceeding with the design and construction of the TTDF and RWPS at the RWRF and the Southwest RWTM pipelines in parallel. The City elected to produce recycled water using MBR technology to replace aging treatment trains at the RWRF and to increase the size of the Southwest RWTM pipelines to deliver additional supply from the RWRF. The City is evaluating the feasibility of providing additional recycled water supply from satellite treatment facilities and those evaluations are currently ongoing.

Approximately $95 million has been invested to construct the TTDF and most of the Southwest RWTM system, with an additional $25 million to be invested to complete buildout. If the City decides to continue with expansion of the RWTM system into the Northwest and Northeast Quadrants, the projected additional cost of the pipelines and booster pumping stations is estimated to be approximately $182 million, as shown in Appendix E. However, expansion of the RWTM system will require the City to continue to invest in additional recycled water supplies and potentially storage facilities, depending on the level of service established for recycled water customers. The TTDF and RWPS were designed to produce and pump 5 MGD of recycled water

at a cost of approximately $40 million. The initial project included provisions in the control building, yard piping, and RWPS for future expansion. Adding TTDF capacity to serve the demands identified in the Southwest Quadrant would likely be similar in cost to the initial investment and could cost an additional $40 million to $60 million. Expanding the system into the Northwest and Northeast Quadrants will require full expansion of RWRF tertiary supply and pumping capacity and to expand the North Fresno WRF at a cost that is likely to exceed what is needed for the Southwest. Defining the scope of those projects requires identification of potential users and the corresponding supply needs, and that work has not progressed to the same level as in the Southwest. Consequently, the level of investment needed for expansion into the Northwest and Northeast quadrants would be difficult to estimate at this time.

The City has stated that an appropriate next step would be to postpone the design of the Northwest and Northeast recycled water systems and focus on developing a Water Reuse Plan that will serve to update the 2010 RWMP and broaden the consideration of how recycled water fits into Fresno's water resources portfolio. This approach is supported by the following:

1. State regulations governing the use of recycled water have changed to include indirect potable reuse and pending regulations for direct potable reuse will allow for a wider variety of beneficial uses. These two opportunities were not available to the City in the development of the 2010 RWMP.
2. Under the requirements of the Sustainable Groundwater Management Act (SGMA), a groundwater sustainability plan (GSP) is being developed for the North Kings Groundwater Sustainability Agency (GSA) that includes policies or provisions that recognize the importance of recycled water as an element in the City's water resources portfolio.
3. Implementation of the residential water meter program, the most recent drought, and additional water conservation measures have changed water usage patterns and decreased water demands overall, which may influence the public's perception of the necessity of expanding the use of recycled water for irrigation.
4. Despite the City's expansion of the use of surface water as a potable water supply source, Northwest Fresno continues to rely solely on groundwater as the source of supply. Recycled water could augment the water supply in an area of the city without easy access to surface water, depending on what is or will be allowable in the current and future regulations.
5. The analysis of the Southwest system concluded that additional recycled water supply, booster pumping, and storage will be needed to serve the irrigation users that have been identified by the City, but additional definition of the level of service is needed, which will drive the approach used to size and operate the supply, booster pumping, and storage, and ultimately the investment the City will need to make to serve the users.
6. The City's discharge permit considers extracted percolated effluent to be groundwater. The City needs to determine the investment needed to fully utilize this supply as compared to expanding tertiary treatment capacity to identify what the best investment is to expand the recycled water supply.

In conclusion, and based upon the issues outlined above, the ideal path forward would be for the City to proceed with the development of a Water Reuse Plan that evaluates alternatives and recommends the best investment for how the City utilizes recycled water in its water resources portfolio.

Appendix A

EDUCATIONAL ACCOUNT CLASS POTENTIAL IRRIGATION DEMAND CALCULATION DATA

Table A-1 Educational Account Class Consumption

Month	2017 Metered Consumption (ac-ft)			2018 Metered Consumption (ac-ft)			Percent Change 2017 to 1018 (%)		
	Water	Irrigation	Total	Water	Irrigation	Total	Water	Irrigation	Total
Agape Corporation	0.9	3.8	4.7	0.3	5.7	6.0	-62.8	50.1	29.3
Anderson, Nelson J	0.1		0.1	0.1		0.1	-7.4		-7.4
CUSD - Boris Elementary	1.6	38.1	39.8	1.6	36.7	38.3	1.2	-3.8	-3.6
CUSD - Clovis West High School	124.1		124.1	118.0		118.0	-4.9		-4.9
CUSD - Copper Hills Elementary	25.5		25.5	32.5		32.5	27.3		27.3
CUSD - Ft Washington Elementary	1.1		1.1	1.3		1.3	20.7		20.7
CUSD - Kastner Intermediate	90.8		90.8	103.1		103.1	13.6		13.6
CUSD - Lincoln Elementary	32.0		32.0	37.8		37.8	18.0		18.0
CUSD - Mt View Elem	34.8		34.8	38.5		38.5	10.6		10.6
CUSD - Temperance-Kutner	1.9	27.0	28.9	1.6	28.7	30.3	-16.9	6.2	4.7
CUSD - Valley Oak Elem	25.3		25.3	24.2		24.2	-4.3		-4.3
CUSD #15000164	86.0	161.7	247.8	115.4	197.0	312.5	34.2	21.8	26.1
California State University, Fresno	0.0		0.0	0.0		0.0			
Central Unified School	4.8	23.3	28.1	3.2	21.9	25.1	-33.3	-5.9	-10.6
Central Unified School District	51.0	264.8	315.7	62.2	447.3	509.5	22.0	68.9	61.4
City of Fresno FAT	0.0		0.0	0.0		0.0			
Creative Alternatives	3.9	10.3	14.2	2.2	4.9	7.2	-42.8	-52.4	-49.8
Diocese of Fresno Education Corp	8.7		8.7	9.9		9.9	14.1		14.1
Ebenezer Church Of God	0.0		0.0	0.0		0.0			
Ellis Family Partnership III	4.3		4.3	3.4		3.4	-19.8		-19.8
FUSD	57.1	76.6	133.7	36.1	117.0	153.1	-36.7	52.7	14.5
FUSD/Addicott School	0.3	6.6	6.8	0.3	5.4	5.7	18.3	-18.3	-16.8
FUSD/Ahwahnee Jr High	10.9	21.6	32.5	15.4	25.2	40.6	41.3	16.7	24.9

Table A-1 Educational Account Class Consumption (continued)

Month	2017 Metered Consumption (ac-ft)			2018 Metered Consumption (ac-ft)			Percent Change 2017 to 1018 (%)		
	Water	Irrigation	Total	Water	Irrigation	Total	Water	Irrigation	Total
FUSD/Alice Birney School	4.9	20.3	25.2	3.2	14.2	17.4	-34.7	-30.0	-31.0
FUSD/Ann Leavenworth Elementary	1.2	28.4	29.6	3.2	19.9	23.1	166.7	-29.9	-21.9
FUSD/Ayer Elementary	12.8		12.8	1.3	15.0	16.3	-89.8	New	27.7
FUSD/Aynesworth Elementary	13.6		13.6	22.3		22.3	63.9		63.9
FUSD/Baird Elem #60222	6.2	17.3	23.5	6.7	20.3	27.0	8.1	17.3	14.9
FUSD/Balderas Elementary	1.7		1.7	1.7	20.6	22.3	-0.2	New	1,189.1
FUSD/Bethune School	13.8		13.8	15.2		15.2	9.9		9.9
FUSD/Bullard High	67.4	16.1	83.5	69.7	23.1	92.8	3.4	43.5	11.1
FUSD/Bullard Talent Elementary		14.3	14.3	0.9	11.7	12.6		-18.2	-11.8
FUSD/Calwa Elementary				17.0		17.0			
FUSD/Centennial Elementary	23.9		23.9	28.6		28.6	19.7		19.7
FUSD/Columbia School	41.1		41.1	0.9		0.9	-97.8		-97.8
FUSD/Computech	8.4	26.7	35.1	10.0	32.3	42.3	19.1	20.8	20.4
FUSD/Cooper Middle School	3.5	37.9	41.4	3.3	5.7	9.0	-5.7	-85.0	-78.3
FUSD/Dailey Elementary	1.5	9.2	10.7	1.6	7.3	8.9	6.7	-20.8	-17.0
FUSD/Dailey/Heckman Elementary	4.9		4.9	9.7		9.7	97.3		97.3
FUSD/De Wolf Continuation	0.7	7.2	7.9	0.9	6.8	7.7	34.8	-4.9	-1.6
FUSD/Del Mar School	3.4	0.0	3.4	3.2	16.3	19.5	-4.8	New	480.4
FUSD/Dorothy Starr Elementary	17.0		17.0	17.4		17.4	2.0		2.0
FUSD/Eaton Elem School	0.9	12.8	13.7	1.0	19.7	20.7	10.1	54.4	51.5

Table A-1 Educational Account Class Consumption (continued)

Month	2017 Metered Consumption (ac-ft)			2018 Metered Consumption (ac-ft)			Percent Change 2017 to 1018 (%)		
	Water	Irrigation	Total	Water	Irrigation	Total	Water	Irrigation	Total
FUSD/Edison High School	63.6	29.6	93.2	39.2	35.4	74.6	-38.4	19.5	-20.0
FUSD/Edith B Storey Elementary	2.8	31.1	33.9	2.8	31.0	33.8	0.0	-0.4	-0.4
FUSD/Ericson Elementary	15.7		15.7	15.7		15.7	0.0		0.0
FUSD/Ernie Pyle School	4.6	14.8	19.4	4.1	14.2	18.3	-10.9	-4.1	-5.7
FUSD/Ewing School	24.3		24.3	23.2		23.2	-4.5		-4.5
FUSD/Figarden Elementary	2.1	15.1	17.3	1.8	3.0	4.8	-18.3	-80.2	-72.5
FUSD/Forkner School	15.5		15.5	1.7	21.5	23.2	-89.1	New	49.7
FUSD/Fort Miller Jr High	33.1		33.1	36.9		36.9	11.5		11.5
FUSD/Frank W Thomas School	24.3		24.3	28.0		28.0	15.4		15.4
FUSD/Fremont School	1.8	3.9	5.7	2.6	2.5	5.2	42.2	-34.0	-9.4
FUSD/Fresno High School	31.1	47.4	78.5	31.8	61.4	93.2	2.2	29.6	18.7
FUSD/Gibson Elementary	39.0		39.0	36.9		36.9	-5.3		-5.3
FUSD/Greenberg Elementary	3.1	20.4	23.5	2.2	21.0	23.2	-26.7	2.9	-0.9
FUSD/Hamilton Elementary	35.8		35.8	40.0		40.0	11.7		11.7
FUSD/Heaton	11.0		11.0	13.4		13.4	21.6		21.6
FUSD/Holland School	7.2	20.4	27.6	8.8	23.1	31.9	22.2	13.2	15.6
FUSD/Homan School	3.8	14.9	18.7	3.4	16.1	19.5	-10.5	8.0	4.3
FUSD/Hoover High School	16.1	103.5	119.6	18.0	92.7	110.7	11.6	-10.4	-7.5
FUSD/I M C	0.4		0.4	0.9		0.9	102.3		102.3
FUSD/J E Young	0.5		0.5	0.4		0.4	-8.6		-8.6

Table A-1 Educational Account Class Consumption (continued)

Month	2017 Metered Consumption (ac-ft)			2018 Metered Consumption (ac-ft)			Percent Change 2017 to 1018 (%)		
	Water	Irrigation	Total	Water	Irrigation	Total	Water	Irrigation	Total
FUSD/Jackson School	7.5	6.4	13.9	1.0	9.4	10.4	-86.2	47.4	-25.0
FUSD/Jane Adams School	1.7	12.5	14.2	0.2	12.7	12.9	-86.9	1.4	-9.5
FUSD/Jefferson School	15.2		15.2	14.1		14.1	-7.2		-7.2
FUSD/John Burroughs School	13.1		13.1	14.5		14.5	10.7		10.7
FUSD/John Muir Elementary	18.6		18.6	2.9		2.9	-84.3		-84.3
FUSD/King Eng Center	16.1		16.1	9.9	6.1	16.0	-38.5	New	-0.6
FUSD/Kings Canyon Jr High	4.3		4.3	8.2	13.3	21.5	89.8	New	396.8
FUSD/Kirk School	12.6		12.6	10.9		10.9	-13.5		-13.5
FUSD/Lane School				5.1		5.1			
FUSD/Lawless Elementary	17.8		17.8	2.3	18.7	21.1	-86.9	New	18.4
FUSD/Lincoln School	11.1		11.1	2.2	5.4	7.6	-80.2	New	-31.3
FUSD/Lowell Elem	14.3		14.3	14.9		14.9	4.2		4.2
FUSD/Malloch	19.8		19.8	21.2		21.2	7.4		7.4
FUSD/Manchester School		24.7	24.7	3.4	16.2	19.6	New	-34.4	-20.6
FUSD/Mayfair Elementary	3.6	10.0	13.6	5.7	9.7	15.4	58.3	-3.1	13.2
FUSD/Mc Cardle School				0.7	12.8	13.5		New	
FUSD/Mc Lane High School	82.2		82.2	61.6		61.6	-25.0		-25.0
FUSD/Miguel Hidalgo Elementary	3.4	19.5	22.9	2.4	28.2	30.6	-30.5	44.6	33.5
FUSD/Norseman School	26.7		26.7	11.6	21.0	32.6	-56.5	New	22.2

Table A-1 Educational Account Class Consumption (continued)

Month	2017 Metered Consumption (ac-ft)			2018 Metered Consumption (ac-ft)			Percent Change 2017 to 1018 (%)		
	Water	Irrigation	Total	Water	Irrigation	Total	Water	Irrigation	Total
FUSD/Powers Elementary	15.3		15.3	14.8		14.8	-3.4		-3.4
FUSD/Robinson School	1.6	8.8	10.4	1.7	10.8	12.5	7.1	23.0	20.6
FUSD/Roeding School	5.0	14.2	19.2	5.1	19.6	24.7	2.0	38.0	28.6
FUSD/Roosevelt High School	15.7	49.0	64.7	32.5	40.9	73.3	106.3	-16.5	13.4
FUSD/Rowell Elementary	1.8	13.8	15.6	1.8	17.2	19.0	0.6	24.6	21.8
FUSD/Scandinavian	4.2	42.7	46.9	3.9	41.0	44.9	-7.0	-4.0	-4.2
FUSD/Sequoia Middle School		24.6	24.6	4.9	25.0	29.8		1.4	21.2
FUSD/Sierra Junior High	4.1	32.6	36.8	6.9	19.6	26.5	67.5	-39.9	-27.9
FUSD/Slater School	21.8		21.8	6.1	3.7	9.8	-71.8	New	-54.8
FUSD/Sunnyside High School	31.9		31.9	28.0	9.3	37.3	-12.2	New	17.1
FUSD/Sunset Elem	15.5		15.5	16.2		16.2	4.7		4.7
FUSD/Susan B Anthony Elem	0.7	11.7	12.4	1.9	22.2	24.1	158.9	89.8	93.8
FUSD/Tehipite Jr High	52.9		52.9	54.1		54.1	2.2		2.2
FUSD/Tenaya School	42.6		42.6	28.8	16.8	45.6	-32.4	New	7.0
FUSD/Tioga School	6.2	33.5	39.7	5.9	37.5	43.4	-4.8	11.9	9.3
FUSD/Viking School	9.8		9.8	39.1		39.1	299.0		299.0
FUSD/Vinland School	23.5		23.5	23.5		23.5	0.0		0.0
FUSD/Warehouse Complex	19.8	4.2	24.0	18.3	4.8	23.1	-7.6	12.8	-4.0
FUSD/Wawona Jr High	48.2		48.2	53.4		53.4	10.8		10.8

Table A-1 Educational Account Class Consumption (continued)

Month	2017 Metered Consumption (ac-ft)			2018 Metered Consumption (ac-ft)			Percent Change 2017 to 1018 (%)		
	Water	Irrigation	Total	Water	Irrigation	Total	Water	Irrigation	Total
FUSD/Webster Elem	9.9		9.9	12.6		12.6	27.3		27.3
FUSD/Winchell School #60219	0.2	12.8	13.1	2.0	15.3	17.2	716.3	19.1	31.8
FUSD/Wishon School	7.6	11.2	18.8	7.3	17.6	24.9	-3.9	57.1	32.4
FUSD/Wolters School	22.2		22.2	26.2		26.2	18.0		18.0
FUSD/Woodrow Wilson School	19.7		19.7	6.8	14.0	20.8	-65.5	New	5.5
FUSD/Year Round Achievement	0.6	35.9	36.4	0.7	26.0	26.7	30.0	-27.5	-26.6
FUSD/Yosemite Junior High	32.8		32.8	6.5		6.5	-80.2		-80.2
Fresno Christian Schools Inc.	1.9		1.9	1.4		1.4	-29.1		-29.1
Fresno City College Library	30.7		30.7	27.4		27.4	-10.7		-10.7
Fresno Co Education	0.3	14.3	14.6	0.5	16.1	16.6	64.0	12.9	14.0
Fresno County Dept. of Education	12.4		12.4	10.6		10.6	-14.5		-14.5
Fresno County EOC	18.6		18.6	14.6		14.6	-21.5		-21.5
Fresno County EOC Youth Shelter	1.9		1.9	1.4		1.4	-25.0		-25.0
Fresno Pacific University	54.7	44.4	99.0	59.9	45.1	105.0	9.6	1.5	6.0
Huffey, Lester & Sally	0.2	1.1	1.3	0.3	0.4	0.7	11.9	-60.7	-47.7
Our Lady of Victory School	10.5		10.5	10.1		10.1	-3.3		-3.3
San Joaquin Memorial High	13.0		13.0	24.8		24.8	91.0		91.0
Sanger Unified School District	6.2		6.2	34.5		34.5	453.1		453.1
St Anthony School	13.8		13.8	5.1		5.1	-62.8		-62.8
St Therese School		5.9	5.9		3.3	3.3		-43.7	-43.7
SCCC District	143.8	44.6	188.3	164.7	47.3	212.0	14.6	6.2	12.6
West Fresno School District	17.3	30.8	48.0	18.5	33.5	52.0	7.1	9.0	8.3
Grand Total	**2,134.5**	**1,634.1**	**3,768.6**	**2,112.4**	**2,065.0**	**4,177.5**	**-1.0**	**26.4**	**10.8**

Table A-2 Educational Account Class Potential Future Recycled Water Irrigation Demand Calculation

Account	Consumption (ac-ft)			Irrigation Percentage of Total Demand (%)	Calculation Method
	Water	Irrigation	Total		
St Therese School		3.3	3.3	100.0	Measured
FUSD/Jane Adams School	0.2	12.7	12.9	98.2	Measured
FUSD/Year Round Achievement	0.7	26.0	26.7	97.3	Measured
Fresno County Education	0.5	16.1	16.6	96.8	Measured
CUSD - Boris Elementary	1.6	36.7	38.3	95.7	Measured
FUSD/Eaton Elementary School	1.0	19.7	20.7	95.3	Measured
CUSD - Temperance-Kutner	1.6	28.7	30.3	94.8	Measured
FUSD/Mc Cardle School	0.7	12.8	13.5	94.7	Measured
Agape Corporation	0.3	5.7	6.0	94.7	Measured
FUSD/Addicott School	0.3	5.4	5.7	94.2	Measured
FUSD/Bullard Talent Elementary	0.9	11.7	12.6	92.8	Measured
FUSD/Forkner School	1.7	21.5	23.2	92.7	Measured
FUSD/Miguel Hidalgo Elementary	2.4	28.2	30.6	92.3	Measured
FUSD/Balderas Elementary	1.7	20.6	22.3	92.3	Measured
FUSD/Susan B Anthony Elementary	1.9	22.2	24.1	92.1	Measured
FUSD/Ayer Elementary	1.3	15.0	16.3	92.0	Measured
FUSD/Edith B Storey Elementary	2.8	31.0	33.8	91.8	Measured
FUSD/Scandinavian	3.9	41.0	44.9	91.4	Measured
FUSD/Rowell Elementary	1.8	17.2	19.0	90.4	Measured
FUSD/Greenberg Elementary	2.2	21.0	23.2	90.4	Measured
FUSD/Jackson School	1.0	9.4	10.4	90.0	Measured

Table A-2 Educational Account Class Potential Future Recycled Water Irrigation Demand Calculation (continued)

Account	Consumption (ac-ft)			Irrigation Percentage of Total Demand (%)	Calculation Method
	Water	Irrigation	Total		
FUSD/Lawless Elementary	2.3	18.7	21.1	88.9	Measured
FUSD/Winchell School #60219	2.0	15.3	17.2	88.7	Measured
FUSD/De Wolf Continuation	0.9	6.8	7.7	88.5	Measured
Central Unified School District	62.2	447.3	509.5	87.8	Measured
Central Unified School	3.2	21.9	25.1	87.2	Measured
FUSD/Robinson School	1.7	10.8	12.5	86.7	Measured
FUSD/Tioga School	5.9	37.5	43.4	86.4	Measured
FUSD/Ann Leavenworth Elementary	3.2	19.9	23.1	86.1	Measured
FUSD/Hoover High School	18.0	92.7	110.7	83.7	Measured
FUSD/Sequoia Middle School	4.9	25.0	29.8	83.6	Measured
FUSD/Del Mar School	3.2	16.3	19.5	83.6	Measured
FUSD/Manchester School	3.4	16.2	19.6	82.6	Measured
FUSD/Homan School	3.4	16.1	19.5	82.6	Measured
FUSD/Dailey Elementary	1.6	7.3	8.9	81.9	Measured
FUSD/Alice Birney School	3.2	14.2	17.4	81.6	Measured
FUSD/Roeding School	5.1	19.6	24.7	79.4	Measured
FUSD/Ernie Pyle School	4.1	14.2	18.3	77.6	Measured
FUSD	36.1	117.0	153.1	76.4	Measured
FUSD/Computech	10.0	32.3	42.3	76.3	Measured
FUSD/Baird Elem #60222	6.7	20.3	27.0	75.2	Measured

Table A-2 Educational Account Class Potential Future Recycled Water Irrigation Demand Calculation (continued)

Account	Consumption (ac-ft)			Irrigation Percentage of Total Demand (%)	Calculation Method
	Water	Irrigation	Total		
FUSD/Sierra Junior High	6.9	19.6	26.5	74.0	Measured
FUSD/Holland School	8.8	23.1	31.9	72.4	Measured
FUSD/Lincoln School	2.2	5.4	7.6	71.2	Measured
FUSD/Wishon School	7.3	17.6	24.9	70.7	Measured
Creative Alternatives	2.2	4.9	7.2	68.7	Measured
FUSD/Woodrow Wilson School	6.8	14.0	20.8	67.2	Measured
FUSD/Fresno High School	31.8	61.4	93.2	65.9	Measured
West Fresno School District	18.5	33.5	52.0	64.4	Measured
FUSD/Norseman School	11.6	21.0	32.6	64.4	Measured
FUSD/Cooper Middle School	3.3	5.7	9.0	63.3	Measured
FUSD/Figarden Elementary	1.8	3.0	4.8	63.1	Measured
CUSD #15000164	115.4	197.0	312.5	63.1	Measured
FUSD/Mayfair Elementary	5.7	9.7	15.4	63.0	Measured
FUSD/Ahwahnee Jr High	15.4	25.2	40.6	62.1	Measured
FUSD/Kings Canyon Jr High	8.2	13.3	21.5	61.8	Measured
Huffey, Lester & Sally	0.3	0.4	0.7	61.6	Measured
FUSD/Roosevelt High School	32.5	40.9	73.3	55.7	Measured
FUSD/Fremont School	2.6	2.5	5.2	49.3	Measured
FUSD/Edison High School	39.2	35.4	74.6	47.5	Measured

Table A-2 Educational Account Class Potential Future Recycled Water Irrigation Demand Calculation (continued)

Account	Consumption (ac-ft)			Irrigation Percentage of Total Demand (%)	Calculation Method
	Water	Irrigation	Total		
Fresno Pacific University	59.9	45.1	105.0	42.9	Measured
FUSD/King Eng Center	9.9	6.1	16.0	38.1	Measured
FUSD/Slater School	6.1	3.7	9.8	37.6	Measured
FUSD/Tenaya School	28.8	16.8	45.6	36.8	Measured
FUSD/Sunnyside High School	28.0	9.3	37.3	25.0	Measured
FUSD/Bullard High	69.7	23.1	92.8	24.9	Measured
SCCC District	164.7	47.3	212.0	22.3	Measured
FUSD/Warehouse Complex	18.3	4.8	23.1	20.7	Measured
Anderson, Nelson J	0.0	0.1	0.1	80.0	Calculated
CUSD - Clovis West High School	23.6	94.4	118.0	80.0	Calculated
CUSD - Copper Hills Elementary	6.5	26.0	32.5	80.0	Calculated
CUSD - Ft Washington Elementary	0.3	1.1	1.3	80.0	Calculated
CUSD - Kastner Intermediate	20.6	82.5	103.1	80.0	Calculated
CUSD - Lincoln Elementary	7.6	30.2	37.8	80.0	Calculated
CUSD - Mt View Elementary	7.7	30.8	38.5	80.0	Calculated
CUSD - Valley Oak Elementary	4.8	19.4	24.2	80.0	Calculated
Cal State Univ Fresno	0.0	0.0	0.0	80.0	Calculated
City of Fresno FAT	0.0	0.0	0.0	80.0	Calculated
Diocese of Fresno Education Corp	2.0	7.9	9.9	80.0	Calculated

Table A-2 Educational Account Class Potential Future Recycled Water Irrigation Demand Calculation (continued)

Account	Consumption (ac-ft)			Irrigation Percentage of Total Demand (%)	Calculation Method
	Water	Irrigation	Total		
Ebenezer Church of God	0.0	0.0	0.0	80.0	Calculated
Ellis Family Partnership III	0.7	2.8	3.4	80.0	Calculated
FUSD/Aynesworth Elementary	4.5	17.8	22.3	80.0	Calculated
FUSD/Bethune School	3.0	12.1	15.2	80.0	Calculated
FUSD/Calwa Elementary	3.4	13.6	17.0	80.0	Calculated
FUSD/Centennial Elementary	5.7	22.9	28.6	80.0	Calculated
FUSD/Columbia School	0.2	0.7	0.9	80.0	Calculated
FUSD/Dailey/Heckman Elementary	1.9	7.8	9.7	80.0	Calculated
FUSD/Dorothy Starr Elementary	3.5	13.9	17.4	80.0	Calculated
FUSD/Ericson Elementary	3.1	12.6	15.7	80.0	Calculated
FUSD/Ewing School	4.6	18.6	23.2	80.0	Calculated
FUSD/Fort Miller Jr High	7.4	29.5	36.9	80.0	Calculated
FUSD/Frank W Thomas School	5.6	22.4	28.0	80.0	Calculated
FUSD/Gibson Elementary	7.4	29.5	36.9	80.0	Calculated
FUSD/Hamilton Elementary	8.0	32.0	40.0	80.0	Calculated
FUSD/Heaton	2.7	10.7	13.4	80.0	Calculated
FUSD/I M C	0.2	0.7	0.9	80.0	Calculated
FUSD/J E Young	0.1	0.3	0.4	80.0	Calculated
FUSD/Jefferson School	2.8	11.3	14.1	80.0	Calculated
FUSD/John Burroughs School	2.9	11.6	14.5	80.0	Calculated
FUSD/John Muir Elementary	0.6	2.3	2.9	80.0	Calculated

Table A-2 Educational Account Class Potential Future Recycled Water Irrigation Demand Calculation (continued)

Account	Consumption (ac-ft)			Irrigation Percentage of Total Demand (%)	Calculation Method
	Water	Irrigation	Total		
FUSD/Kirk School	2.2	8.7	10.9	80.0	Calculated
FUSD/Lane School	1.0	4.1	5.1	80.0	Calculated
FUSD/Lowell Elementary	3.0	11.9	14.9	80.0	Calculated
FUSD/Malloch	4.2	17.0	21.2	80.0	Calculated
FUSD/Mc Lane High School	12.3	49.3	61.6	80.0	Calculated
FUSD/Powers Elementary	3.0	11.8	14.8	80.0	Calculated
FUSD/Sunset Elementary	3.2	13.0	16.2	80.0	Calculated
FUSD/Tehipite Jr High	10.8	43.3	54.1	80.0	Calculated
FUSD/Viking School	7.8	31.3	39.1	80.0	Calculated
FUSD/Vinland School	4.7	18.8	23.5	80.0	Calculated
FUSD/Wawona Jr High	10.7	42.7	53.4	80.0	Calculated
FUSD/Webster Elementary	2.5	10.1	12.6	80.0	Calculated
FUSD/Wolters School	5.2	21.0	26.2	80.0	Calculated
FUSD/Yosemite Junior High	1.3	5.2	6.5	80.0	Calculated
Fresno Christian Schools Inc	0.3	1.1	1.4	80.0	Calculated
Fresno City College Library	5.5	21.9	27.4	80.0	Calculated
Fresno County Dept of Education	2.1	8.5	10.6	80.0	Calculated
Fresno County EOC	2.9	11.7	14.6	80.0	Calculated
Fresno County EOC Youth Shelter	0.3	1.1	1.4	80.0	Calculated
Our Lady of Victory School	2.0	8.1	10.1	80.0	Calculated
San Joaquin Memorial High	5.0	19.9	24.8	80.0	Calculated
Sanger Unified School District	6.9	27.6	34.5	80.0	Calculated
St Anthony School	1.0	4.1	5.1	80.0	Calculated
Grand Total	**1,155.1**	**3,022.4**	**4,177.5**		

Appendix B

CALTRANS POTENTIAL RECYCLED WATER IRRIGATION DEMAND

CALTRANS RECYCLE WATER USE PROJECTION 8-07-18										Carollo Calculation		
		Run 4 to 5 Pumps Maximum Simutaneosly, 24hrs at 2X Per Week				Approx Peak Demand/POC/Day	Peak Max GPM Rate	Exist Potable Meter		Connection Pt	Max Irrigation Rate	Irrigation Days Needed for POC
						Max 50gpm/valve	Any DAY During	Servicing IC &				
			Pump/IC	Total IC's GPM	Stations Used	24hrs (1440 min)	24 hr period	Pump				
POC #1 Future POC Location Unknow	180	EB 180 CLOVIS OFFRAMP (Bakman)	851(835)	645	17	54,635	200 GPM	70176524-Bakman		Not included		
	180	WB 180 CLOVIS ONRAMP (Bakman)	852 (836)	760	22	49,745		70176519-Bakman				
	180	EB 180 CLOVIS ONRAMP (Bakman)	853(837)	587	15	56,352		70271399-Bakman				
	180	WB 180 CLOVIS OFFRAMP (Bakman)	854(838)	840	25	48,384		70271400-Bakman				
		Approx POC Peak Demand Per Day				209,117						
POC #2 Future POC Location Unknown	180	EB 180 FOWLER OFFRAMP	855(839)	1254	31	58,250	250 GPM	12504923		1	250	1
	180	WB 180 FOWLER/OFFRAMP	856(840)	1335	28	68,657		12517043				
	180	EB 180 FOWLER ONRAMP	857(841)	693	21	47,520		12504925				
	180	EB 180 FOWLER EB LOOP ONRAMP	858(842)	1328	31	61,688		12504926				
	180	EB `180 AT ARMSTRONG	859(843)	236	12	28,320						
		Approx POC Peak Demand Per Day				264,435						
POC #3 Future POC Location Unknown	180	EB 180 TEMPERANCE OFFRAMP	860(Purpule)	44	4	15,840	250 GPM			2	250	1
	180	TEMPERANCE AVENUE SOUTH	861(845)	1666	40	59,976		12504928				
	180	TEMPERANCE AVENUE SOUTH(NW 180)	862(844)	1855	33	80,945						
	180	TEMPERANCE AVENUE NORTHBD	863(847)	1130	27	60,267		14139142				
	180	TEMPERANCE AVENUE NORTHBD(NE180)	864(846)	1774	39	65,502		12504929				
		Approx POC Peak Demand Per Day				282,530						
*Option: Combine 3 POC's Into 1 POC/1 Meter. Peak max GPM Rate remains as noted. Each block of 4 (or 5) pumps would run two days per week. Day 7 option for catchup of down systems.												
POC-A Proposed Divisadero/41	41	SB 41 EAST HUNTINGTON AVE (SOUTH)	436	354	8	63,720	400 GPM	12504291		3	200	2
	41	SB 41 EAST HUNTINGTON AVE (SOUTH)	437	590	17	49,976						
	41	NB 41 EAST HUNTINGTON AVE (NORTH)	438	621	17	52,602		15005563				
	41	NB 41 EAST HUNTINGTON AVE (NORTH)	439	718	22	46,996						
	41	SB 41 @ Belmont	441	1015	23	63,548		13596056				
	41	NB 41 @ Belmont	440	994	23	62,233		13650772				
	180	180/41 EB Offramp	828(814)	660	17	55,906		13596030				
	180	180/41 EB Offramp	829	449	16	40,410						
		Approx POC Peak Demand Per Day				435,392						
POC-B Proposed Divisadero/41	180	41/180 EB Onramp	830	390	17	33,035	200 GPM	12416444		4	200	1
	180	WB 180/N 1ST ST.	831-832	836	22	54,720		12504990				
	180	WB 180/N 1ST ST. (819)-(06-43180)	834	650	18	52,000		14092167				
	180	EB 180/N. FISHER ST.	833	636	24	38,160		12504282				
		Approx POC Peak Demand Per Day				177,915						
LOCATION OF RECYCLED WATER POC CURRENTLY UNKNOWN (PRELIMINARY PUMP GROUPING)	180	WB 180/11TH ST.	835	630	17	53,365	300 GPM	13596046		5	200	1
	180	WB 180/E. CLAY/N. ROWELL AVE.	837	808	15	77,568		13596041				
	180	WB 180/168 NB ON/E. TYLER AVE.	840	324	28	16,663		12517023				
	180	WB 180/168 NB OFF/E. TYLER AVE.	843	350	12	42,000		12504979				
	168	SB 168/ OLIVE AVE.	838	323	25	18,605		13596034				
	180	WB 180 Chestnut WB Offramp	844(829)	410	11	53,673		12229894				
		Approx POC Peak Demand Per Day				261,873						

		Run 4 to 5 Pumps Maximum Simutaneosly, 24hrs at 2X Per Week				Approx Peak Demand/POC/Day	Peak Max GPM Rate	Exist Potable Meter				
						Max 50gpm/valve	Any DAY During	Servicing IC &				
			Pump/IC	Total IC's GPM	Stations Used	24hrs (1440 min)	24 hr period	Pump				
LOCATION OF RECYCLED WATER POC CURRENTLY UNKNOWN (PRELIM. PUMP GROUPING)	180	EB 180/E. HARVEY/N. CEDAR	836	522	22	34,167	200 GPM	12504938		6	200	1
	180	EB 180 CEDAR ONRAMP/E. HARVEY	839	757	31	35,164		13650874				
	180	EB 180 E. HARVEY/N. MAPLE	841	398	21	27,291		12504985				
	180	EB 180 E. HARVEY/N. SIERRA VISTA AVE	842	267	31	12,403		12517044				
		Approx POC Peak Demand Per Day				109,025						
LOCATION OF RECYCLED WATER POC CURRENTLY UNKNOWN (PRELIMINARY PUMP GROUPING)	180	EB 180 HARVEY-WINERY	845(828)	470	15	45,120	300 GPM	70177536 Bakman		Not included		
	180	WB 180 E HARVEY-WINERY	846(830)	178	5	51,264		70173980 Bakman				
	180	EB 180 OFFRAMP/N. PEACH AVE.	847(831)	836	22	54,720		70176522 Bakman				
	180	WB 180 ONRAMP/N. PEACH AVE.	848(832)	650	18	52,000		70176523 Bakman				
	180	EB 180 PEACH AVE. (EASTERLY)	849(833)	479	17	40,574		70149034 Bakman				
	180	WB 180 OFFRAMP/N. PEACH AVE.	850(834)	864	23	54,094		70176520 Bakman				
		Approx POC Peak Demand Per Day				297,772						
LOCATION OF RECYCLED WATER POC CURRENTLY UNKNOWN	168	NB 168/ E LAMONA AVE.	599	837	27	44,640	150 GPM	13596140		7	150	1
	168	NB 168/ E FLORADORA	600	235	12	28,200		13596043				
	168	NB 168/ E HOME	601	582	14	59,863		12504275				
		Approx POC Peak Demand Per Day				132,703						
LOCATION OF RECYCLED WATER POC CURRENTLY UNKNOWN (PRELIMINARY PUMP GROUPING)	168	NB 168 McKINLEY NB ONRAMP	602	524	23	32,807	400 GPM	12517029		8	200	2
	168	SB 168 SB E. McKINLEY OFFRAMP/BARTON	605	531	24	31,860		12517034				
	168	SB 168/ E. CLINTON AVE.	603	851	25	49,018		12517022				
	168	NB 168/ E. VASSAR AVE.	604	727	21	49,851		12517041				
	168	NB 168 SHIELDS NB OFFRAMP/E. CORNELL	606	613	19	46,459		12504296				
	168	NB 168 SHIELDS NB OFFRAMP/E. SIMPSON	608	363	24	21,780		12517042				
	168	SB 168 SHIELDS SB ONRAMP	607	548	18	43,840		12504288				
	168	SB 168 SHIELDS SB OFFRAMP/E. ANDREWS	609	449	18	35,920		12504297				
		Approx POC Peak Demand Per Day				311,535						
LOCATION OF RECYCLED WATER POC CURRENTLY UNKNOWN (PRELIMINARY PUMP GROUPING)	168	NB 168 AT E. ROBINSON/HAYSTON AVE.	610	848	16	76,320	450 GPM	12229893		9	250	2
	168	SB 168 N. OF E. DAKOTA	611	412	16	37,080		12229877				
	168	SB 168 ASHLAN ONRAMP	612	476	19	36,076		12229880				
	168	SB 168 ASHLAN ONRAMP	614	505	20	36,360						
	168	NB 168 ASHLAN ONRAMP	613	522	24	31,320		12229883				
	168	NB 168 ASHLAN ONRAMP	615	432	20	31,104						
	168	NB 168 E. GETTYSBURG AVE.	616	799	21	54,789		12504293				
	168	SB 168 N. BONADELLE/E. ALAMOS	617-618	621	23	38,880		12504294				
		Approx POC Peak Demand Per Day				341,928						

		Run 4 to 5 Pumps Maximum Simutaneosly, 24hrs at 2X Per Week				Approx Peak Demand/POC/Day	Peak Max GPM Rate	Exist Potable Meter				
						Max 50gpm/valve	Any DAY During	Servicing IC &				
			Pump/IC	Total IC's GPM	Stations Used	24hrs (1440 min)	24 hr period	Pump				
LOCATION OF RECYCLED WATER POC CURRENTLY UNKNOWN (PRELIMINARY PUMP GROUPING)	180	WB 180 Harvey/Clark	827	645	19	48,884	300 GPM	12504292		10	200	1
	180	EB 180 ABBEY ST. EB ONRAMP	826	553	18	44,240		12504980				
	180	WB 180 BETWEEN ABBEY & BLACKSTONE	825	139	7	28,594		13650900				
	180	WB 180 THOMAS/GLEN	824	533	18	42,640		14138570				
	180	WB 180 VAN NESS E.	823	217	11	28,407		12229915				
	180	WB 180 VAN NESS W.	822	292	14	30,034		12229915				
LOCATION OF RECYCLED WATER POC CURRENTLY UNKNOWN (PRELIMINARY PUMP GROUPING)	180	WB 180 FULTON ST. ONRAMP	821	339	12	40,680	300 GPM	12229935		11	200	1
	180	WB 180 E. MILDREDA AVE.	818	318	9	50,880		12229934				
	180	EB 180 BROADWAY E.	820(Y)	255	11	33,382		12504213				
	180	EB 180 BROADWAY W.	819 (X)	255	10	36,720		12504250				
	180	WB 180 G. ST./DIVISADERO ST.	817	57	14	5,863		13596059				
	180	WB 180 & 99 TO 180 WB ONRAMP	815(803)	731	22	47,847		12504220				
Recycle Water POC Currently unknown	99	SB99/180 NIELSEN	811-812	845	26	46,800		13596075		12	100	1
	99	NB99/180 NIELSEN	813	Data Unavail.								
Exist. Recycle Water Stubout Parkway	99	NB 99@ Belmont Onramp (RR to N. of Belmc	951	1016	24	60,960	100 GPM	15005438		13	100	1
	99	SB 99@ Belmont Offramp (RR to N. of Belmc	952	725	18	58,000						
		Approx POC Peak Demand Per Day				118,960						
Exist. Recycle Water Stubout Roeding Prk	99	NB 99@ Olive NB Offramp	952	700	20	50,400	100 GPM	Meter On Olive?		14	250	2
	99	NB 99@ Olive NB Offramp	953 SB	865	20	62,280						
		Approx POC Peak Demand Per Day				112,680						
	99	CALTRANS DISTRICT OFFICE	DEMAND CURRENTLY UNKNOWN									
	99	PINE ST. MAINT. YARD-Sweepers-Dust Ctrl.										
	99	NB 99@ McKinley Offramp	IN CONSTRUCTION-TO BE MODIFIED									
	99	SB 99@McKinley Onramp										
POC Amador	99	SB99 S. THORNE AVE. CULDESAC	814 €	1215	33	53,018	200 GPM	14138595		15	200	1
	99	NB99/180EB ONRAMP/EL DORADO	816	889	33	38,793		13596049				
	99	SB99 @ AMADOR	949(732)	556	13	61,588		12504214				
	99	SB 99@ STANISLAUS	948(731)	773	20	55,656		12504221				
		Approx POC Peak Demand Per Day				209,055						
POC SB 99/ FRESNO ST.	99	SB 99@ Fresno St. (South of Fresno St.)	946(729)	860	19	65,179	100	12504278		16	100	1
	99	SB 99@ Fresno St. (North of Fresno St.)	947(730)	515	23	32,243		13334331				
		Approx POC Peak Demand Per Day				97,422						
POC SB99/N OF INYO	99	SB 99@ Inyo (For 99SB/Kern St.)	945(726)	472	14	48,549	50	12504272		17	50	1
POC SB99/S OF INYO	99	SB 99@ Inyo (For 99SB/Mono St.)	943	361	9	57,760	50	99275489		18	50	1

		Run 4 to 5 Pumps Maximum Simutaneosly, 24hrs at 2X Per Week				Approx Peak Demand/POC/Day	Peak Max GPM Rate	Exist Potable Meter				
						Max 50gpm/valve	Any DAY During	Servicing IC &				
			Pump/IC	Total IC's GPM	Stations Used	24hrs (1440 min)	24 hr period	Pump				
POC NB99/N OF INYO Proposed 6" Recycle Water Service	99	NB 99@ Kern St.	944	437	11	57,207		12504272		19	250	3
	99	NB California-Monterey St.	942(725)	326	15	31,296		??				
	99	99/41 NB @41 Ramp/S. Rose-E. Florence	429	450	30	21,600		99275490				
	99	99/41 NB @41 Ramp/S. Rose-E. Florence	430	437	20	31,464		99275490				
	99	99/41 SB 99 Church/Kirk	427-428	400	17	33,882	450	98820658				
	99	SB 99@ Church St.	940	606	18	48,480		14139159				
	99	NB 99@ Church St.	941	430	18	34,400		14139066				
	41	SB 41 @ Grove	423-426	590	24	35,400		14138803				
	41	NB 41 @ Grove	425	600	21	41,143		12504287				
	41	SB 41 E. Vine ST.	420	No Info Avail.				12504262				
	41	NB 41 @ E. Kaviland Ave (Moved to 425)						12504286				
	99	NB 99 Jensen Offramp	939	No Info Avail.				12504134				
LOCATION OF RECYCLED WATER POC CURRENTLY UNKNOWN	41	SB 41 RR to Van Ness (Santa Clara)	431	302	9	48,320		13332428		20	150	1
	41	SB 41 "O" Street	434-435	1290	33	56,291		15005579				
	41	NB 41 Van Ness to RR	432-433	950	42	32,571		98820659				
		Approx POC Peak Demand Per Day				137,182						
						3,150,324						
						131263.5196						

Connection Pt		CALCULATIONS IN PROGRESS 8-7-18						Connection Pt		21	50	1	
21	41	NB MCKINLEY OFFRAMP	444/445		99	NB 99 MCKINLEY OFFRAMP	954	35		22	50	1	
22	41	SB 41 OFFRAMP/N. AUGUSTA ST.	446/447		99	SB 99 MCKINLEY ONRAMP	955			23	50	1	
23	41	SB 41 OFFRAMP/N. VALENCIA/CLINTON	448/449		99	SB 99 PARKWAY & TO MOTEL DR.	956	36		24	150	1	
24	41	NB 41 SHIELDS/THESTA ST.	450/451		99	SB 99 SHIELDS AVE. ONRAMP	957	37		25	50	1	
	41	SB 41 SHIELDS/HUNTER/N. CLARK	452		99	NB 99 SHIELDS AVE. OFFRAMP	958			26	100	1	
	41	NB 41 SHIELDS ONRAMP	450/451		99	SB 99 ASHLAN AVE. OFFRAMP	959/961	38		27	150	1	
25	41	SB 41 CLARK/DAYTON	452/453		99	NB 99 ASHLAN ONRAMP	960			28	50	1	
26	41	NB 41 ASHLAN OFF/N.THESTA ST.	454/455		99	SB 99 N. CORNELIA AVE. OFFRAMP	962	39		29	100	1	
	41	NB 41 ASHLAN ONRAMP	456/457		99	NB 99 S. OF SHAW AVE.	963	40		30	50	1	
27	41	NB 41 SHAW AVE OFFRAMP/N. THESTA	458/459		99	NB 99 AT N. BARCUS AVE/ W. BAR	964	41		31	100	1	
	41	SB 41 SHAW AVE ONRAMP	461		99	SB 99 HERNDON/N. PARKWAY ON	968	42		32	100	1	
	41	NB 41 SHAW AVE ONRAMP	460		99	NB 99 HERNDON AVE. OFFRAMP	967			33	200	1	
28	41	SB 41 E. BARSTOW AVE.	462/463							34	50	1	
29	41	NB 41 BULLARD OFFRAMP	464							35	100	1	
	41	NB 41 BULLARD ONRAMP	465							36	50	1	
30	41	SB 41 E. ESCALON AVE.	466							37	100	1	
31	41	NB 41 HERNDON AVE OFFRAMP	467							38	100	1	
	41	NB 41 HERNDON AVE ONRAMP	468							39	50	1	
32	41	SB 41 E. ALLUVIAL AVE., S. OF ALLUVIAL	469							40	50	1	
	41	SB 41 E. ALLUVIAL AVE., N. OF ALLUVIAL	470							41	50	1	
33	41	NB 41 FRIANT AVE SE. OF FRIANT	471							42	100	1	
	41	SB 41 FRIANT AVE SW. OF FRIANT	472									48	
	41	NB 41 FRIANT AVE NE. OF FRIANT	473										
	41	SB 41 FRIANT AVE NW. OF FRIANT	474								5,400	gpm peak hour irrigation potential	
34	41	NB 41 N OF W. AUDUBON DR.	480								50	gpm capacity per pump	
											108	total number of pumps available to run	
											36	pumps run per day for 6 day, 2x per week cycle	
											1,800	gpm maximum for 24 hours	
											2,592,000	gallons per day	

Appendix C

SOUTHWEST RECYCLED WATER SYSTEM POTENTIAL RECYCLED WATER IRRIGATION DEMAND

Table C-1 Southwest Users and Associated Recycled Water Demands

Customer	Customer Class	MDD (gpm)	PHD (gpm)	Hours of Irrigation
Existing Customers				
Quist	Agriculture	1,300	1,300	24
Pellman	Agriculture	1,300	1,300	24
Roeding Park	Park	267	640	10
Westside Auto	Industrial	8.0	30	6
Fresno Memorial	Cemetery	131	450	7
Subtotal	-	3,005	3,720	-
Future Southwest Users				
St Peter's Cemetery	Cemetery	152.7	458.2	8
Liberty Cemetery	Cemetery	83.3	250.0	8
Belmont Memorial Park	Cemetery	172.3	517.0	8
Multiple Cemeteries	Cemetery	451.5	1,354.4	8
Masis Ararat Cemetery	Cemetery	80.0	240.0	8
El Capitan Middle	Central USD	83.3	250.0	8
Polk Elem	Central USD	74.7	224.0	8
Madison Elementary	Central USD	56.1	168.3	8
McKinley Elementary	Central USD	66.7	200.0	8
Caltrans 180/Fruit	Freeway	16.7	50.0	8
Caltrans 99/Fresno	Freeway	66.7	200.0	8
Caltrans 99/Amador	Freeway	16.7	50.0	8
Caltrans - 99	Freeway	100.0	300.0	8
Caltrans 180/Hughes	Freeway	33.3	100.0	8
Caltrans 41/H	Freeway	16.7	50.0	8
Caltrans 41/Divisadero	Freeway	66.7	200.0	8
Columbia Elem	Fresno USD	44.3	133.0	8
Computech Middle	Fresno USD	63.0	245.5	8
King Elementary	Fresno USD	44.3	101.6	8
Gaston Middle	Fresno USD	87.5	350.0	8
Edison High	Fresno USD	43.7	166.0	8
Fresno City College	College-Landscape	116.3	348.8	8
Fresno City College	College-Forest	523.1	523.1	24

Table C-1 Southwest Users and Associated Recycled Water Demands (continued)

Customer	Customer Class	MDD (gpm)	PHD (gpm)	Hours of Irrigation
Future Southwest Users (continued)				
Fink-White Park	Park	61.0	183.0	8
Veteran's Memorial	Park	27.7	83.0	8
Courthouse Park	Park	116.7	350.0	8
Frank Ball Park	Park	19.3	58.0	8
Eaton Plaza	Park	21.0	63.0	8
Hinton	Park	19.3	58.0	8
Kearney Triangle	Park	18.3	55.0	8
AmeriPride	Private/Commercial	67.3	202.0	8
Community Regional	Private/Commercial	173.0	519.0	8
City Hall	Private/Commercial	27.7	83.0	8
Chukchansi Park	Private/Commercial	59.3	178.0	8
Oasis Development	Residential	210.5	631.5	8
Subtotal	-	3,281	12,663	-

Appendix D

PROGRESS MEETING PRESENTATION

Recycled Water System Planning

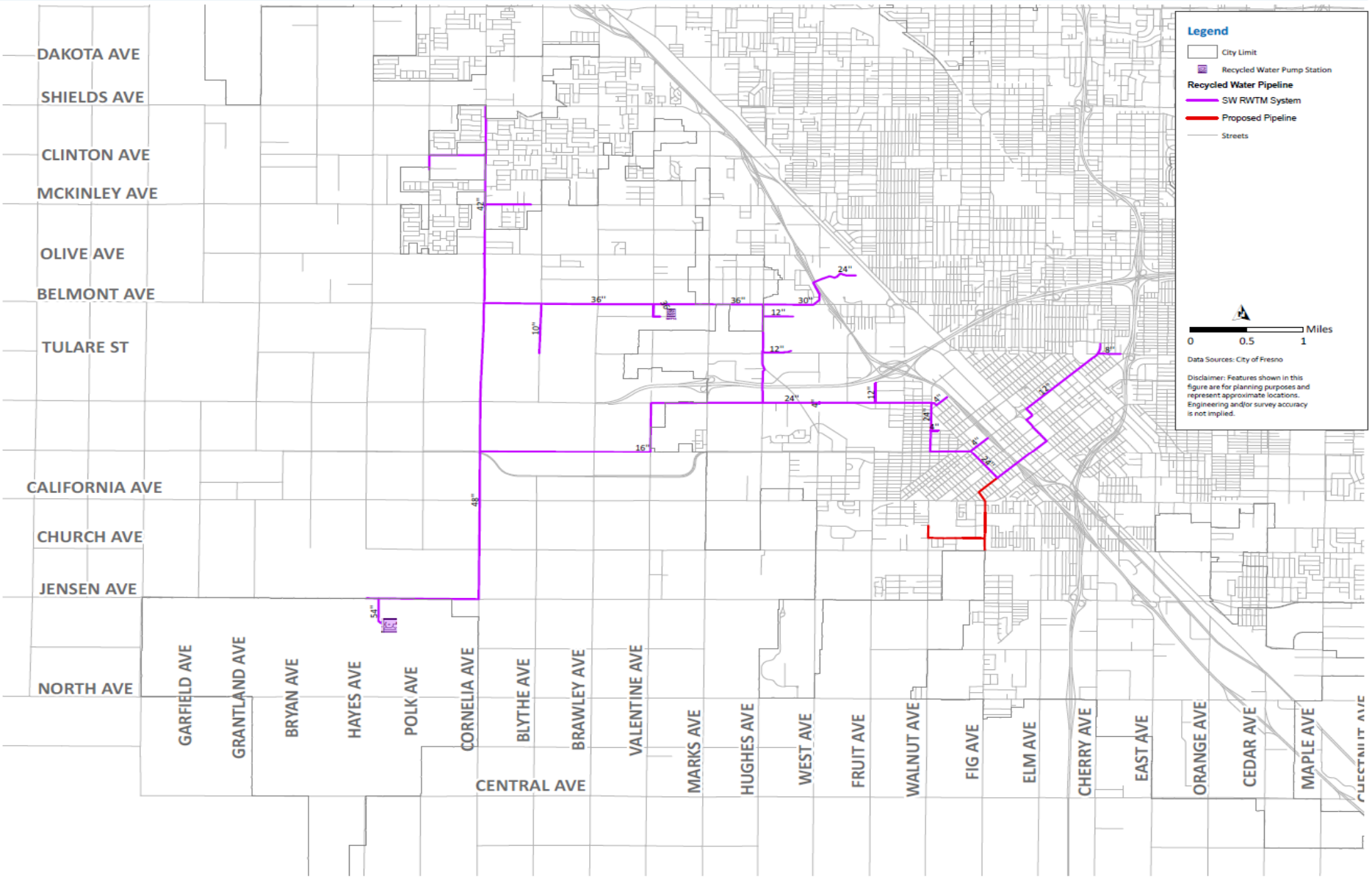
Evaluation of Southwest Buildout and Pumping and Storage Requirements

May 22, 2018

Engineers...Working Wonders With Water®

Meeting Agenda

- SW RWTM System at Buildout
- Potential Customers
- Planning and Evaluation Criteria
- Hydraulic Model Analysis-Buildout of Southwest
  - Booster Pump Station 1 with Storage
  - Booster Pump Station 1 Only
  - Upsizing RWPS and Increasing RW Supply
- Next Steps



carollo

Southwest Buildout

Recycled Water Model Development Project

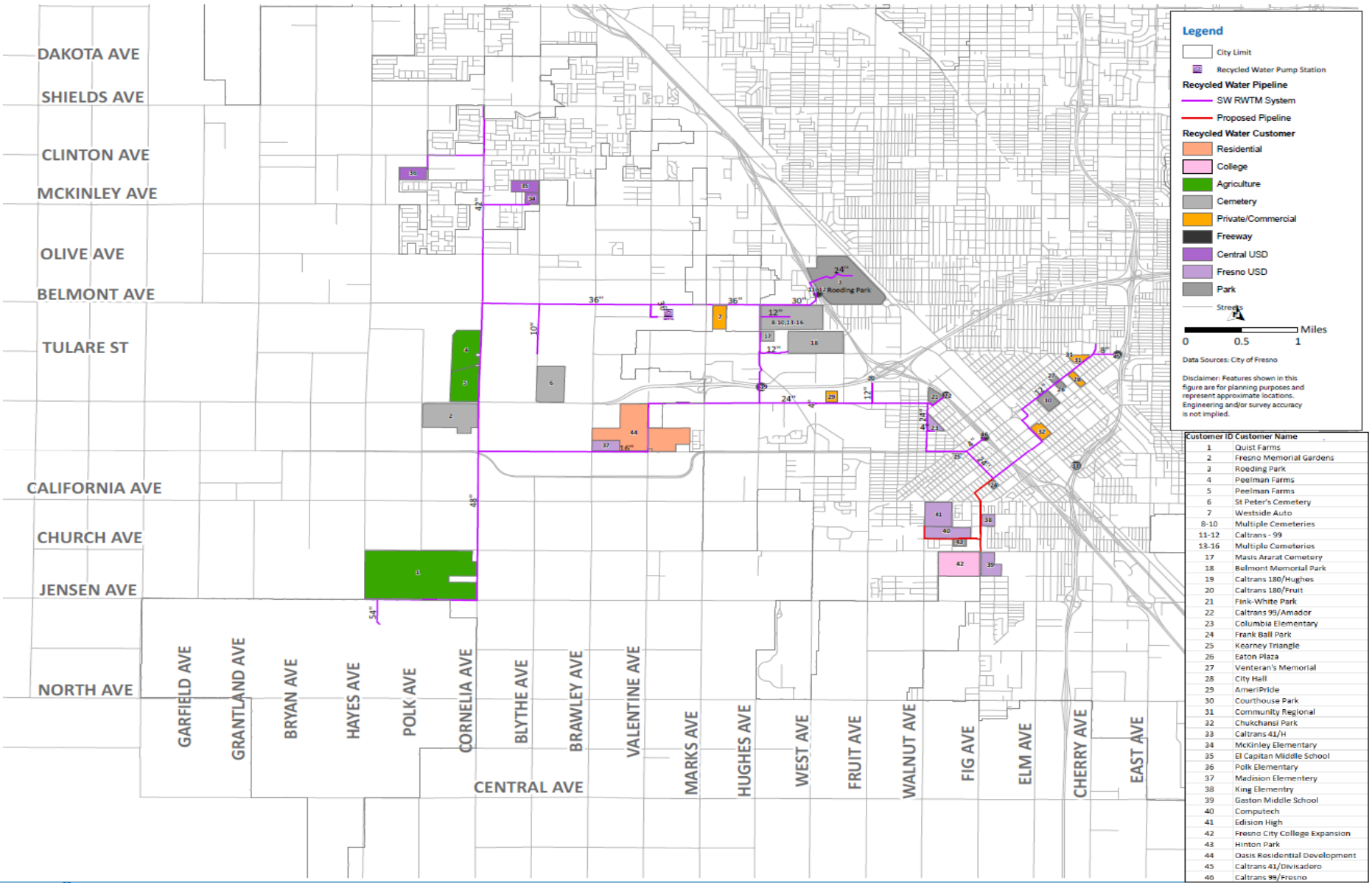
POTENTIAL COSTUMERS

Summer 2018 Demands

Users	Demand (gpm)	Demand (mgd)	Time (hrs)	Volume (MG)
Quist	1,300	1.87	24	1.87
Fresno Memorial	450	0.65	7	0.19
Peelman	1,300	1.87	24	1.87
Westside Auto	30	0.04	6	0.011
Roeding Park	640	0.92	10	0.38
Total	**3,720**		**-**	**4.33**

Full Buildout Demands

Future SW Users	Peak Hour Demand (gpm)	Peak Hour Demand (MGD)	Time (hrs)	Max Day Demand (MG)
Cemeteries	3,270	4.71	7-8	1.57
Schools	1,917	2.76	8	0.92
CalTrans	950	1.37	8	0.46
Parks	1,490	2.15	8-10	0.79
Private/Commercial	1,012	1.45	6-8	0.49
Residential	632	0.91	8	0.30
Agriculture	2,600	3.74	24	3.74
Total	**11,870**	**17.09**	**-**	**8.27**



Customer ID	Customer Name
1	Quist Farms
2	Fresno Memorial Gardens
3	Roeding Park
4	Peelman Farms
5	Peelman Farms
6	St Peter's Cemetery
7	Westside Auto
8-10	Multiple Cemeteries
11-12	Caltrans - 99
13-16	Multiple Cemeteries
17	Masis Ararat Cemetery
18	Belmont Memorial Park
19	Caltrans 180/Hughes
20	Caltrans 180/Fruit
21	Fink-White Park
22	Caltrans 99/Amador
23	Columbia Elementary
24	Frank Ball Park
25	Kearney Triangle
26	Eaton Plaza
27	Venteran's Memorial
28	City Hall
29	AmeriPride
30	Courthouse Park
31	Community Regional
32	Chukchansi Park
33	Caltrans 41/H
34	McKinley Elementary
35	El Capitan Middle School
36	Polk Elementary
37	Madison Elementery
38	King Elementry
39	Gaston Middle School
40	Computech
41	Edision High
42	Fresno City College Expansion
43	Hinton Park
44	Oasis Residential Development
45	Caltrans 41/Divisadero
46	Caltrans 99/Fresno

carollo

Last Revised: May 21, 2018[pw:\\RO-PW-INT.Carollo.local:Carollo\Documents\Client\CA\FresnoBepace\City\314\0Aos\Data\GIS\CustomersSW.mxd

Southwest Recycled Water Customers

Recycled Water Model Development Project

PLANNING AND EVALUATION CRITERIA

Evaluation Criteria

Description	Value	Units
Minimum Pressure (PHD)	40	psi
Pipeline Criteria		
Maximum Velocity (PHD)	8	fps
Maximum Headloss	10 feet/1,000 feet	-
Hazen-William C-factor	145 -120	-
Storage Volume		
Operational	PHD-MDD	MG
Peaking Factors		
Max Day Demand	2.4 x ADD	
Peak Hour Demand	9.3 x ADD	

Recycled Water Model Development Project

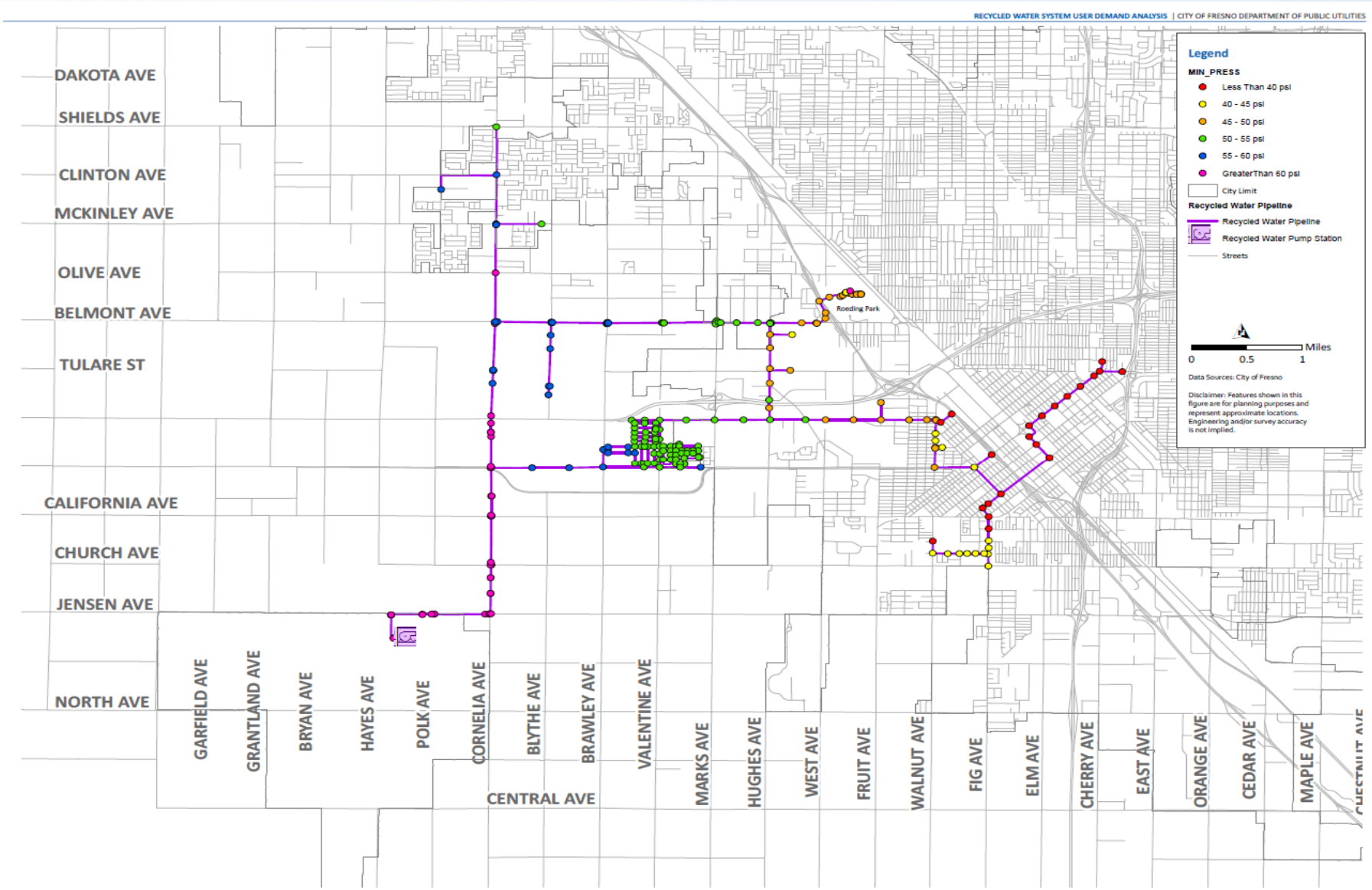
ANALYSIS

Scenario 3: Expand RWPS

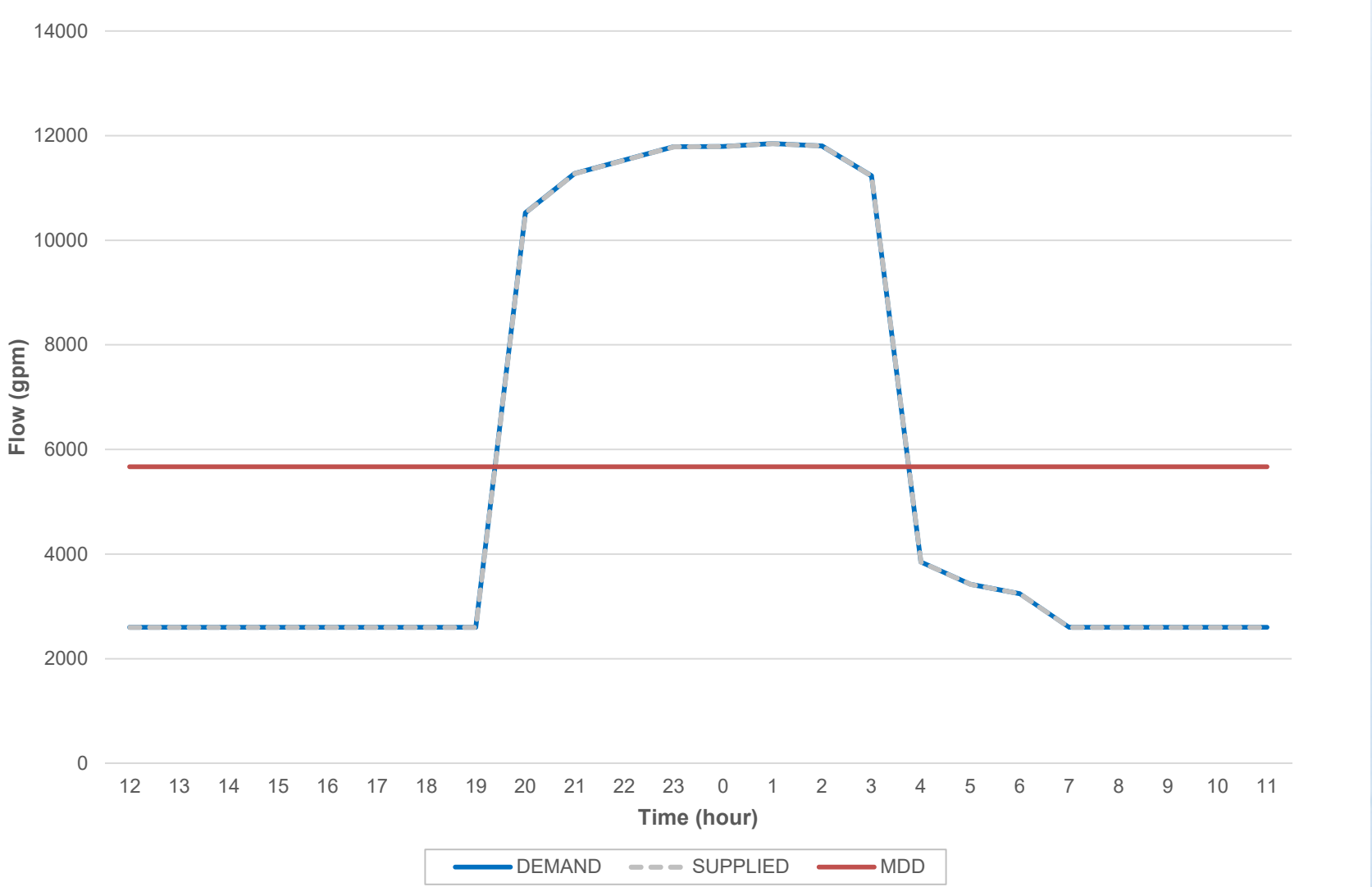
- RW Supply Needed – 8.3 MGD
- RWPS Capacity Needed – 17.1 MGD

Future SW Users	Peak Hour Demand (gpm)	Peak Hour Demand (MGD)	Time (hrs)	Max Day Demand (MG)
Cemeteries	3,270	4.71	7-8	1.57
Schools	1,917	2.76	8	0.92
CalTrans	950	1.37	8	0.46
Parks	1,490	2.15	8-10	0.79
Private/Commercial	1,012	1.45	6-8	0.49
Residential	632	0.91	8	0.30
Agriculture	2,600	3.74	24	3.74
Total	**11,870**	**17.09**	**-**	**8.27**

Scenario 3: PHD Minimum Pressures



Scenario 3: Demand vs Supply



Scenario 1: PS 1 with Storage

- Peak Hour Demand – 17.1 MGD
- Max Day Demand – 8.3 MG
- Existing RWPS Capacity – 8.64 MGD

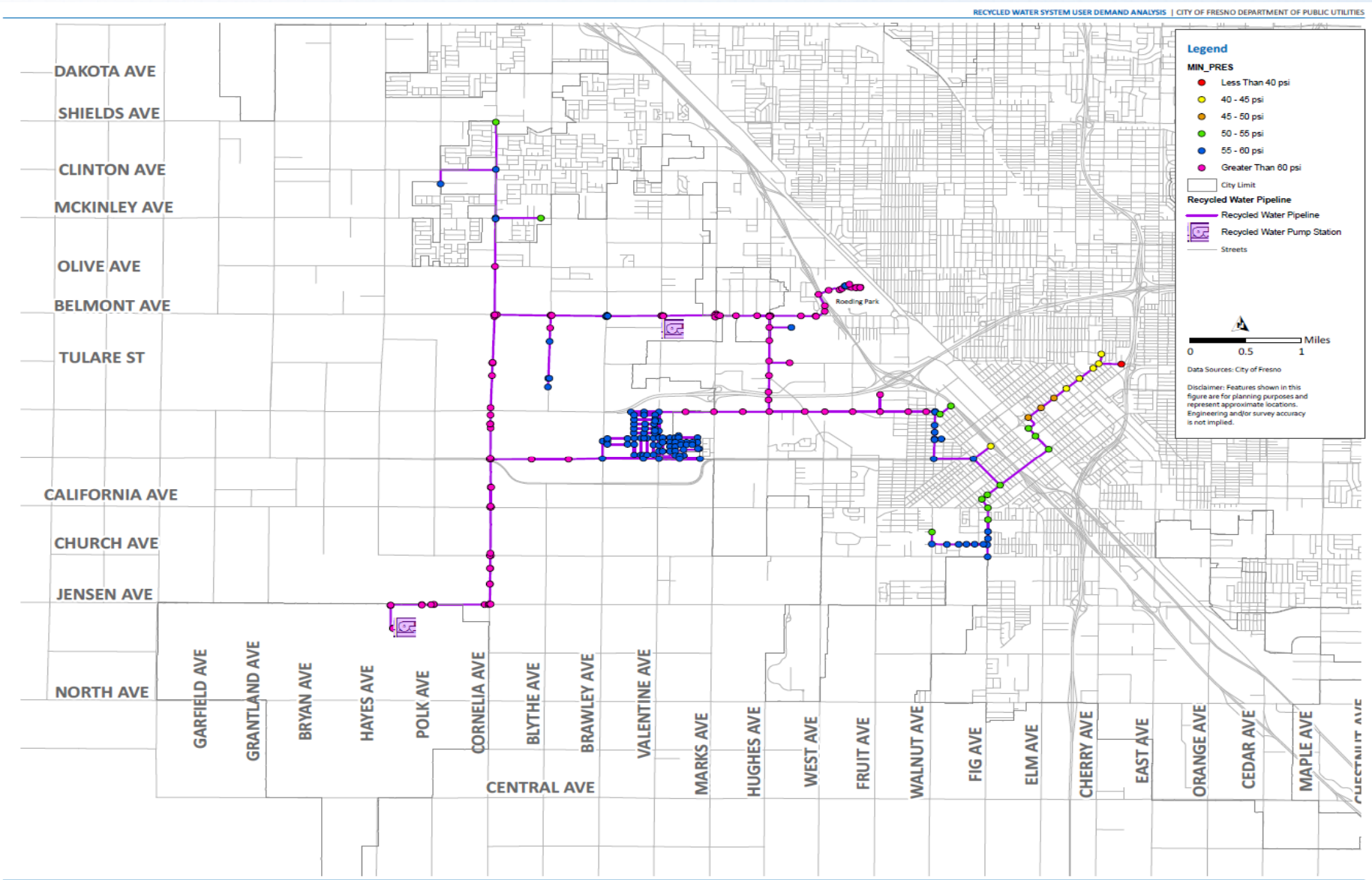
Assumptions:

- Ag users irrigate consecutively
- FCC MLK campus demand equal to Edison/Computech

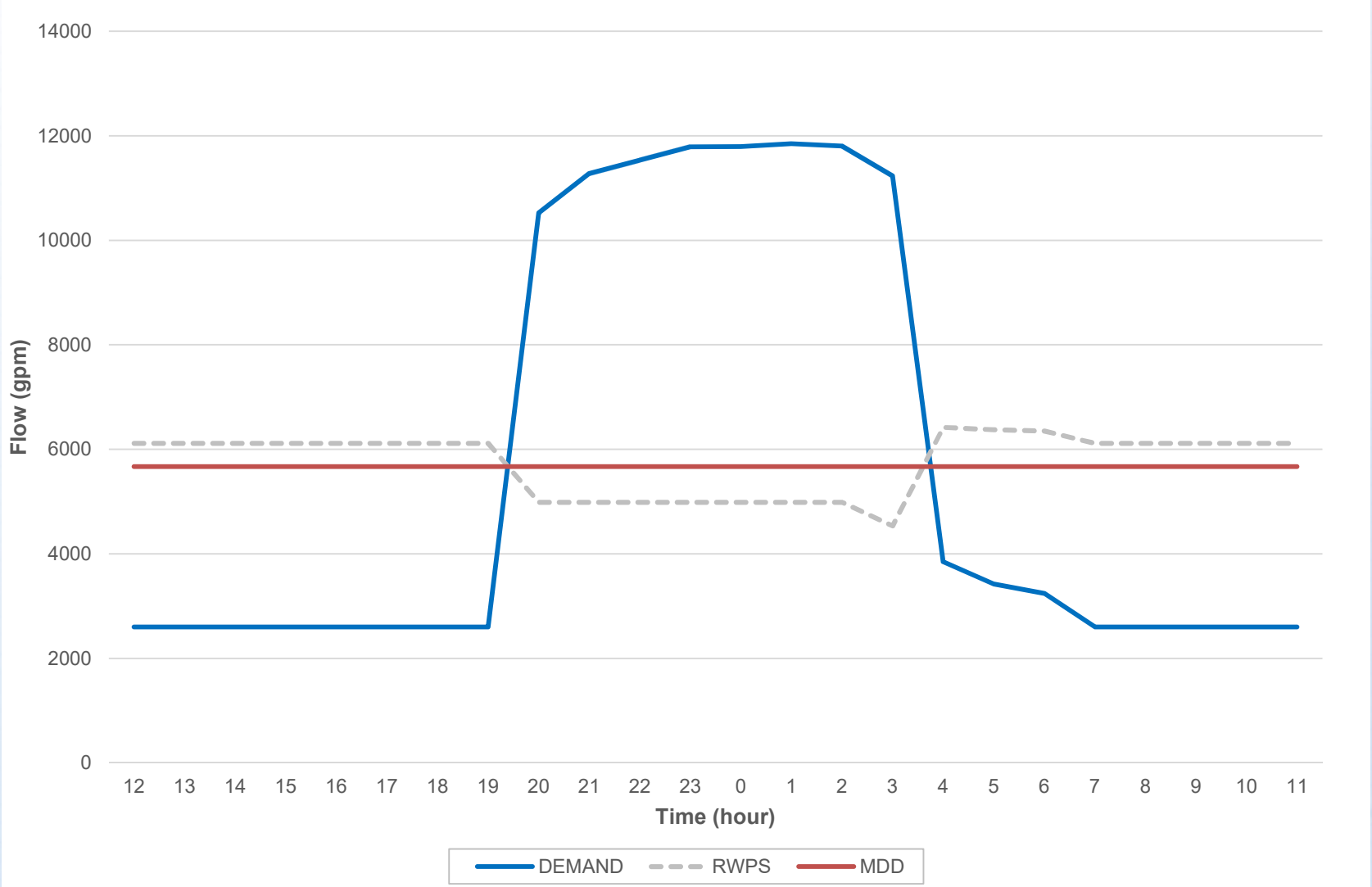
Scenario 1: PS 1 with Storage

- RW Supply Needed – 8.3 MGD
- Booster Pump Station Capacity Needed – 9.8 MGD
- Operational Storage Volume Needed – 3 MG

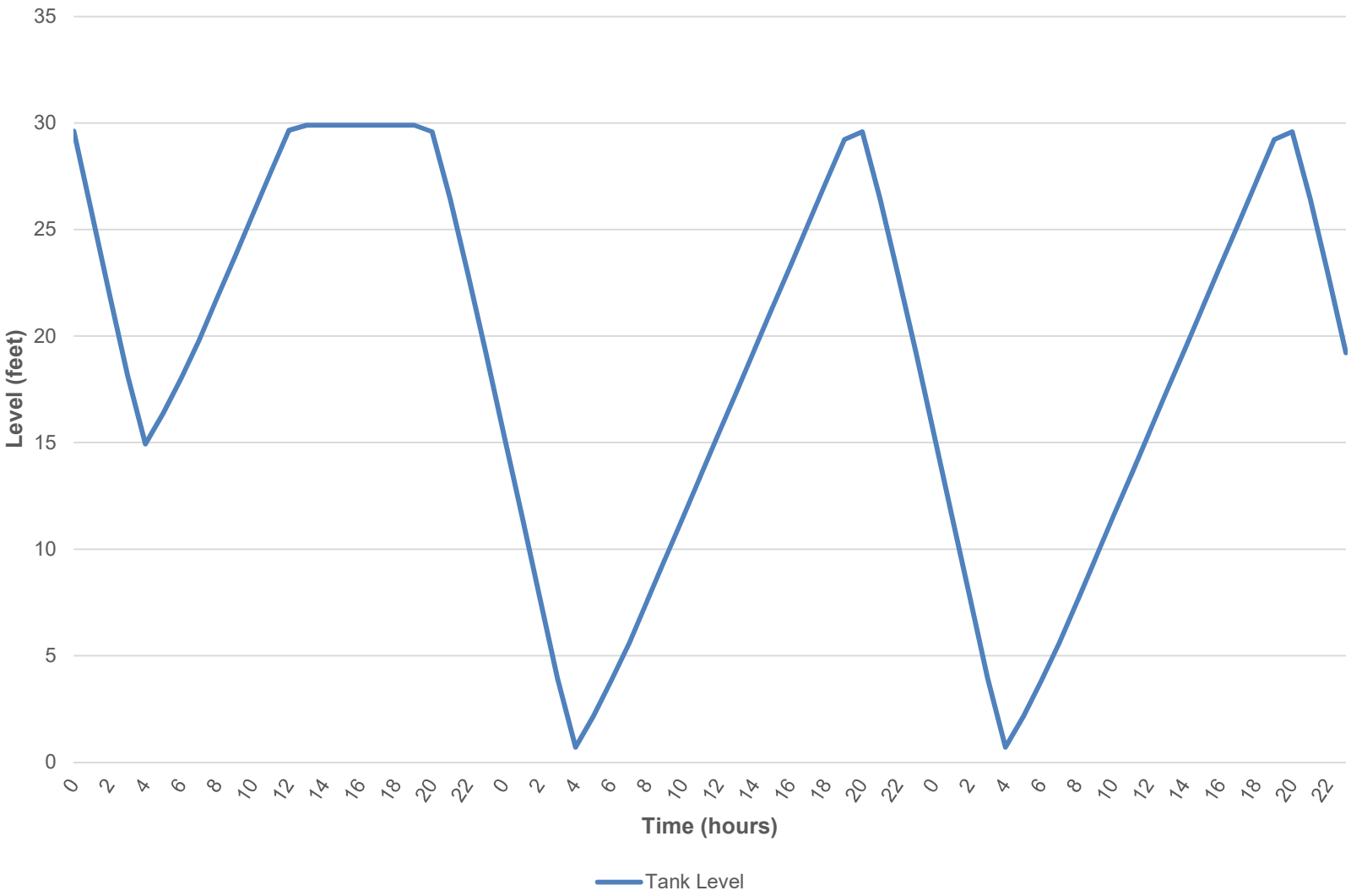
Scenario 1: PHD Minimum Pressures



Scenario 1: Demand vs Supply



Scenario 1: Tank Level



Scenario 1 Discussion

- Scheduling agricultural irrigation will reduce PHD and MDD
- FCC MLK demands needed

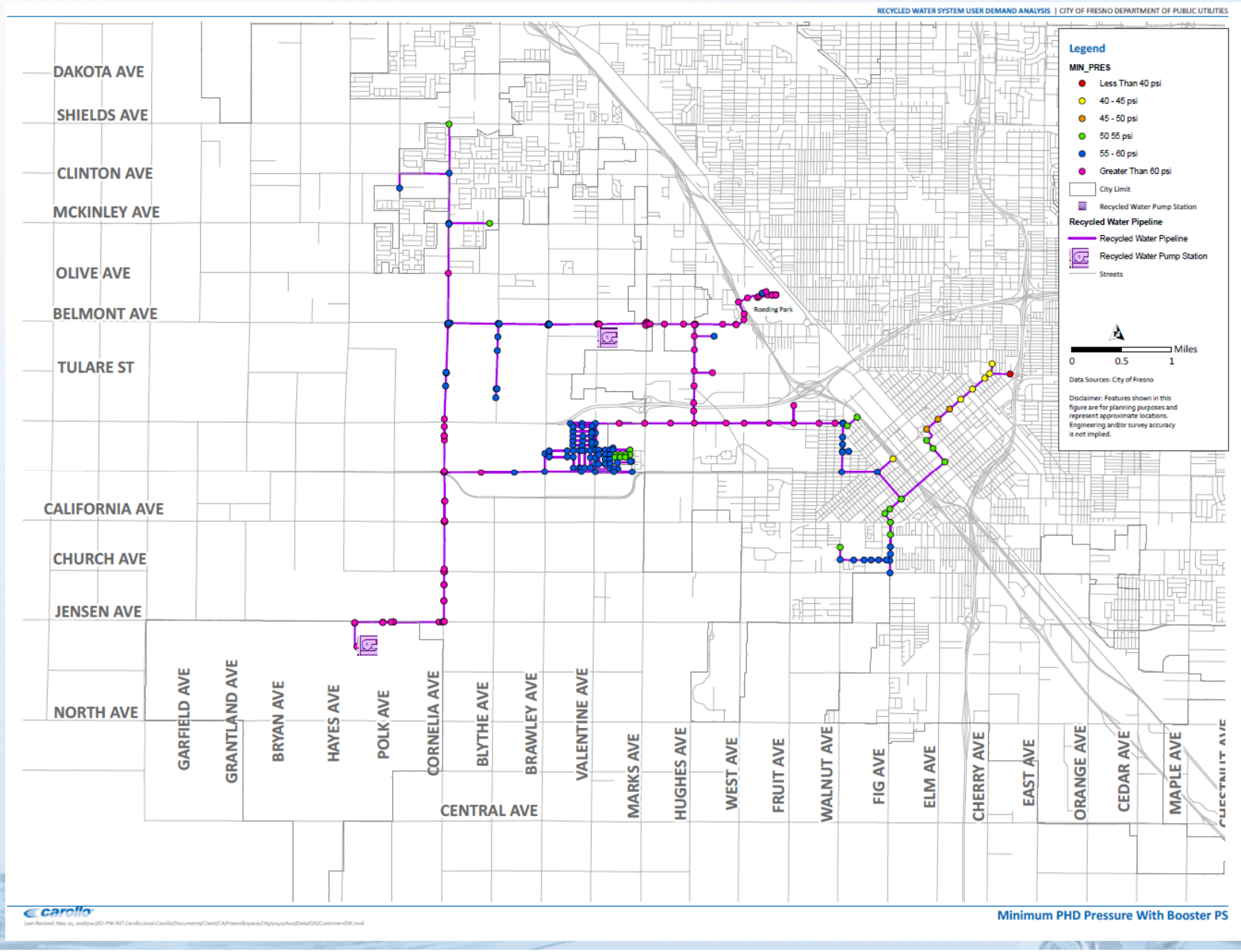
Future SW Users	Peak Hour Demand (gpm)	Peak Hour Demand (MGD)	Time (hrs)	Max Day Demand (MG)
Cemeteries	3,270	4.71	7-8	1.57
Schools	1,917	2.76	8	0.92
CalTrans	950	1.37	8	0.46
Parks	1,490	2.15	8-10	0.79
Private/Commercial	1,012	1.45	6-8	0.49
Residential	632	0.91	8	0.30
Agriculture*	1,300	1.87	24	1.87
Total	**10,570**	**15.22**	**-**	**6.4**

Scenario 2: PS 1 Only

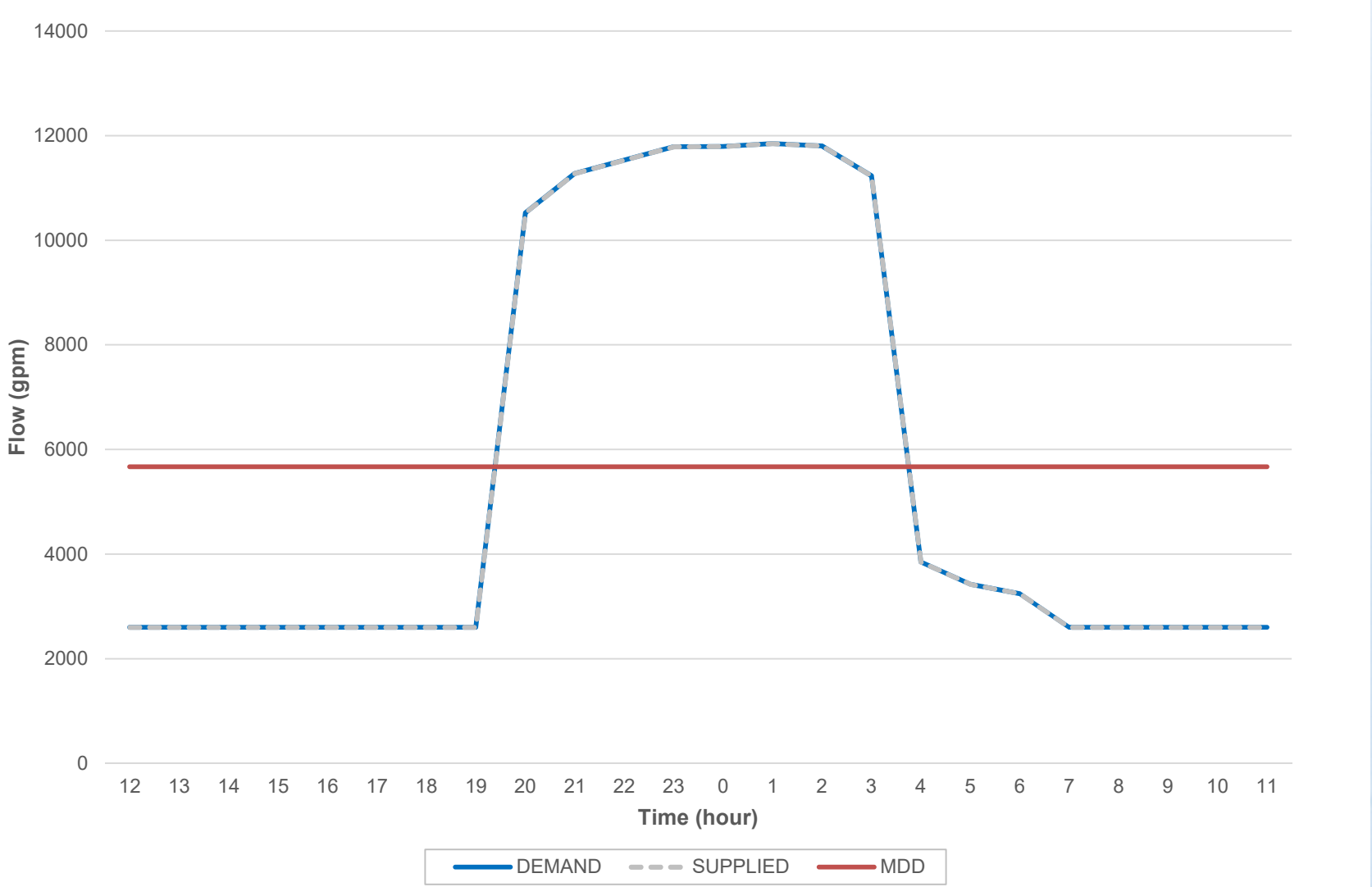
- RW Supply Needed – 8.3 MGD
- RWPS Capacity Needed – 17.1 MGD
- Booster Pump Station Capacity Needed – 9.8 MGD

Future SW Users	Peak Hour Demand (gpm)	Peak Hour Demand (MGD)	Time (hrs)	Max Day Demand (MG)
Cemeteries	3,270	4.71	7-8	1.57
Schools	1,917	2.76	8	0.92
CalTrans	950	1.37	8	0.46
Parks	1,490	2.15	8-10	0.79
Private/Commercial	1,012	1.45	6-8	0.49
Residential	632	0.91	8	0.30
Agriculture	2,600	3.74	24	3.74
Total	**11,870**	**17.09**	**-**	**8.27**

Scenario 2: PHD Minimum Pressures



Scenario 2: Demand vs Supply



Recycled Water Model Development Project

QUESTIONS

Appendix E

NORTHWEST AND NORTHEAST PRELIMINARY COST ESTIMATE

Fresno Recycled Water Master Plan - Northwest and Northeast Recycled Water Distribution Systems
City of Fresno

Engineer's Opinion of Probable Construction Cost

June 17, 2019

	Description	Quantity	Unit	Unit Cost	Extension
1	Mobilization	lump sum		$ 2,086,000.00	$ 2,086,000.00
1	Mediator (Assume 6 Separate Projects)	lump sum		$ 150,000.00	$ 150,000.00
2	Worker Protection from Caving Ground in Excavations	lump sum		$ 1,756,000.00	$ 1,756,000.00
3	Traffic Control, Public Convenience and Safety	lump sum		$13,657,000.00	$ 13,657,000.00
4	Storm Water Pollution Prevention & Dust Control	lump sum		$ 449,000.00	$ 449,000.00
5	Clearing and Grubbing	lump sum		$ 1,366,000.00	$ 1,366,000.00
6	42-inch Recycled Water Transmission Main	49,100	ln ft	$ 547.00	$ 26,857,700.00
7	36-inch Recycled Water Transmission Main	11,500	ln ft	$ 505.00	$ 5,807,500.00
8	30-inch Recycled Water Transmission Main	23,000	ln ft	$ 410.00	$ 9,430,000.00
9	24-inch Recycled Water Transmission Main	13,300	ln ft	$ 358.00	$ 4,761,400.00
10	20-inch Recycled Water Transmission Main	19,400	ln ft	$ 300.00	$ 5,820,000.00
11	18-inch Recycled Water Transmission Main	7,900	ln ft	$ 225.00	$ 1,777,500.00
12	16-inch Recycled Water Transmission Main	5,600	ln ft	$ 150.00	$ 840,000.00
13	12-inch Recycled Water Transmission Main	14,200	ln ft	$ 98.00	$ 1,391,600.00
14	10-inch Recycled Water Transmission Main	23,900	ln ft	$ 90.00	$ 2,151,000.00
15	8-inch Recycled Water Transmission Main	27,200	ln ft	$ 85.00	$ 2,312,000.00
16	42-inch Butterfly Valve	25	ea	$ 62,000.00	$ 1,550,000.00
17	36-inch Butterfly Valve	7	ea	$ 50,000.00	$ 350,000.00
18	30-inch Butterfly Valve	13	ea	$ 30,000.00	$ 390,000.00
19	24-inch Butterfly Valve	7	ea	$ 22,000.00	$ 154,000.00
20	20-inch Butterfly Valve	15	ea	$ 17,000.00	$ 255,000.00
21	18-inch Butterfly Valve	7	ea	$ 14,400.00	$ 100,800.00
22	16-inch Butterfly Valve	3	ea	$ 11,100.00	$ 33,300.00
23	12-inch Gate Valve	9	ea	$ 6,600.00	$ 59,400.00
24	10-inch Gate Valve	20	ea	$ 4,500.00	$ 90,000.00
25	8-inch Gate Valve	26	ea	$ 3,200.00	$ 83,200.00
26	Air Release/Vacuum Breaker Station	29	ea	$ 26,000.00	$ 754,000.00
27	Permanent Blow-Off Assembly	34	ea	$ 15,000.00	$ 510,000.00
28	Corrosion Protection	lump sum		$ 678,000.00	$ 678,000.00
29	Temporary Trench Resurfacing	20,000	ln ft	$ 15.00	$ 300,000.00
30	Permanent Trench Resurfacing	195,100	ln ft	$ 105.00	$ 20,485,500.00
31	Northwest Booster Pump Station - Herndon and Hayes	lump sum		$ 3,900,000.00	$ 3,900,000.00
32	Northwest Booster Pump Station - Herndon and Fruit	lump sum		$ 3,300,000.00	$ 3,300,000.00
33	Northeast Booster Pump Station - Nees and Millbrook	lump sum		$ 2,700,000.00	$ 2,700,000.00
34	Misc. Facilities and Operations	lump sum		$ 5,320,000.00	$ 5,320,000.00
				Subtotal Amount:	$ 121,625,900.00
				Contingencies (approx. 25%):	$ 30,406,100.00
				Total Construction Cost:	**$ 152,032,000.00**
	Engineering, Construction Services and Environmental (approx. 20%):				$ 30,406,000.00
				Total Project Cost	**$ 182,438,000.00**