Exhibit A

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City of Fresno

Recycled Water Master Plan

December 2010

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Engineers...Working Wonders With Water®

City of Fresno

RECYCLED WATER MASTER PLAN

December 2010

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RECYCLED WATER MASTER PLAN

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INTRODUCTION

1.1 INTRODUCTION

In 2009, the State of California adopted a Recycled Water Policy establishing a mandate to increase the use of recycled water in California by 200,000 acre-feet per year by 2020 and by an additional 300,000 acre-feet per year by 2030. In support of these goals, the City has embarked on a Recycled Water Master Plan (Master Plan). The Master Plan is intended to serve as a basis to support the City's decision making process in selecting recycled water projects. The expansion of the recycled water system will enable the City to offset potable water use, enhance the sustainability of the water supply, and lessen the burden on the wastewater treatment plant percolation ponds that are currently used for effluent discharge.

The City is required by the Central Valley Regional Water Quality Control Board (RWQCB) to evaluate the quality of the groundwater beneath the percolation ponds. Constituents of concern are salts, nitrogen, and metals (arsenic and manganese) that are mobilized from the alluvium under reducing conditions created by effluent percolation. Reducing the hydraulic and constituent loading burden on the percolation ponds by implementing a significant reuse program would lower the concentrations of these constituents in the groundwater.

This chapter summarizes the purpose of the Master Plan, related facilities and institutional agreements, prior studies and the types of reuse that will be considered as part of this Master Plan. Many of the reuse options considered could offset existing uses of the City's potable supplies and some selected private wells. Other options could exchange the recycled water with other agencies for potable water credit. Groundwater recharge with recycled water could indirectly supplement potable water supplies.

Therefore, the intent of the Master Plan is to plan and implement a phased recycled water treatment and distribution system that:

- Protects and improves groundwater quality by reducing the use of percolation ponds that currently handle effluent discharge;
- Increases the use of recycled water through urban reuse, groundwater recharge and agricultural reuse to help meet the increasing need water demands in the region;
- Expands the recycled water system in order to enable the City to offset potable water use, thereby enhancing the sustainability of the water supply;
- Puts into practice a recycled water plan and ordinance that supports implementing reuse in the City for existing and future users.

The Master Plan examines urban reuse, agricultural reuse, groundwater recharge, and institutional exchanges of recycled water for potable water. Potential annual recycled water deliveries were calculated and then used to determine the cost-effectiveness of implementing various recycled water alternatives. The Master Plan also considered diversification as an important strategy for the City to maintain a reliable wastewater disposal and reuse system.

Concurrently to this Master Planning effort, a Recycled Water Ordinance is being developed to require use by existing and future water users, including commercial, residential, and industrial properties.

1.2 BACKGROUND

This section reviews the existing wastewater treatment facilities, existing recycled water use, the related agreements pertaining to wastewater treatment and discharge, and past and ongoing studies and reports relevant to the Master Plan.

1.2.1 Existing Facilities and Recycled Water Use

1.2.1.1 Fresno/Clovis Regional Wastewater Reclamation Facilities

The Regional Wastewater Reclamation Facilities (RWRF) serve the cities of Fresno and Clovis; the Pinedale Water District and Pinedale Utilities District, both of which are within the city limits of Fresno; and some areas within Fresno County not within the city limits of Fresno or Clovis. The RWRF treats domestic, commercial, and industrial wastewater from this service area. The RWRF has a rated capacity of 88 million gallons per day (mgd), but the annual average daily flows are approximately 70 mgd (80,000 AFY). The City of Clovis owns 9.3 mgd treatment capacity, while the City of Fresno owns the rest. The City of Fresno is responsible for day-to-day operations at the RWRF, and is the responsible entity for ensuring regulatory compliance with the RWRF's Waste Discharge Requirements (WDRs).The location of the RWRF is shown on Figure 1.1.

The RWRF is an activated sludge facility producing undisinfected secondary effluent. The majority of the wastewater treated at the RWRF is discharged to percolation ponds. Approximately ten percent of the total secondary undisinfected effluent flow is delivered directly to neighboring farmland for restricted irrigation of feed/fodder and fiber crops. Approximately 19 to 43 percent of the RWRF percolated effluent is extracted and delivered to Fresno Irrigation District (FID). The unused percolated effluent remains in the groundwater basin where it migrates laterally to the southwest. The remaining percolated effluent could be extracted for other non-potable beneficial uses.

1.2.1.2 Existing Recycled Water Use at RWRF

The City provides farmers with undisinfected secondary effluent for restricted irrigation of nonfood crops on agricultural land on-site and off-site the RWRF. On-site reclamation refers to parcels near the RWRF that are owned by the City and leased to farmers. Off-site reclamation refers to irrigation on privately owned agricultural land. The City holds the

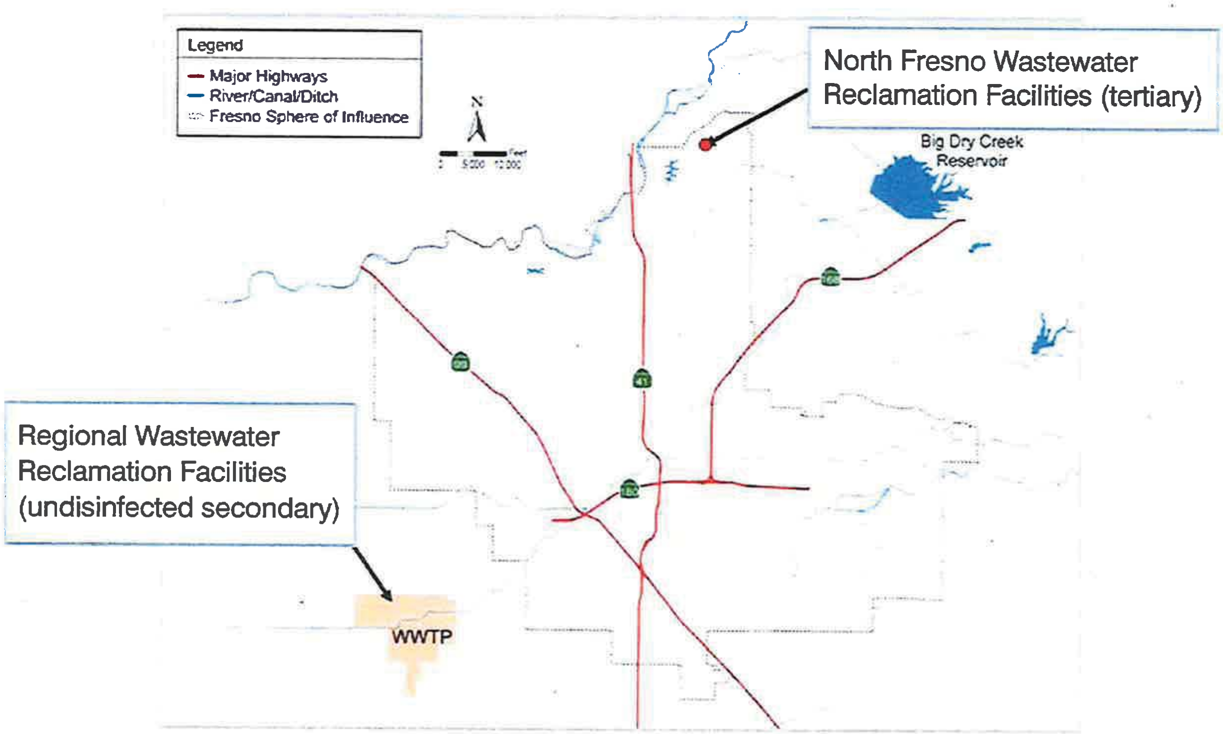

Figure 1.1
RWRF AND NORTH FRESNO WRF LOCATIONS
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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WDRs for the individual farmers who lease the property owned by the City. The landowners hold the WDRs for irrigation on private land. Figure 1.2 shows the areas irrigated with RWRF effluent. As shown in Table 1.1, the combined on-site and off-site agricultural discharge is about 6,000 to 10,000 AF/year, or approximately 10 percent of the total plant flow.

The following is a list of on-site farmers receiving restricted-use recycled water from the RWRF as of December 2009:

- Quist Dairy, six parcels with a total of 458 acres
- Daniel Souza, one parcel totaling 158 acres
- Stephen England, two parcels totaling 285 acres

The following is a list of off-site farmers receiving restricted-use recycled water from the RWRF as of December 2009:

- Alfred Coelho with 520 acres
- Daniel Souza with 786 acres
- Golden State Vintners with 800 acres

Recycled water is made available to the farmers at no charge. Farmers are typically required to install and operate at their expense the necessary pumps and pipelines to transport the recycled water to their own land. On some occasions, the City has provided pipeline and pumping facilities.

FID has historically received between 15,000 and 34,000 AFY of extracted groundwater (percolated effluent). This water is delivered to FID canals and then conveyed to downstream local farmers. Historic recycled water usage and delivery of extracted groundwater is shown in Table 1.1.

1.2.1.3 <u>North Fresno Wastewater Reclamation Facility</u>

The North Fresno Wastewater Reclamation Facility (North Fresno WRF) was recently constructed to serve the residential and commercial development and golf course in a portion of northeast Fresno. It was constructed with sequencing batch reactor (SBR) technology for secondary treatment, cloth media filtration for tertiary treatment, and sodium hypochlorite for disinfection. The permitted capacity of the plant is 0.71 mgd average monthly flow and 1.07 mgd maximum daily flow. The location of the North Fresno WRF is shown on Figure 1.1.

Recycled water in excess of turf demands can be dechlorinated and discharged to a nearby percolation basin, which is owned by the Fresno Metropolitan Flood Control District.

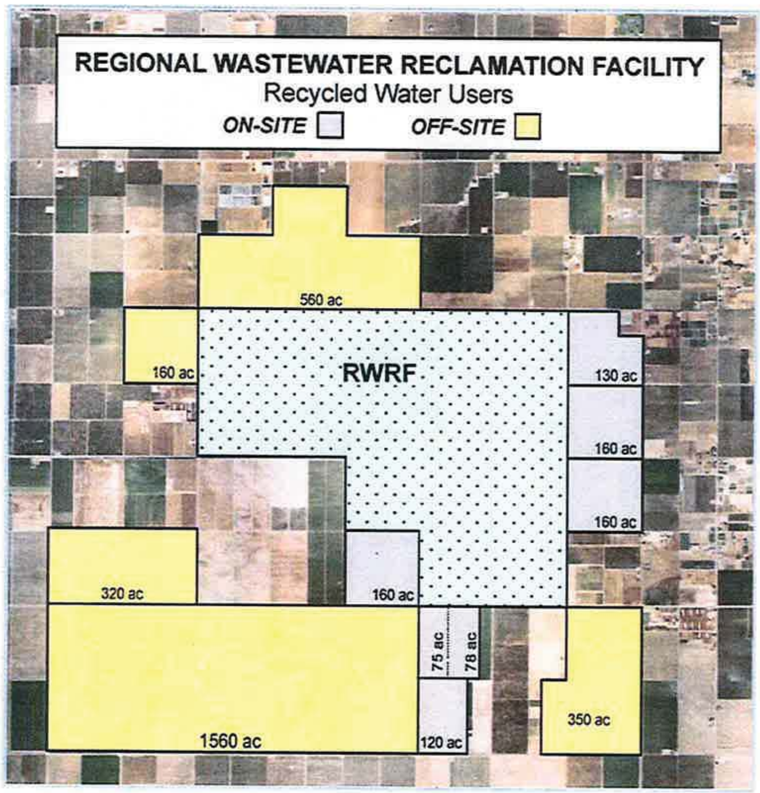

Figure 1.2
FARMLAND IRRIGATED WITH RWRF EFFLUENT
RECYCLED WATER MASTER PLAN
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Table 1.1 Existing Recycled Water Usage at the RWRF
Recycled Water Master Plan
City of Fresno

Year	Plant Influent Acre Feet	Effluent Direct Use To Farmers Acre Feet	Extracted Groundwater Discharge to FID Canals Acre Feet	Total Recycled Acre Feet	Percentage Recycled (%)
2000	76,197	3,798	15,633	19,431	26%
2001	76,236	4,972	26,824	31,796	42%
2002	78,078	6,756	28,902	35,658	46%
2003	78,504	6,715	33,958	40,673	52%
2004	79,452	9,103	32,324	41,427	52%
2005	78,894	8,509	25,022	33,531	43%
2006	80,801	7,405	17,479	24,884	31%
2007	78,009	10,935	27,532	38,467	49%
2008	77,301	10,918	23,215	34,133	44%

1.2.2 Interagency Agreements

1.2.2.1 City of Clovis

On March 3, 1977, the City entered into a joint powers agreement (JPA) with the City of Clovis. The JPA and subsequent agreements provide the following purpose for the joint capacity use, and capacity rights ownership:

- Designates the City of Fresno as the entity responsible for day to day management, operation, and maintenance of the collection system and treatment facilities.
- Establishes capital and operating cost basis.
- Allocates collection system capacity.
- Allows Clovis to acquire additional flow capacity in future sewers and treatment facilities as needed, based on paying a pro-rated share of the cost of such facilities.

The City of Clovis does participate in paying for capital projects for effluent disposal facilities (percolation ponds and associated pipelines and canals, etc.). This includes paying for effluent recycling facilities (pumps, pipelines, canals, etc.) and the groundwater extraction well system. City of Clovis pays a pro rata share of both operations and maintenance (O&M) and capital expenditures using formulas set forth in the JPA. The formulas use either an actual flow percent or a capacity share percent to determine the pro rata share of costs to Clovis.

1.2.2.2 Fresno Irrigation District

In 1974 the City entered into an exchange agreement with FID to establish a groundwater reclamation system consisting of on-site extraction wells and piping that delivers groundwater to FID's Dry Creek and Houghton Canals. The extracted water typically mixes with a variable amount of surface water prior to use on crops, including fodder, fiber, and food for human consumption (e.g., almonds, beans, peaches, raisins, and wine grapes, etc.). The extracted groundwater is discharged to the canals during the growing season for agricultural use on the western side of FID's service area. Each canal can convey up to the 200 cubic feet per second. To date there are no regulatory restrictions on the use of extracted groundwater.

The 1974 agreement between the City and FID stipulates the following:

- City must discharge a minimum of 100,000 AF of extracted groundwater to FID during any ten-year period.
- City may discharge a maximum of 30,000 AF of extracted groundwater to FID in a given year.
- For every acre-foot of extracted groundwater the City discharges to FID, the City is entitled to receive 0.46 AF of surface water from FID.

The City has not historically used its full entitlement of surface water from this FID agreement due to lack of demand and adequate facilities (recharge basins or water treatment facilities).

Any increase in the discharge of extracted groundwater to FID beyond that stipulated in the 1974 agreement is subject to FID approval. The agreement also stipulates the City cannot extract the filtered effluent from beneath the RWRF in volumes that will cause the groundwater level to drop below levels observed in the previous year.

The City and FID have a separate cooperative agreement, dated 1976, that provides for the agencies to use FID's distribution system to satisfy their respective water supply rights, and to work together to protect and preserve the groundwater basin. The agreement also stipulates that the City will retain its treated effluent within the boundaries of FID unless written consent is obtained.

1.2.2.3 Central Valley Energy Center

The City and Central Valley Energy Center (CVEC) entered into an agreement effective August 27, 2001 which allow CVEC to purchase recycled water. Recycled water would be provided primarily from new reclamation wells built specifically for the CVEC project. The facility has not been constructed, and it is not known when the project will be implemented. The terms of the agreement extend to the year 2061. All costs associated with new wells and pipeline facilities necessary for the conveyance would be the responsibility of CVEC.

The maximum allowable quantity of recycled water from the existing and new wells combined is limited to a maximum 7,000 AF/year.

1.2.3 Ongoing and Previous Reports and Studies

The following is a summary of the reports and studies that are ongoing, or have previously been completed, and pertain to the Master Plan.

1.2.4.1 2025 General Plan

The City's General Plan and EIR, adopted in November 2002, provide long-range planning for development over the next two decades. It includes community and specific plans that address growth and infill in different areas of the City. The General Plan identified two growth areas, the North Growth Area and the Southeast Growth Area. The North Growth Area has since been developed and is served by the North Fresno Wastewater Reclamation Facility. The General Plan also established objectives and policies to encourage development/revitalization of the Centre City area and to promote densification through formation of Intensity Corridors. Highway 41 has been designated an Intensity Corridor.

The population and growth projections in the General Plan were based upon the robust growth at the time the Plan was developed. Because of the recent housing market decline, development has slowed significantly. In addition, based on discussions with the Planning and Development Department, the City's new focus for growth is densification and in-fill. Therefore, the General Plan will be revisited in the coming years. It is likely that as the General Plan changes, planning scenarios for the use of the Recycled Water Master Plan will also need to be updated.

1.2.4.2 SEGA Plan and Satellite Treatment Study

Incorporation of the Southeast Growth Area (SEGA) into the City was a major goal of the 2025 General Plan. To accommodate future growth, the City considered building a satellite recycled water facility (SRWF) in SEGA. Two reports were prepared, the 2001 "Satellite Wastewater Treatment Plant Study" and the 2006 "Satellite Plant Study Update." Two possible locations for the satellite plant were identified in this general area. Based on an analysis of the service areas, the capacities would be either 12 mgd or 15 mgd. In addition to distributing the recycled water to various users mentioned above, effluent flows would also be discharged to the FID canals for unrestricted agricultural irrigation reuse. During the winter months flows would be discharged to percolation ponds or irrigation canals.

The original intent of the City is that SEGA would be self-sustaining with respect to water and wastewater. The City has a separate specific plan under development to further define the SEGA development and the use of recycled water within SEGA. Therefore, evaluation of recycled water uses within the SEGA area was beyond the scope of this Master Plan. With the decline in development and the redirection of the General Plan, it is likely that

SEGA will develop at a much slower rate than envisioned in the 2025 General Plan. Due to the uncertainty in SEGA's development, the site and capacity of a future recycled water facility in this area is unknown (see Figure 1.3).

1.2.3.1 Best Practicable Treatment and Control Comprehensive Evaluation

The City's Waste Discharge Requirements (WDR 5-01-0136) requires that the RWRF identify waste constituents that threaten to degrade the groundwater, and complete a technical evaluation with recommendations for how these constituents will be treated or controlled in the discharge via a "Best Practicable Treatment and Control (BPTC) Comprehensive Evaluation" report. The BPTC was submitted to the RWQCB in December 2009 and addressed the six COCs that were identified in "Final List of Constituents of Concern for Best Practicable Treatment and Control" (Carollo Engineers) submitted in January 2007. The six COCs were:

- Arsenic
- Manganese
- Total Dissolved Solids (TDS).
- Electrical Conductivity (EC).
- Sodium.
- Total Nitrogen.

A major recommendation of the evaluation for each COC was to reduce hydraulic and COC loading into the percolation ponds by direct effluent recycling. This Recycled Water Master Plan provides an alternative use for the RWRF's effluent.

1.3 TYPES OF REUSE

This section describes the types of reuse considered in this Master Plan. The categories of reuse are urban irrigation, groundwater recharge, agricultural irrigation and fisheries enhancement.

1.3.1 Urban Reuse

Urban reuse is composed of the following demands for recycled water:

- Irrigation of public and private landscaped areas.
- Industrial uses (heating, cooling, industrial laundries, and other approved uses).
- Dual plumbing for toilet flushing in condominiums and institutional buildings.
- Ornamental lakes or fountains.

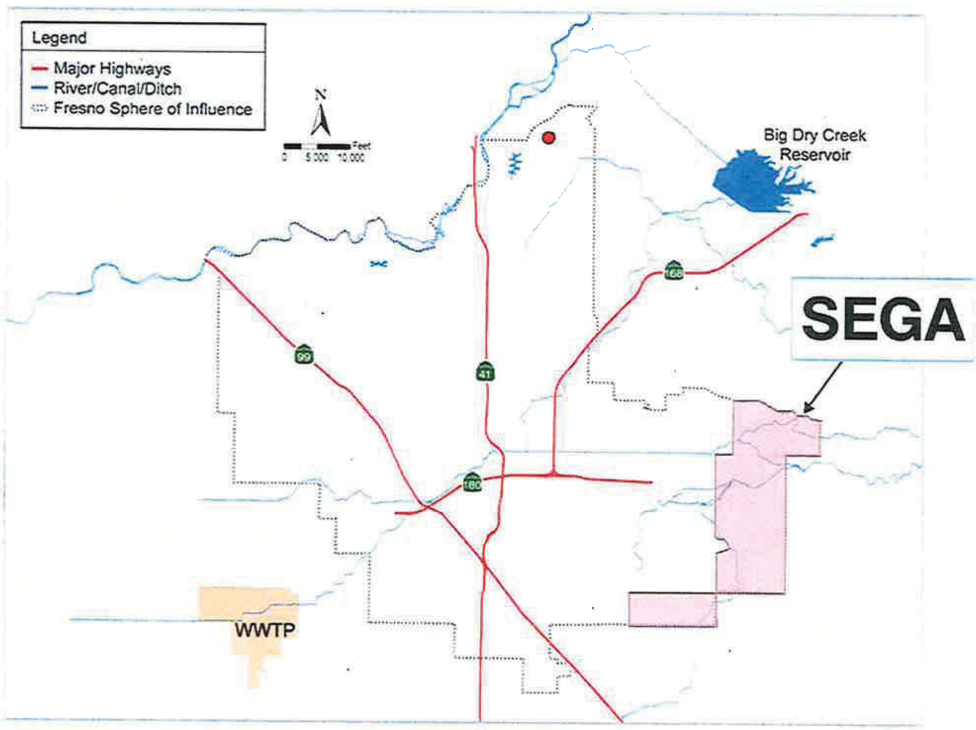

Figure 1.3
LOCATION OF SOUTHEAST GROWTH AREA (SEGA)
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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Although these are all possible uses for recycled water, some are easier to implement than others. Installation of a recycled water distribution system ("purple pipe") can be expensive, especially through a fully developed area, and potential demands need to be sufficiently large to warrant it.

1.3.1.1 Irrigation

Irrigation reuse is the largest potential existing potable offset. In general, golf courses are the largest application for irrigation reuse, followed by parks, schools, cemeteries and large water features. Highway median irrigation can also be a significant use in some areas, depending on the land area. Irrigation of new development areas is considered to the limited extent possible given the redirection of the General Plan discussed above.

The Recycled Water Ordinance will require use of recycled water by existing and future irrigation users including commercial, institutional and governmental properties, apartment and condominiums, single family residences, home owners associations (HOA), and open spaces.

1.3.1.2 Dual Plumbing

Dual plumbing poses a real opportunity for potable offset recycled water use in new facilities, and the concept is gaining wider public acceptance. Due to the difficulty and expense to dual plumb existing buildings, this has not been included as a significant use in the Master Plan. However, the proposed Recycled Water Ordinance does require dual plumbing in new nonresidential construction, new apartments and condominiums, and in apartments and condominiums that undergo significant remodeling and the remodel cost exceeds 30 percent of the property value.

1.3.1.3 Industrial

Although the City has many industrial users, only a few of them have large uses that can be offset with recycled water. Most of the industries in Fresno are food processors, and for public health reasons or public perception, recycled water is generally not used in food processing operations. The viable industrial uses consist mainly of industrial laundries or heating/cooling demands for large buildings. The Recycled Water Ordinance will require use of recycled water by existing and future industrial users.

1.3.2 Groundwater Recharge

Groundwater recharge is the augmentation of potable groundwater supplies with recycled water. Recharge can be performed via spreading (or "recharge") basins or direct injection. The state's draft Groundwater Recharge Reuse Regulations require reverse osmosis and advanced oxidation for direct injection. Due to the very high costs for these treatment requirements, this Master Plan only considered spreading basins for groundwater recharge.

Groundwater recharge is a desirable use since it can occur year-round, whereas irrigation demand is seasonal. Treatment facilities that produce high quality recycled water during the summer months for irrigation may also serve groundwater reuse recharge projects (GRRPs) during the winter.

Recharge potential is limited by land available for basins and the ability to obtain an adequate supply of diluent water. Diluent water is the water used to dilute the recycled water in the GRRP. It can be surface water, storm water, or groundwater. The draft regulations require a 4:1 blend of diluent water with recycled water for surface spreading recharge projects.

Due to the permitting process, as discussed in Chapter 2, implementation of GRRPs takes longer to implement. For this reason, GRRPs may not be implemented immediately, but may play an important role in the long term strategy for water supply and reuse implementation in Fresno. Potential sites for recharge basins are identified, as well as the issues and steps needed to implement groundwater recharge.

1.3.3 Agricultural Reuse

Agricultural irrigation represents the largest potential for beneficial reuse because the RWRF is surrounded by agricultural lands. As noted earlier, the City currently applies undisinfected secondary effluent to agricultural lands for restricted use. Depending on the crop, this type of use does not require additional wastewater treatment. The City could possibly expand its use of recycled water by delivering either secondary or tertiary treated water directly to local farmers.

Agricultural users in the vicinity use FID water and their own groundwater wells, not the City's potable supply. To derive a potable offset or "new supply" benefit from an agricultural reuse program, an agreement where the City exchanges recycled water for surface water would be needed.

As discussed under Section 1.2, the City has an existing exchange agreement with FID. The City has the option of reentering into negotiations with FID to increase deliveries of the extracted water to FID canals, or to deliver tertiary recycled water to the FID for unrestricted reuse. If a new exchange agreement is negotiated, both water and recycled water facilities would need to be constructed: Additional facilities may be needed to deliver larger recycled water flows from the RWRF to FID's canals. Additional facilities may be needed within the city to convey and treat FID's surface water for potable use, or to recharge it to the groundwater aquifer. The City has master planned the expansion of the northeast water treatment plant and construction of another southeast water treatment plant.

Agricultural exchange agreements with other water and irrigation districts are also possible. Any agreement would consist of exchanging recycled water for surface water. Additional conveyance facilities would be needed to deliver recycled water beyond the boundaries of

FID and additional water facilities would be required to accept and use a new surface water supply. This would be subject to FID consent, as discussed in Section 1.2.

1.3.4 Fisheries Enhancement Exchange

The US Bureau of Reclamation (USBR) is required by a court order to release sufficient water from the Friant Dam to maintain fish flows downstream in the San Joaquin River. An institutional exchange agreement may be possible whereby the City could deliver recycled water to supplement fish flows in exchange for a smaller amount of surface water to augment potable supplies. Since this alternative involves surface water discharge, the City would be required to obtain an NPDES permit.

1.4 RECYCLED WATER MASTER PLAN ORGANIZATION

The remainder of the Master Plan further develops the background, site-specific factors in the City and potential project alternatives for implementing recycled water projects in Fresno. The organization of the Master Plan is as follows:

- Chapter 2 – Regulatory and Water Quality Issues
- Chapter 3 –Potential Recycled Water Demands
- Chapter 4 – Project Alternatives
- Chapter 5 – Summary and Recommendations

REGULATORY AND WATER QUALITY REQUIREMENTS

2.1 INTRODUCTION

The purpose of this chapter is to identify existing and proposed state and regional regulatory requirements governing recycled water use in the City of Fresno. This chapter also analyzes the suitability of the RWRF effluent for irrigation.

2.2 CURRENT RECYCLED WATER REGULATIONS

The State Water Resources Control Board (SWRCB), the Regional Water Quality Control Boards (RWQCBs), and the California Department of Public Health (CDPH) have regulatory authority over projects using recycled water. The primary regulation governing recycled water use is the California Code of Regulations, Title 22.

2.2.1 California Code of Requirements - Title 22

Title 22 requirements are established and administered by the CDPH. Title 22 defines four types of recycled water uses based on the treatment process used, and the effluent total coliform bacteria, and turbidity levels. The CDPH has established the permitted uses for these four types of recycled water quality as summarized in Table 2.1. Title 22 also establishes approved uses of recycled water for industrial use, as shown in Table 2.2.

Table 2.1 Summary of Approved Title 22 Uses of Recycled Water for Irrigation
Recycled Water Master Plan
City of Fresno

Treatment Level	Approved Uses	Total Coliform (median)
Disinfected Tertiary	Spray Irrigation of Food Crops	2.2 / 100 ml
	Landscape Irrigation(1)	
	Unrestricted Recreational Impoundment	
Disinfected Secondary 2.2	Surface Irrigation of Food Crops	2.2 / 100 ml
	Restricted Recreational Impoundment	
	Surface Irrigation of Orchards, Vineyards	
Disinfected Secondary 23	Pasture for Milking Animals	23 / 100 ml
	Landscape Irrigation(2)	
	Landscape Impoundment	
Undisinfected Secondary	Fodder, Fiber and Seed Crops	N/A

Notes:
(1) Includes unrestricted access golf courses, parks, playgrounds, school yards, and other landscaped areas with similar access.
(2) Includes restricted access golf courses, cemeteries, freeway landscapes, and landscapes with similar public access.

Table 2.2 Summary of Approved Title 22 Industrial Recycled Water Uses
Recycled Water Master Plan
City of Fresno

Supply for Cooling and Air Conditioning:	
Industrial or commercial cooling or air-conditioning involving cooling tower, evaporative condenser, or spraying that creates mist	
Industrial or commercial cooling or air-conditioning not involving cooling tower, evaporative condenser, or spraying that creates mist	
Other Allowed Uses:	
Flushing toilets and urinals	Structural fire fighting
Priming drain traps	Non-structural fire fighting
Industrial process water that may contact workers	Industrial process water that will not come into contact with workers
Industrial boiler feed water	Mixing concrete
Decorative fountains	Flushing sanitary sewers
Commercial laundries	Soil compaction
Consolidation of backfill material around potable water pipelines	Artificial snow making for commercial outdoor use
Dust control on roads and streets	Cleaning roads, sidewalks, and outdoor work areas
Commercial car washes, not heating the water, excluding the general public from washing processes	

2.2.2 Recycled Water State Policy

Recycled water projects have historically been difficult to permit. The SWRCB recognized that a burdensome and inconsistent permitting process can impede the implementation of recycled water projects. As a result, the SWRCB adopted a Recycled Water Policy (RW Policy) in 2009 to establish more uniform requirements for water recycling throughout the State, and to streamline the permit application process in most instances.

The RW Policy includes a mandate that the State increase the use of recycled water over 2002 levels by at least 200,000 acre feet per year (AFY) by 2020, and by an additional 300,000 AFY by 2030. The RW Policy also includes goals for stormwater reuse, conservation and potable water offsets by recycled water. The onus for achieving these mandates and goals is placed both on recycled water purveyors and potential users.

Absent unusual circumstances, the RW Policy states that recycled water irrigation projects that meet CDPH Title 22 requirements and other State or Local regulations be issued permits by Regional Boards within 120 days. These streamlined projects will not be required to include a groundwater monitoring component.

The RW Policy requires development of salt/nutrient management plans for every basin in California. These plans are to be adopted as Basin Plan amendments by 2015. These management plans will be developed by local stakeholders and funded by the regulated community. The City is participating in the Central Valley Salinity Alternatives for Long Term Sustainability (CV SALTS) group, which is made up of stakeholders who are leading this effort in the Central Valley.

The findings of the salt/nutrient management plans will govern whether anti-degradation analyses are necessary for specific projects. While the plans are in the process of being drafted, anti-degradation analyses will be required for recycling projects where the discharge is more than 10 percent of the basin's available assimilative capacity for one project, or 20 percent for multiple projects. The RW Policy does not address the CDPH draft regulations for groundwater recharge.

The RW Policy specifies that a Blue-Ribbon Advisory Panel be convened to guide future actions with respect to Compounds of Emerging Concern (CECs). If any regulations arise from new knowledge of risks associated CECs, then projects will be given compliance schedules.

2.2.3 Groundwater Recharge Regulations

CDPH issued Draft Groundwater Recharge Reuse Regulations in 2008. A summary of the draft regulations is provided in this section, and a copy of the full draft regulations is included in Appendix A. Final regulations are not expected in the near future.

The draft regulations for a groundwater recharge reuse project (GRRP) include requirements in the following areas:

- Method of recharge
- Level of treatment
- Contribution of recycled water
- Retention time
- Water Quality

Regulations are established for the two methods of groundwater recharge, surface spreading or injection of recycled water into a groundwater aquifer. The level of treatment required depends on the method of recharge selected. For either method, the recycled water at a minimum shall be disinfected and filtered to meet tertiary treatment standards as defined by Title 22.

The draft regulations require that only a fraction of the water recharged through spreading basins may consist of recycled water. The remaining fraction must be diluent water from another source. The requirements for initial recycled water contribution for the different methods of recharge and level of treatment are listed in Table 2.3.

Table 2.3	Initial Recycled Water Contribution (RWC) for Different Types of GRRPs Recycled Water Master Plan City of Fresno
Type of GRRP	**Initial RWC**
Subsurface injection with Reverse Osmosis (RO) and advanced oxidation	50 percent
Subsurface injection without RO and advanced oxidation	Not permitted
Surface spreading with RO and advanced oxidation	50 percent
Surface spreading without RO	20 percent

The diluent water contribution is calculated as a 60-month rolling average. Therefore, diluent water can be banked in anticipation of, or made up after, a dry year. Sources for diluent water can include surface water, storm water or groundwater.

The draft recharge regulations dictate the retention time between recharge site and the nearest drinking water well, as measured by tracer studies. For each GRRP, the recycled water shall be retained underground for a minimum of six months to control pathogenic microorganisms.

The recycled water quality for a GRRP must meet the standards set by the CDPH and are reviewed and permitted on a site-specific, project-by-project basis. The concentration of total nitrogen in a new GRRP must either be less than 5 milligrams per liter (mg/L) measured in the treated effluent above ground, or 10 mg/L measured in the groundwater. The total organic carbon (TOC) limit in the filtered effluent must be less than 16 mg/L, and the limit in the groundwater is 2.5 mg/L for the initial recycled water contribution of 20 percent.

GRRPs must be monitored for regulated chemicals, including organic and inorganic chemicals, radionuclides, disinfection byproducts, lead and copper to ensure compliance with Title 22 maximum contaminant levels (MCLs). Monitoring is also required for a set of unregulated chemicals, priority toxic pollutants and other chemicals that the CDPH specifies, which may include pharmaceuticals, endocrine disruptors and other indicators of municipal waste.

CDPH will only consider an application to implement a recharge project if the Agency managing the treatment facility has in place a pretreatment and source control program. Additionally, before a GRRP is permitted, the Agency must have a plan for an alternative drinking water source in case the GRRP violates California drinking water standards or is degraded so that it is no longer is a safe source of drinking water. A list of steps necessary for the approval of a GRRP is provided in Appendix B.

2.2.4 Updates to the 2010 California Plumbing Code

The California Plumbing Code was recently updated to relax the restrictive rules for installing dual plumbing for indoor recycled water use, as well as for gray water. These changes pertain to Chapter 16 of Title 24, Part 5, of the California Code of Regulations.

The code revisions for recycled water were approved by the Building Standards Commission and will be part of the 2010 Code. The new rules remove some of the restrictions on the installation of recycled water pipe in buildings. The major features of the new dual plumbing rules are:

- Recycled water pipe can now run in the same wall/ceiling cavity as potable pipe.
- The labeling requirements for purple pipe are relaxed.
- The annual inspection is a visible inspection, followed by a cross-connection test if there's reason to believe a cross-connection exists, rather than an automatic cross-connection test each year.

2.3 FUTURE REGULATORY CONSIDERATIONS

Future regulatory concerns for the use of recycled water consist of the potential regulation of endocrine disrupting chemicals and other compounds of emerging concern (CECs). The State Recycled Water Policy highlights CECs as a potential issue for recycled water. A discussion of the current status of these emerging pollutants is provided below.

2.3.1 Microconstituents

In recent years there have been heightened scientific awareness and public debate over potential impacts that may result from exposure to microconstituents, some of which are endocrine disrupting compounds (EDCs). Humans, fish, and wildlife species could potentially be affected by sufficient environmental exposure to EDCs.

In 1996, new legislation required that the U.S. EPA "determine whether certain substances may have an effect in humans that is similar to an effect produced by a naturally occurring estrogen or other such endocrine effect." In response, the EPA developed the Endocrine Disrupter Screening and Testing Advisory Committee. This effort to develop a robust test to identify EDCs is ongoing, and its results may lead to increased monitoring and limits on CECs in recycled water in the future.

Based on the current state of knowledge and the low levels of microconstituents in surface waters, it is likely to be many years before any such standards are promulgated. Nonetheless, in December 2009, the EPA took the first step in the regulation of microconstituents in water by putting 13 of these compounds on their Contaminant Candidate List. These compounds will be tested in the future to determine whether drinking water criteria are necessary. If in the future these compounds are given human health criteria, they will be given limits in GRRPs.

While there are no current regulations regarding these constituents in recycled water, the State Recycled Water Policy convened a Blue Ribbon Panel to advise regulators as to the best way to proceed with monitoring for EDCs and other CECs. In June, 2010, the Blue Ribbon Panel released its recommendations for monitoring CECs in recycled water. The Panel recommends immediately monitoring for caffeine, 17-beta estradiol (a sex hormone) and triclosan (the active ingredient in antimicrobial soaps). In November 2010, the SWRCB will decide how to incorporate them into future permits. It will be important to continue to track research and regulations related to microconstituents in recycled water.

2.4 WATER QUALITY REQUIREMENTS

Water quality parameters such as salinity, nitrogen and metals can affect the acceptability of recycled water by users. This section reviews recommended water quality levels for reuse and compares these to the RWRF effluent.

2.4.1 General Irrigation Use Guidelines

The successful long-term use of recycled water for landscape and agricultural irrigation depends more on rainfall, leaching, soil drainage, irrigation water management, salt tolerance of plants, and soil management practices than upon water quality itself.

The Fresno RWRF effluent and extraction well monitoring results for 2008 were reviewed for key irrigation water quality parameters. Table 2.4 shows the RWRF effluent and extracted water quality compared to water quality guidelines for irrigation. Based on existing data, the degree of use restriction for irrigation parameters ranges from none to moderate; therefore the RWRF's effluent and extracted quality is appropriate for irrigation. However, if effluent is used for groundwater recharge, it will require nitrification and denitrification to meet the total nitrogen requirements.

Table 2.5 summarizes the concentrations of trace elements in the RWRF effluent and extracted well water. None of these constituents are at sufficiently high concentrations to be of concern as a water quality issue for agriculture or urban irrigation.

2.4.2 Water Quality for Industry

Industrial reuse applications approved by Title 22 and listed in Table 2.2 include applications such as cooling towers, ash sluicing, commercial vehicle washing, laundry facilities, dust control, fire protection, and waste dilution. In addition, petroleum refineries, chemical plants, and metal working facilities have recycled water uses beyond cooling purposes.

Table 2.4 Site Specific Salinity Objectives for Dominant Crops
Recycled Water Master Plan
City of Fresno

Constituent	EC, dS/m	TDS, mg/L	Chloride, mg/L	Sodium, mg/L	Boron, mg/L	Sodium Adsorption Ratio	Total Nitrogen, mg/L
Average RWRF Effluent Concentration	0.79	430	77	82	0.2	3.2	17
Average Extraction Well Concentration	0.85	525	87	84	0.2	2.5	2.6
General Guidelines[1]	0.7 - 3.0	450 - 2000	70 - 355	>70	1.0 - 2.0	3 - 9	Agronomic Rates
Site-Specific Limits for AGR[2]	1.4	766	175	161	1.0	N/A	Agronomic Rates
Most Sensitive Crops	Almonds and Grapes		Almonds		Unknown		

Notes:
(1) For Slight to Moderate Restrictions on use. Source: Ayers and Westcot 1984.
(2) Source: Grattan and Isidoro-Ramirez, 2005.

Table 2.5 Recommended Maximum Concentrations of Trace Elements for Agricultural Use
Recycled Water Master Plan
City of Fresno

Element	Recommended Limit (mg/L)[1]	Average Effluent Concentration (mg/L)	Average Extraction Well Concentration (mg/L)
Aluminum	5.0	0.026	<0.02
Arsenic	0.10	0.001	0.017
Cadmium	0.01	0.0008	0.0002
Chromium	0.10	0.0017	0.0008
Copper	0.20	0.006	0.003
Iron	5.0	0.4	0.09
Manganese	0.20[2]	0.036	*1.0*
Nickel	0.20	0.0028	0.015
Lead	5.0	0.0004	0.0003
Selenium	0.02	0.001	0.002
Zinc	2.0	0.04	0.006

Notes:
(1) Source: Ayers and Westcot, 1984
(2) Usually only toxic to plants in acidic soils

Parameters of concern for industrial reuse include calcium, magnesium, and hardness. As the concentrations of these parameters are similar in the RWRF effluent and in the City's potable water supplies, recycled water is considered suitable for industrial applications. For laundry facilities water must be nonstaining. Generally, this means that the water should be low in iron, manganese and color. The City would therefore need to verify that the constituents present do not stain. Commercial laundries are listed as potential recycled water users by the EPA (Guidelines for Water Reuse, US EPA, 2004).

2.5 REGULATIONS FOR DISCHARGE TO THE SAN JOAQUIN RIVER

If discharge to the San Joaquin river was part of a recycled water program, for example, as part of a fisheries enhancement program, an NPDES permit would be required. The North Fresno WRF already has an NPDES permit (CA0085189) , whose requirements indicate what would be required in a future NPDES permit. In general, permit limits for river discharge would be more extensive and restrictive than limits for urban or agricultural irrigation reuse.

Average month effluent limitations for the existing North Fresno WRF NPDES permit include:

- BOD – 10 mg/L
- TSS – 10 mg/L
- Total nitrogen – 10 mg/L (including 2 mg/L as ammonia and 8 mg/L as nitrate)

Additionally, the City would need to monitor and meet limits for colifom, electrical conductivity, chlorine residual and toxicity.

POTENTIAL RECYCLED WATER DEMANDS

3.1 INTRODUCTION

As discussed in Chapter 1, there are four types of reuse considered in this master plan: urban reuse (including irrigation and industrial uses), agricultural reuse, groundwater recharge and fisheries enhancement. This Chapter focuses on identifying and quantifying potential demand for the reuse opportunities and describes the overall approach used to evaluate the options. The discussion herein provides the basis for the selection and grouping of users into the project alternatives that are identified in Chapter 4.

3.2 URBAN REUSE OPPORTUNITIES

The types of urban recycled uses identified include urban irrigation (i.e., school yards, parks, cemeteries, golf courses, highway medians, Home Owners Associations (HOAs)) and industrial uses. Residential uses were also considered. This section describes how potential urban reuse customers (or users) were identified.

3.2.1 Recycled Water Ordinance

In order to implement the Recycled Water Program, the City needs to develop and adopt a "Recycled Water Ordinance." The purpose of the ordinance is to establish water recycling policy and criteria for its use within the Sphere of Influence. In general, the Ordinance will accomplish the following:

- Establish Administrative Authority
- Establish approved uses of recycled water
- Define areas of potential eligibility for recycled water service
- Specify mandatory and voluntary uses of recycled water, depending on user classifications
- Require installation of transmission and distribution infrastructure
- Encourage the use of voluntary retrofits for existing users that may not be addressed in the ordinance
- Require the City of Fresno to prepare Rules and Regulations
- Provide enforcement and severability clauses

The City needs to prepare "Rules and Regulations Governing the Distribution and Use of Recycled Water" that will be consistent with the Ordinance. The Rules and Regulations will govern the design, construction, and use of both the distribution system, to be operated by the City, and on-site recycled water systems to be operated by the users. The Wastewater

Management Division of the Department of Public Utilities will have the authority to enforce the Rules and Regulations by virtue of the Recycled Water Ordinance. The Wastewater Management Division will provide all operation, oversight, and administration of the Rules and Regulations for the end use of recycled water. In general, the Rules and Regulations document will include the following elements:

- Responsibilities for the City, Users, and Use Area Supervisors
- Requirements for the design, installation, and inspection of the distribution systems and on-site recycled water systems
- Application procedures and the City approval process
- Operation, Maintenance, and Management responsibilities for Users and the City
- Cross connection control test procedures
- Employee training requirements
- Prohibitions and Enforcement

3.2.2 Quadrants

Since the City is spread out over such a large area (105 square miles), the study area was divided into quadrants to facilitate the configuration of project alternatives, as illustrated in Figure 3.1. Potential users will typically be grouped by quadrants and served by recycled water produced either in that quadrant via the addition of satellite treatment or by a pipeline from the RWRF.

3.2.3 Existing Potential Urban Recycled Water Users

Of the existing urban water users, approximately 300 potential non-residential recycled water customers were identified by reviewing city GIS data for parks, schools, golf courses, and cemeteries. The customers were refined using multiple sources including previous reports, discussions with City staff, City water meter records and GIS mapping. In addition, large residential users were identified by identifying areas in the City with large lots and using GIS data and aerials to estimate potential irrigation demands.

3.2.3.1 Non-Residential Urban Irrigation Reuse

Potential recycled water demand at school yards, parks, cemeteries, and golf courses, was estimated based on the irrigable area obtained from GIS data and aerial maps. The estimated percentage of irrigable areas for different types of land uses are listed in Appendix C. The expected landscape irrigation requirements were calculated using climatological data for the Fresno area.

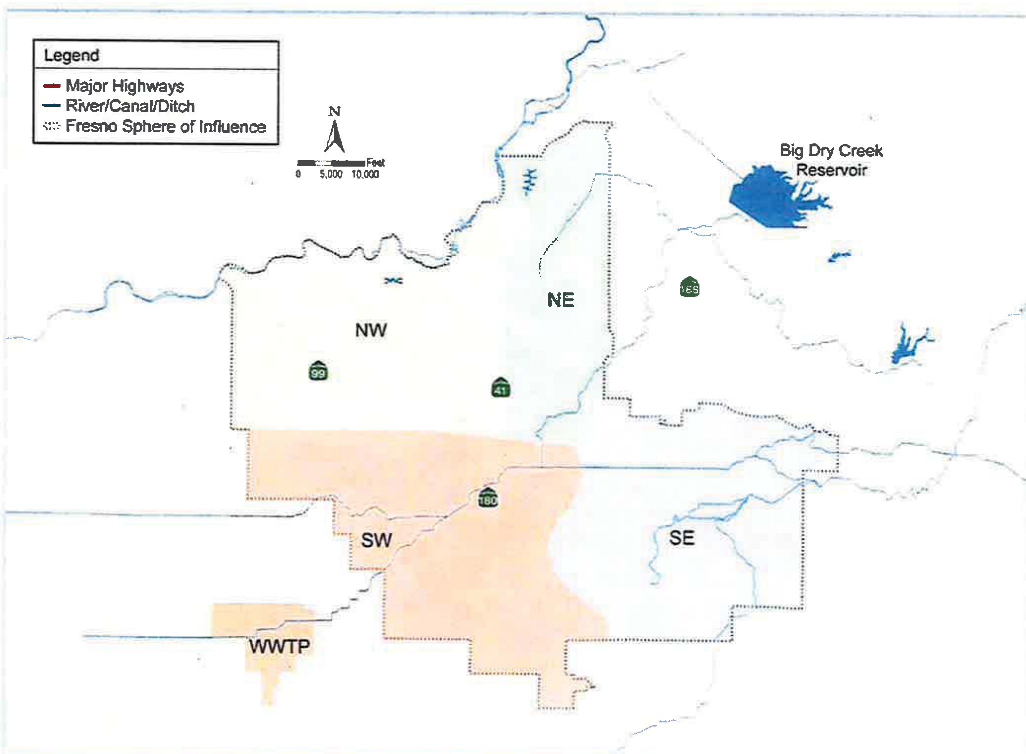

Figure 3.1
MAP OF QUADRANTS FOR
RECYCLED WATER PROJECT ALTERNATIVES
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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The City is in the process of implementing a water meter program for residential users. The City already meters non-residential users, however, although total water use data is available for many customers, metered water use data is not specifically broken out for irrigation uses. Therefore, landscape irrigation reuse requirements were calculated based on evapotranspiration and rainfall data. Calculated irrigation requirements were also used to estimate peak month demand, peak day demand, and peak hour demand for distribution system sizing considerations.

The amount of irrigation required for the potential irrigation customers is directly dependent on precipitation quantities in the region. The amount of precipitation, evapotranspiration, and irrigation required for the potential irrigation customers are listed in Table 3.1. The reference evapotranspiration was obtained from the California Irrigation Management Information System (CIMIS) evapotranspiration zoning map. To calculate the landscape evapotranspiration, the landscaped area crop coefficient was estimated using information contained in the Guide to Estimating Irrigation Water Needs of Landscape Plantings in California (2000) by the California Department of Water Resources. Based on interviews with local golf course superintendents, the main irrigable species used for landscaping in Fresno is warm-season turfgrass. It is assumed that parks, schools and cemeteries also use warm season turf grass (including varieties such as bermuda grass, bahia grass, buffalo grass, etc.), which is the "typical" type of grass used in areas with hot summers.

As can be seen in Table 3.1, the net annual average landscape irrigation requirement in the study area is approximately 32 inches (or 2.7 feet) per year. Based on data from CIMIS, the irrigation season is roughly March through October, a period of 245 days. Landscape irrigation demand peaks in the month of July, which is estimated to be 6.3 inches, or 20 percent of the annual total.

The recycled water system storage, pumping, and pipeline sizing requirements are based on the maximum day demand. The maximum day peaking factor represents the average day of the maximum month demand. The peak hour demand takes into account variations in demand over a 24-hour period. Urban irrigation of large areas (such as golf courses) commonly occurs at night over an 8-hour period; therefore the peak hour demand is generally 3 times larger than the maximum day demand.

To quantify total recycled water demand, peaking factors are used to calculate the average day, maximum day, maximum month and peak hour demands as follows:

- Average day flow = 1.0
- Maximum month to average day flow = 2.4 (based on climatological data)
- Maximum day to average day flow = 3.1 (30 percent higher than maximum month)
- Peak hour to average day flow = 9.3 (based on an 8-hr/d irrigation period)

Table 3.1 Average Annual Landscape Irrigation Requirements
Recycled Water Master Plan
City of Fresno

Month	Landscape Area Irrigation Required(1) (Inches)	Average Rainfall(2) (Inches)	Net Irrigation Requirement(3) (Inches)	Percent of Annual Net Irrigation Requirement(4) (%)
January	0.72	2.11	0.0	0%
February	1.26	1.90	0.0	0%
March	1.98	1.87	0.1	0%
April	***3.06***	***1.01***	***2.8***	***9%***
May	***3.96***	***0.37***	***4.9***	***15%***
June	***4.68***	***0.14***	***6.1***	***19%***
July	***4.68***	***0.01***	***6.3***	***20%***
August	***4.14***	***0.01***	***5.6***	***17%***
September	***3.24***	***0.16***	***4.2***	***13%***
October	***2.16***	***0.51***	***2.2***	***7%***
November	1.08	1.14	0.0	0%
December	0.54	1.58	0.0	0%
Total	**31.50**	**10.81**	**32.2**	**100%**
			2.7 feet	

Notes:

(1) Landscaped area irrigation required was obtained using the reference evapotranspiration from the California Irrigation Management Information System ET Zone Map. According to Water Use Classification of Landscape Species (WUCOLS) reference map, the City of Fresno is located in Zone 12. Irrigation requirements are calculated as $ET_L = K_L * ET_o$ Where: ET_L = Evapotranspiration of landscaped areas (in inches), K_L = Landscaped area crop coefficient, ET_o = Reference evapotranspiration (in inches).The ET values are adjusted for the landscape irrigation coefficient K_L, where $K_L = K_s * K_{mc} * K_d$ which accounts for the species, microclimate and vegetation density. These factors were estimated to be 0.6, 1, and 1, respectively.

(2) Source: Fresno Station #042357 Data from the Western Regional Climate Center Precipitation Gauges, 1948-2008; ***Bold italics in table represent irrigation season.***

(3) [Evapotranspiration - Rainfall] *1.15/0.85. Where 0.85 = 85% Irrigation Factor (Average value from Carlos and Guitjens, University of Nevada) and 1.15 = 15% Leaching Fraction (Average value from Ayers and Westcot, "Water Quality for Agriculture", Food and Agriculture Organization of the United Nations).

(4) Current month net irrigation requirement divided by total net irrigation requirement.

Treatment facility capacity was based on maximum day demand, and distribution system sizing was based on a combination of maximum day and peak hour demand, depending on whether storage is available near users. While this approach is conservative for pipe sizing, and pipeline sizes can be reduced if storage near users is identified, it allows capacity in the pipeline for serving potential new or unidentified users along the pipe route.

A full list of all the non-residential urban irrigation sites identified, the estimated irrigable acreage, and the estimated average annual water demand is included in Appendix C. In total over 12,000 acre feet per year (AFY) of potential urban irrigation demand was identified for irrigation of parks, schools, cemeteries and golf courses. These users are located throughout the City, and average pipeline costs to serve smaller users are approximately $1.2 million per mile. Therefore, serving the largest users will drive the development of the distribution system alignments.

3.2.3.2 Residential and Commercial Irrigation Reuse

There are limited examples of residential recycled water irrigation projects in California. One example is the El Dorado Irrigation District where the Serrano planned community installed recycled water during the initial construction of the development for the purpose of irrigating residential irrigation in front and back yards. Another example is Irvine Ranch Water District where a few hundred estate-sized residential lots use recycled water for front and backyard irrigation. In general, backyard irrigation is less desirable than front yard irrigation because of the lack of access for any maintenance concerns.

Implementation of recycled water for densely developed existing residential or commercial areas would be difficult due to the amount of roadway or private land that must be disturbed for a minimal demand at each turnout. Typically, only front yards are served for residential irrigation, so that the City doesn't need to maintain a lateral that traverses to the back of the homeowner's property. If the City wishes to serve residential and commercial users, the average demand is approximately 25 AFY per mile of pipe (assuming an average of 5 percent irrigable area in commercial areas and 20 percent irrigable areas in residential areas of 5 lots per acre and less).

It will be less expensive and will cause less disturbance to the community to install purple pipe in new residential areas compared to existing residential areas. However, there are a few existing residential areas, such as the Fig Garden Community, where there are large lot sizes and dirt shoulders where installing purple pipe for irrigation would yield a greater return in recycled water supplied per mile of pipe installed than other more densely developed areas.

Toilet flushing is another possible use for recycled water in new multi-unit developments. The demand for toilet flushing ranges from 11 to 43 AFY per mile of pipe for a 10 to 40 unit complex.

3.2.3.3 Industrial Reuse

Industrial users with high water use were identified by the City's water billing records. As part of the industrial pretreatment program, industries are required to report different types of water use to the City. Using these records, it is possible to estimate the potential recycled water demand. Based on Title 22 approved uses, the following types of industrial water use in Fresno can be served by recycled water:

- Sanitary (i.e., restrooms) - for toilet flushing at industrial sites
- Process water except for food processors
- Cleanup/wash down except for food processors
- Boiler Feed
- Cooling
- Irrigation

Title 22 does not allow the use of recycled water in food processing facilities where food can come into contact with the water. However, some of the non-food processing water uses listed above can also be served with recycled water at industries that process food. Assuming that all the above allowable uses are served with recycled water, as shown in Table 3.2, the potential recycled water demand for industries is 2,595 AFY. The Recycled Water Ordinance encourages existing industries to recondition their facilities to use recycled water.

Unlike irrigation reuse which peaks during the summer and drops to zero in the winter, the non-irrigation and non-food processing types of uses identified for industrial reuse vary throughout the year, but are expected to have a steadier demand with lower seasonal peaks.

3.2.3.4 Caltrans (Highway median irrigation)

The Caltrans median irrigation system is made up of individual points of connection with the City's water distribution system, and is not internally interconnected. Each point of connection can irrigate an area up to three quarters of a mile in each direction.

Table 3.2 Potential Industrial Users Recycled Water Demand
Recycled Water Master Plan
City of Fresno

Name of Industry	Type of Industry and Major Use (for Recycled Water)	Existing Water Use (AFY)
Ameripride	Laundry – Wash water	126
Angelica Textile Services	Laundry– Wash water	125
Aramark	Laundry– Wash water	160
Beef Packers	Food Processor – Boiler/Cooling	62
California Dairies (Danish Creamery)	Food Processor – Toilet Flushing/Boiler/Cooling	632
Cellulo Co.	Filter Manufacturer – Process	167
Cornnuts Inc.	Food Processor – Boiler	8
Darling International	Food Processor – Cooling	68
Foster Farms Belgravia	Food Processor - Toilet Flushing/Cooling	147
Foster Farms Dairy	Food Processor – Boiler/ Cooling	50
Foster Farms Poultry	Food Processor – Toilet Flushing/Boiler/Cooling	131
Fresno Community Hospital	Hospital – Cooling and Irrigation	108
Kraft Foods (Capri Sun)	Food Processor – Boiling/Cooling	171
Lyons Magnus	Food Processor – Boiler/Cooling	23
Mission Linen	Laundry– Wash water/Toilet Flushing	78
Pacific Choice Brands	Food Processor – Boiler/Cooling	99
Pepsi-Cola Bottling	Food Processor - Toilet Flushing/Boiler/Cooling	20
Producer's Dairy	Food Processor - Toilet Flushing/Boiler/Cooling	16
Prudential Overall Supply	Laundry – Wash water	43
Saint Agnes Hospital (2006)	Hospital – Cooling/Irrigation	42
University Medical Ctr.	Hospital – Cooling	51
Veterans Administration Hospital	Hospital – Cooling/Irrigation	88
Wawona Frozen Foods (Fresno)	Food Processor – Boiler/Cooling	44
Zacky Turkey	Food Processor – Boiler/Cooling	136
	Total	**2,595**

There are few freeway crossings, so in most cases a single point of connection only irrigates one side of the freeway. Caltrans' total water annual water use for 2008 and 2009, as billed by the City, is approximately 800 AFY. While it may not be feasible to run purple pipe to every Caltrans connection, individual points of connection can represent significant water use – up to 20 AFY each.

Many of the newer and improved highways are using plant-specific sprinklers and are no longer irrigating with long sweeping big gun sprinklers that spray water over a large area. This type of irrigation system is being phased out due to water waste and runoff issues. As landscaped areas along the freeways are upgraded, they will use much less water. That being said, highway medians remain a key targeted recycled water user in this Master Plan.

3.2.4 Recycled Water for Future Development

The City's General Plan and EIR, adopted in November 2002, provide long-range planning for development over the next two decades. It includes community and specific plans that address growth and infill in different areas of the City. The General Plan identified two growth areas, the North Growth Area and the Southeast Growth Area. The North Growth Area has since been developed and is served by the North Fresno Wastewater Reclamation Facility. The General Plan also established objectives and policies to encourage development/revitalization of the Centre City area and to promote densification through formation of "Intensity Corridors". The area on either side of Highway 41 has been designated an "Intensity Corridor."

The population and growth projections in the General Plan were based upon the robust growth at the time the Plan was developed. Because of the recent housing market decline, development has slowed significantly. In addition, based on discussions with the Planning and Development Department, the City's new focus for growth is densification and in-fill. Therefore, the General Plan will be revisited in the coming years. It is likely that as the General Plan changes, planning scenarios for the Recycled Water Master Plan will also need to be updated.

The revised General Plan's focus on densification may result in the decrease of irrigable green space for future developments. However, there will be increased opportunities to implement reuse for dual plumbing inside new buildings. In general, the City intends for recycled water to be an integral component of future development. The draft Ordinance requires use of recycled water for irrigation of landscape in common areas and front yards for new developments. The Ordinance also requires dual plumbing for new apartments and condominiums.

Incorporation of the Southeast Growth Area (SEGA) into the City was a major goal of the 2025 General Plan. The original intent of the City was that SEGA would be self-sustaining with respect to water and wastewater and the City intended to build a satellite recycled water facility for SEGA. The City intends to have a separate specific plan under development to further define the SEGA development and the use of recycled water within SEGA. The SEGA specific plan was put on hold during the duration of this master planning process. Therefore, evaluation of recycled water uses within the SEGA area is beyond the scope of the Recycled Water Master Plan (Master Plan). However, opportunities to utilize a satellite facility for users in the southeast quadrant outside of SEGA will be considered in the Master Plan. With the decline in development and the redirection of the General Plan, it is likely that SEGA will develop at a much slower rate than envisioned in the 2025 General Plan.

Due to the uncertainties surrounding the location and timing of future developments, it is difficult to quantify potential reuse demands for serving these future users. In general estimated demands for future residential development range from 13 AFY per mile of pipeline for high-density residential development (apartment buildings) to 35 AFY per mile for low-density residential development (2 homes per acre). For indoor dual plumbing in condominiums and apartments, demand can range up to 43 AFY per mile for a forty-unit building. Distribution systems are sized so that they can accommodate future growth, so delivering recycled water to new developments will be part of future growth and infill projects.

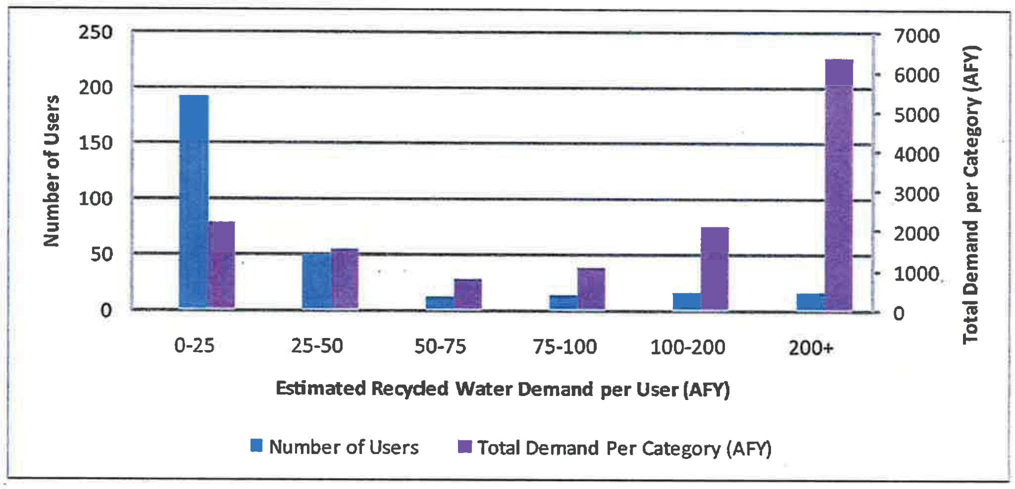
Future service to the Hwy 41 intensity corridor is included in this Master Plan. Based on a combination of dual plumbed mid- and high-rise development with 10 percent irrigable green space, the estimated demand for an 8-mile stretch along this corridor is approximately 300 AFY.

Areas within the City, primarily in the southwest and southeast quadrants, that are currently being used for agricultural are zoned for future residential development. Pipelines that go through these areas will be sized to deliver water to future residences at a rate of 35 AFY per mile. In the meantime, recycled water can be made available to any willing agricultural users that are along the pipeline alignment.

3.2.5 Distribution of Recycled Water to Urban Customers

Urban reuse provides an opportunity to implement recycled water projects that directly offset potable water and are highly visible to the community. However, urban reuse is more distribution system-intensive than other alternatives such as groundwater recharge and agricultural reuse, since landscape irrigation and industrial users are spread out across the City. While all irrigation and allowable industrial users are potential recycled water customers, aligning the distribution system to first serve large users, provides the most "bang for the buck" in pipeline construction.

The majority of the estimated demand is among existing large water users. Figure 3.2 shows the distribution of estimated use volumes among the potential users. As seen, the largest demand comes from eleven users with an individual demand exceeding 200



This graph illustrates that the "biggest bang for the buck" in distributing recycled water for urban reuse is to serve users of more than 200AFY.

Figure 3.2
DISTRIBUTION OF NUMBER OF RECYCLED WATER USERS AND TOTAL RECYCLED WATER DEMAND
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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AFY each. These larger users are generally land-intensive parks, cemeteries and golf courses that are located around the outskirts of the City. These 11 large volume users account for approximately 60 percent of the total estimated irrigation demand (or 8,000 AFY). The City will maximize the initial use of recycled water at the lowest cost by designing a recycled water distribution system to primarily serve these potential customers. The use of recycled water can be further maximized by connecting smaller nearby users to the distribution system connecting the large users. Additional smaller users can then be connected in the future, since they will have little impact on the sizing of the distribution system or treatment facilities.

In addition to large users, recycled water will be delivered to high profile, demonstration sites, such as City Hall. Recycled water will also be provided in the future to new "green" development where recycled water would be used for landscape irrigation and indoor dual plumbing.

3.3 AGRICULTURAL REUSE

Fresno is fortunate in that agricultural reuse provides a significant opportunity for recycled water use with relatively low capital, regulatory and operational investment. There are five types of opportunities for direct agricultural reuse considered in this Master Plan:

- Expansion of direct deliveries of undisinfected secondary effluent to farmers
- Direct deliveries of tertiary treated effluent for unrestricted reuse to farmers
- Expansion of the existing practice of delivering extracted percolated effluent to Fresno Irrigation District (FID) via canal system
- Delivery of tertiary treated effluent for unrestricted reuse to FID via canal system
- Delivery of tertiary treated effluent for unrestricted reuse to another agency via pipeline

Based on the existing RWRF flow (approximately 80,000 AFY) and existing reuse volumes (approximately 35,000 AFY of direct secondary effluent reuse and extracted percolate delivered to FID), up to 45,000 AFY of additional effluent could be used for other purposes. The existing agreement with FID prevents the RWRF from taking any action that would lower the groundwater in the vicinity of the RWRF below the previous year's levels. While the amount of diversion or extraction allowable without affecting groundwater levels has not been studied, it is assumed that the full flow of the RWRF is available for beneficial reuse since there is currently a groundwater mound beneath the RWRF.

3.3.1 Direct Delivery of Undisinfected Secondary Effluent via Pipeline

The RWRF currently delivers approximately 10,000 AFY of undisinfected secondary effluent to nearby growers of non-food crops. RWRF staff performed a preliminary evaluation of expanding the direct reuse system to nearby growers willing to accept recycled water (shown in Figure 3.3). Corn for animal feed is allowed under Title 22 to be irrigated with undisinfected secondary effluent. Between the two identified corn-growing farms, an additional 1,400 acres could be served with undisinfected secondary effluent, provided that piping was available to convey the water. Corn uses approximately 3 feet of water per acre per year, so the 1,400 acres translates to a recycled water demand of 4,200 AFY. Expanding direct delivery of secondary effluent recycled water to nearby farmers relieves the hydraulic loading on the RWRF percolation ponds and meets the City's goal to increase recycling.

3.3.2 Direct Delivery of Tertiary Effluent to Growers via Pipeline

In addition to expanding the existing secondary reuse system, the City could upgrade its treatment facilities and deliver tertiary water to individual farmers for unrestricted reuse.

Serving the users directly would require installing a new distribution system to serve individual users. Farmers in the area are already served by an extensive canal system managed and owned by FID. Based on the City's direction, this alternative was not considered further in this Master Plan for large scale implementation of reuse to local farmers, as it would be more cost effective to utilize the existing canal system. However, individual growers could be served with turnouts from the urban reuse distribution system. Demands have been estimated at 450 to 900 AFY per mile of pipeline, assuming 1/8 to 1/4 mile of land could be irrigated on either side of a pipeline.

3.3.3 Expand Existing Practice of Delivering Extracted Percolate to FID Canals

Between 2000 and 2008, the RWRF extracted up to 34,000 AFY of percolated effluent from extraction wells and delivered this water to FID canals for use by downstream agricultural users (See Table 1.1 in Chapter 1). This alternative would expand on this existing practice to increase pumping from the groundwater beneath the percolation ponds for delivery to FID.

The City is surrounded by agricultural areas that are served by FID. FID maintains 800 miles of canals and provides water to 150,000 acres of farmland. A list of growers in the area immediately adjacent to the RWRF (Township 14, Range 19) was obtained from the County so that agricultural water demands could be estimated. Table 3.3 shows the annual demand of crops commonly grown near the RWRF. An average annual irrigation demand of 3.2 feet was calculated by taking an area-weighted average of the demands of all the crops.

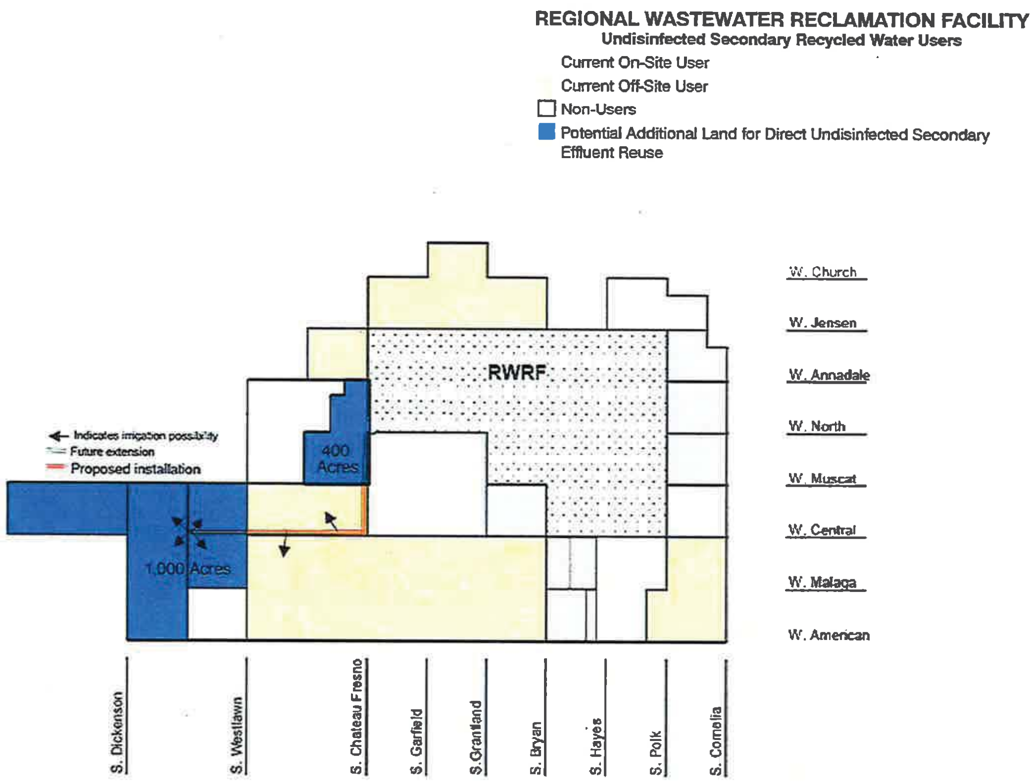

Figure 3.3
POTENTIAL EXPANSION OF DIRECT REUSE DELIVERY SYSTEM
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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Figure 3.4 shows the FID canal system in the vicinity of the RWRF. The City currently provides extracted water in the Houghton and Dry Creek canals near the RWRF. Depending on the alternative considered and the location of new treatment systems and pipelines, additional supply of recycled water can be delivered to various canals within the

Table 3.3 Irrigation Demands of Crops Prevalent Near the RWRF
Recycled Water Master Plan
City of Fresno

Crop	Annual Irrigation Demand (feet)
Alfalfa	4.5
Citrus	3.0
Corn	3.0
Orchard	3.9
Other(1)	2.7
Pasture	4.6
Small Grain	1.4
Vineyard	2.7

Note:
(1) "Other" is an estimate for crops that do not fall into the listed categories.

FID system. The City's current extraction wells and pipeline system for delivery to each of these canals cannot accommodate more flow; therefore new infrastructure would be required.

Preliminary discussions with FID have indicated that if the appropriate contracts and agreements were in place, they would be willing to operate their canals continuously to convey recycled water away from the RWRF to agricultural users or recharge basins. Further discussions with FID to better define canal capacity would be necessary prior to implementing this alternative.

In the past, pumping extracted groundwater from below the percolation ponds for use in agricultural irrigation has not been regulated. Due to concerns that this existing practice may be regulated differently in the future, research is being started to demonstrate the effectiveness of soil-aquifer treatment (SAT). The research is expected to show that SAT (of unfiltered and undisinfected wastewater) produces high quality water that is equivalent to Title 22 requirements for unrestricted reuse.

Agricultural reuse by sending either extracted percolate or tertiary water to FID canals presents an opportunity to exchange surface water for the recycled water. The existing agreement with FID would need to be renegotiated to allow increased deliveries. The City has not historically used its full entitlement of surface water from the existing FID agreement due to lack of demand and adequate facilities (recharge basins or water

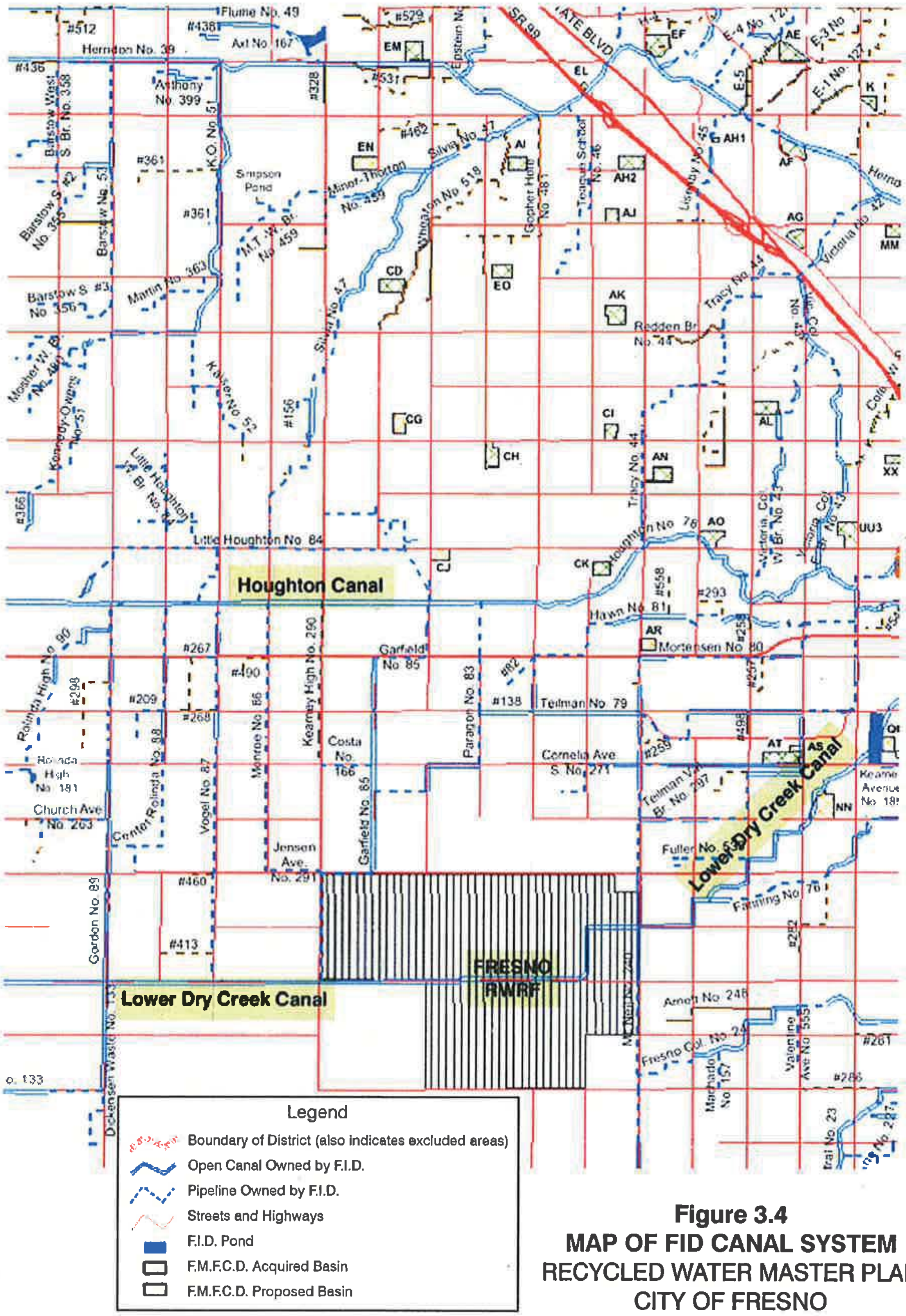

Figure 3.4
MAP OF FID CANAL SYSTEM
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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treatment facilities). Additional facilities would be needed within the city to convey and treat FID's surface water for potable use, or to recharge it to the groundwater aquifer. The City has master planned the expansion of the northeast water treatment plant and construction of another southeast water treatment plant. As the City faces dwindling water supplies and decreasing groundwater levels, the surface water exchange will become more critical to its overall water portfolio.

3.3.4 Delivery of Tertiary Effluent to FID Canals

Instead of delivering extracted groundwater to FID canals, tertiary treated recycled water could be delivered directly to the canals. This alternative would require the RWRF to upgrade to tertiary treatment. The City would also need to renegotiate its agreement with FID to allow this type of delivery. This alternative would be more expensive than delivery of extracted percolated effluent (due to the additional treatment), while providing the same volume of water. However, this alternative is considered in the Master Plan in case the Regional Water Quality Control Board (RWQCB) does not recognize the percolation and extraction as equivalent to tertiary treatment in the future. Again, in order to take advantage of any new exchange agreement, additional facilities would be needed to convey and treat FID's surface water for potable use, or to recharge it to the groundwater aquifer.

3.3.5 Delivery of Recycled Water to Other Agencies via Pipeline

Delivery to other agencies, or irrigation districts, would likely require the RWRF to upgrade to tertiary treatment. In addition, the City would need to renegotiate its agreement with FID to convey recycled water outside FID's boundaries. This alternative was explored in the 1996 RWRF Master Plan, and the relevant section of that study is included in Appendix D. As this alternative has many institutional and political challenges, it will not be further explored as part of this Master Plan. However, in the interest of providing a diverse portfolio of options, the City should consider evaluating opportunities for potable water exchanges with other agencies in the future.

3.4 GROUNDWATER RECHARGE OPPORTUNITIES

Groundwater reuse recharge projects (GRRPs) are an opportunity to directly augment the City's potable supply, and provide a use for recycled water during the winter. Fresno's residents are already familiar with surface water recharge facilities scattered throughout the City, so the public is more likely to accept groundwater recharge than other cities unfamiliar with the concept.

Fresno's groundwater recharge potential depends on the ability to site basins in areas that have high percolation, the availability of diluent water and the travel time of percolated recycled to drinking water wells. As discussed in the regulatory section (Chapter 2), recharge basins must have six-months of hydraulic separation from the point of recharge to the nearest drinking water well. This separation requirement limits the ability to site recharge facilities in the more developed parts of the City. Most likely, recharge facilities will be sited in the less developed areas of Fresno where there are fewer drinking water wells.

3.4.1 Diluent Water Sources

As discussed in Chapter 2, recharge regulations require that recycled water be blended with diluent water at a 1:4 ratio for surface spreading of tertiary recycled water. There are typically two sources of water that can be used for the diluent water: stormwater and raw (untreated) surface water. Fresno is fortunate to have several possible sources of diluent water: surface water from the US Bureau of Reclamation (USBR), Kings River entitlements for being inside FID boundaries, as well as stormwater managed by the Fresno Metropolitan Flood Control District (FMFCD). FMFCD operates recharge basins throughout the City for the purpose of recharging raw surface water and stormwater.

In discussions with FMFCD staff, they have indicated their willingness to work with City staff to provide diluent water in exchange for new recharge basins that would provide additional capacity for stormwater storage. Ideally, they prefer not to comingle recycled water in their stormwater basins in order to separate maintenance and operation issues between the two agencies and to simplify permitting issues. Stormwater would primarily be available as diluent water during the winter months. Surface water could theoretically be provided year-round for use as diluent water.

3.4.2 GRRP Basin Siting and Sizing

If stormwater water is to be used as diluent water, the best place to site the GRRP basins is adjacent to FMFCD basins or conveyance facilities. This way, stormwater can easily be conveyed into the recycled water recharge basins. If surface water is used as diluent water, then the water would be supplied from FID canals directly into the GRRP basins and the basins would best be sited near the canals.

The City is also considering the construction of "super-recharge basins" to increase the capacity to recharge surface water. If these basins are constructed, a portion of the recharge water could be made up of recycled water, provided there is adequate (6 months) travel time to the nearest drinking water well. Tentative locations of these super-recharge basins are shown in Figure 3.5.

The size of the GRRP basins will likely be driven by the availability of land (rather than the area needed to percolate the available recycled water) as the City is well developed in many parts of town. Basin sizing will also be driven by the volume and timing of delivery of diluent water, as there is four times more volume of diluent water required for blending than there is recycled water recharged. If diluent water is provided by FMFCD, then it will only be available during the winter, which is likely the same time that excess recycled water will be available for recharge (i.e., during the non-irrigation season). In this situation, the basin would need to be large enough to accommodate water from both sources at the same time. The amount of recycled water that can be percolated in a given area is maximized if

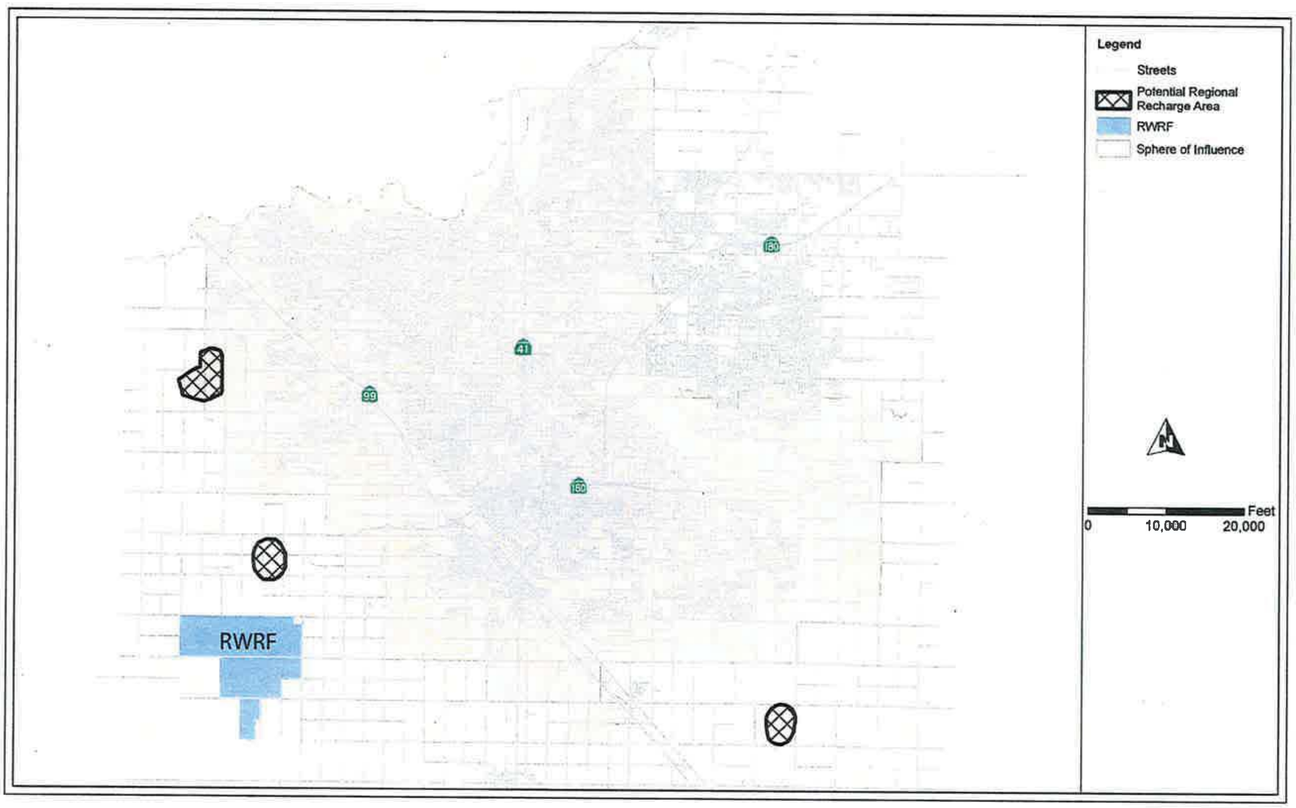

Figure 3.5
TENTATIVE LOCATIONS OF SUPER-RECHARGE BASINS
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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diluent water is provided during a different time of year, or in an adjacent basin, so that the recycled water does not have to compete for basin capacity with the diluent water.

Percolation rates have been measured in FMFCD basins varying from 1.2 to 4.8 inches/ day. Similar percolation rates would be expected in future GRRP basins. These percolation rates result in a recharge capacity of 33,000 to 130,000 gallons/acre/day (0.1 to 0.4 acre feet/acre/day) while the basin is in use. Percolation rates are highest on the west side of town, where it is also easiest to supply recycled water from the RWRF, and where fortunately there is an abundance of undeveloped land available. Including super-recharge basins, a total of approximately 2,450 acres of land have been preliminarily identified as possible sites for recharge basins. If all the identified sites were implemented, approximately 31,850 AFY of recycled water could be recharged (using an average percolation rate of 2.4 inch/day).

3.5 FISHERIES ENHANCEMENT EXCHANGE OPPORTUNITIES

The USBR is required by a 2006 Federal Court settlement to release sufficient water from the Friant Dam to maintain fish flows downstream in the San Joaquin River. One reuse alternative identified early in this Master Plan was the potential use of recycled water for stream flow enhancement.

In discussions with the USBR, agency representatives indicate that the amount of recycled water that could be supplied is a tiny fraction of the volume that is needed for fish flow maintenance in the river. The amount of water required to enhance San Joaquin River, 500,000 AFY, is significantly more than the City's entire potential recycled water supply, which is less than 80,000 AFY. The USBR staff also expressed concerns that the water quality and the temperature of the recycled water may be not being appropriate for the fisheries. Additionally, the USBR requires the water mostly in the spring when there is a high demand for recycled water for irrigation uses.

As a result of all this, discussions with the USBR were not pursued further, since fisheries enhancement exchange did not appear to be viable.

PROJECT ALTERNATIVES

4.1 INTRODUCTION

Presented in this chapter is the development of the various recycled water uses (urban, agricultural and groundwater recharge) into project alternatives to be carried forward for further analysis. The project alternatives were configured to maximize the delivery of recycled water to each quadrant of the City, and to provide adequate cost and implementation information for moving forward with a recommended recycled water program.

4.2 SUMMARY OF PROJECT ALTERNATIVES

Project alternatives were developed for each type of water reuse including urban irrigation and industrial reuse, groundwater recharge, and agricultural reuse alternatives. Components of the project alternatives included: regional treatment or satellite treatment, distribution system, collection system flow diversions for satellite treatment, and influent and effluent storage.

4.2.1 Urban Alternatives

The City was divided into quadrants to develop the configuration of urban reuse project alternatives. Potential users were identified in each quadrant. Alternatives were then developed by grouping users in each quadrant and determining how they could be served. There were two treatment (recycled water production) alternatives considered when serving urban users: Alternative 1) delivering recycled water from the RWRF; and Alternative 2) delivering recycled water from Satellite Recycled Water Facilities (SRWFs) located in the vicinity of the uses. The designation of Alternative 1 or 2 were applied to recycled water use in each of the quadrants: the Southwest, Northwest, Northeast and Southeast. The project alternatives are summarized in Table 4.1. The total estimated demand that could be served by each alternative is also listed in Table 4.1, along with treatment flows. Alternatives in the same quadrant do not necessarily have the same demand, as different alignments allow serving different users.

Potential users were grouped into alternatives based on volume of demand and location. The larger users with demands over 100 AFY dictated the proposed pipeline alignments. In general these large users, such as golf courses, cemeteries and parks are located on the edges of town. Serving these larger users created a "backbone" distribution system around the City with spurs into the more densely developed areas to pick up additional users. The identified larger users and their demands are shown in Figure 4.1 along with the proposed backbone distribution system. Groundwater recharge opportunities could also be served by

Table 4.1	Summary of Urban Reuse Project Alternatives Recycled Water Master Plan City of Fresno			
Quadrant/ Alternative	Demand AFY[(1)]	Treatment Capacity at RWRF (mgd)[(1,2)]	Treatment Capacity at SRWF (mgd)[(2)]	Comments
SW - 1	4,140/5255	5.5/8.1	-	Served entirely from the RWRF
SW - 2	4,340	1.4	4.1	Served partially from the RWRF and partially from a SRWF at either Fruit & Church or south of Roeding Park
NW - 1	1,951/3,733	5.3/10.4	-	Served entirely from the RWRF
NW - 2	1,709	-	4.7	Served from a new SRWF at Herndon and Hayes
NE - 1	2,720/3,568	3.7/6.1	1.07	Served partially from the RWRF and partially from the North Fresno WRF
NE - 2	508	-	1.07	Served entirely from the North Fresno WRF
NE - 3.A	263	-	0.7	Served from a new SRWF on CSUF campus
NE - 3.B	4,900	-	4.0	Served from a new SRWF at Granite Park
SE - 1	995/1,820	2.8/5.1	-	Served entirely from the RWRF
SE - 2	951	-	3.0	Served from a new SRWF near at the fairgrounds, or a nearby park in SEGA

Notes:
(1) Where numbers are presented as x/y, x is the demand or flow without residential and commercial reuse, and y is the number including residential and commercial reuse. Demands do not include potential for groundwater recharge.
(2) Treatment flows based on maximum day demand of potential urban irrigation and industrial reuse customers.

this distribution system during off-irrigation periods. Groundwater recharge basins could be filled in the winter when urban irrigation demands are minimal.

The backbone distribution system alignments shown in Figure 4.1 were selected based on consideration of the following elements: available right-of-way, utility conflicts, traffic volumes, highway and railroad crossings, jurisdictional agencies and special circumstances.

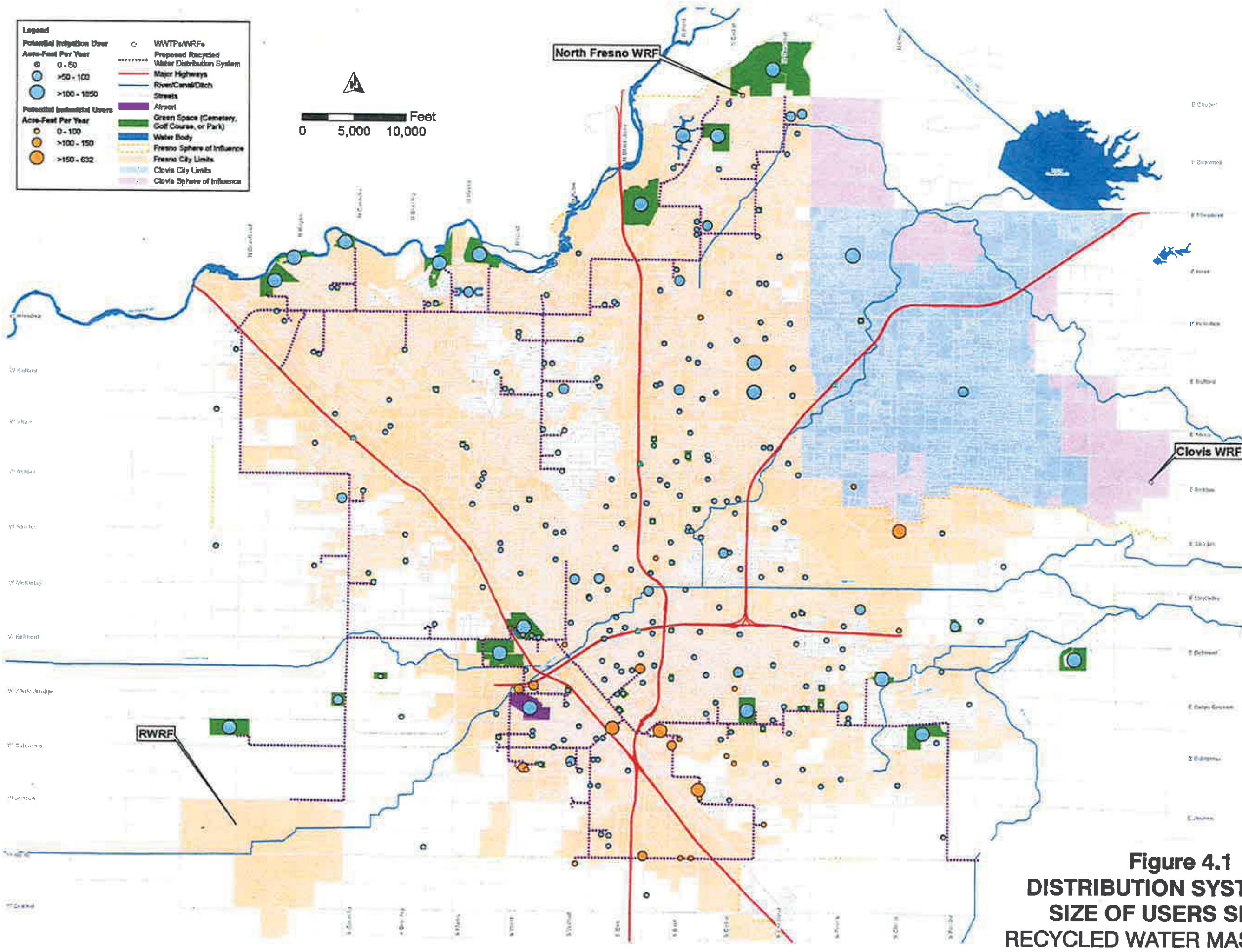

Figure 4.1
DISTRIBUTION SYSTEM AND SIZE OF USERS SERVED
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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Although the distribution system was aligned to primarily serve larger users, for Alternative 1 (served from the RWRF) it was sized to accommodate smaller existing and future users as well. For the most part, significant numbers of smaller users cannot be served in Alternative 2 (served from SRWFs) since flows would not be sufficient to serve these smaller users. The additional users served under Alternative 1 include: 1) existing residential and commercial areas, and 2) future residential and commercial areas identified in the latest General Plan. Summarized in Table 4.2 are the potential demands for existing and future residential and commercial areas if all users within a mile of distribution pipeline are served with recycled water for irrigation. It was assumed for residential areas that only front yards would be irrigated with recycled water. Also shown in Table 4.2 are the assumptions of the demands to be served for the purposes of developing cost estimates.

Table 4.2 Potential Irrigation Demand for Existing and Future Residential[1] and Commercial Users within 1 Mile of Distribution System
Recycled Water Master Plan
City of Fresno

Quadrant	Northeast	Northwest	Southeast[2]	Southwest	Total
Water use if all identified users served (AFY)					
Existing	1552	2628	1212	580	**5968**
Future	288	1876	876	2500	**5544**
Assumption of demand to be served (AFY)					
Existing (1/2 of users)	776	1314	606	290	**2984**
Future (1/4 of users)	72	469	219	625	**1386**
Distribution system (miles)[3]					
Existing (1/2 of users)	31	54	23	15	**123**
Future (1/4 of users)	4	19	9	23	**55**

Notes:
(1) For residential densities up to 5 lots per acre.
(2) Does not include future demands in SEGA planning area.
(3) Distribution system length was estimated by using a ratio of the total length of City's 8-inch potable water system to the total City land area and multiplying this ratio by the area of commercial and residential areas proposed to be served by recycled water.

Once the "back bone" of the distribution system is established for larger recycled water users under Alternative 1, the City has the flexibility to extend laterals up existing residential streets and through commercial areas to serve the smaller users. Since it is not likely that all users will be served, in an effort to not oversize the treatment and distribution system, it was assumed that half of the identified existing residential (with densities up to 5 lots per acre) and commercial users would be served. Specific areas and developments for residential irrigation will be identified in the future. Pipeline cost for serving existing residential and commercial users was estimated to be $700,000/mile, including turnouts to individual users. The average demand for existing residential and commercial users served per mile was estimated to be 25 AFY/mile.

As discussed in earlier chapters, the City's General Plan is in the process of being updated and based on discussions with the planning department there will be a renewed focus on densification in the City. As a result, outlying areas that are adjacent to the proposed distribution system may not be developed as previously identified in the existing General Plan. Therefore, it was assumed that future development demands will be far less (assumed one quarter) of the potential area identified in the General Plan within one mile of the distribution system. It is anticipated that the costs for serving recycled water to future development will be borne by the developer (based on the proposed "Purple Pipe Ordinance").

The existing General Plan also identifies a future high-rise and mid-rise intensification corridor along Highway 41. It was assumed that this corridor would be served with recycled water for toilet flushing. This would offset an additional 200 AFY beyond the demands listed in Table 4.2. Existing and future users are shown in Figures 4.2 and 4.3.

4.2.2 Agricultural Alternatives

There were three agricultural reuse alternatives carried forward for further development in this Master Plan. They were: AG 1 - expanding the existing system to deliver additional undisinfected secondary effluent to local users; AG 2 - expanding deliveries of extracted percolated effluent to FID; and AG 3 - upgrading to tertiary treatment and delivering recycled water to growers for unrestricted reuse. These alternatives are summarized in Table 4.3.

Table 4.3 Summary of Agricultural Reuse Project Alternatives
Recycled Water Master Plan
City of Fresno

Quadrant/ Alternative	Demand AFY	Tertiary Treatment Capacity at RWRF (mgd)	Comments
AG - 1	4,200	-	No additional treatment is necessary
AG - 2	20,000	-	No additional treatment necessary, but additional facilities for extraction and delivery is required.
AG - 3	20,000	27(1)	Assuming increased extraction of percolate for unrestricted reuse is not permittable by RWQCB. New tertiary facilities required.

Note:
(1) Based on estimated peak day demand.

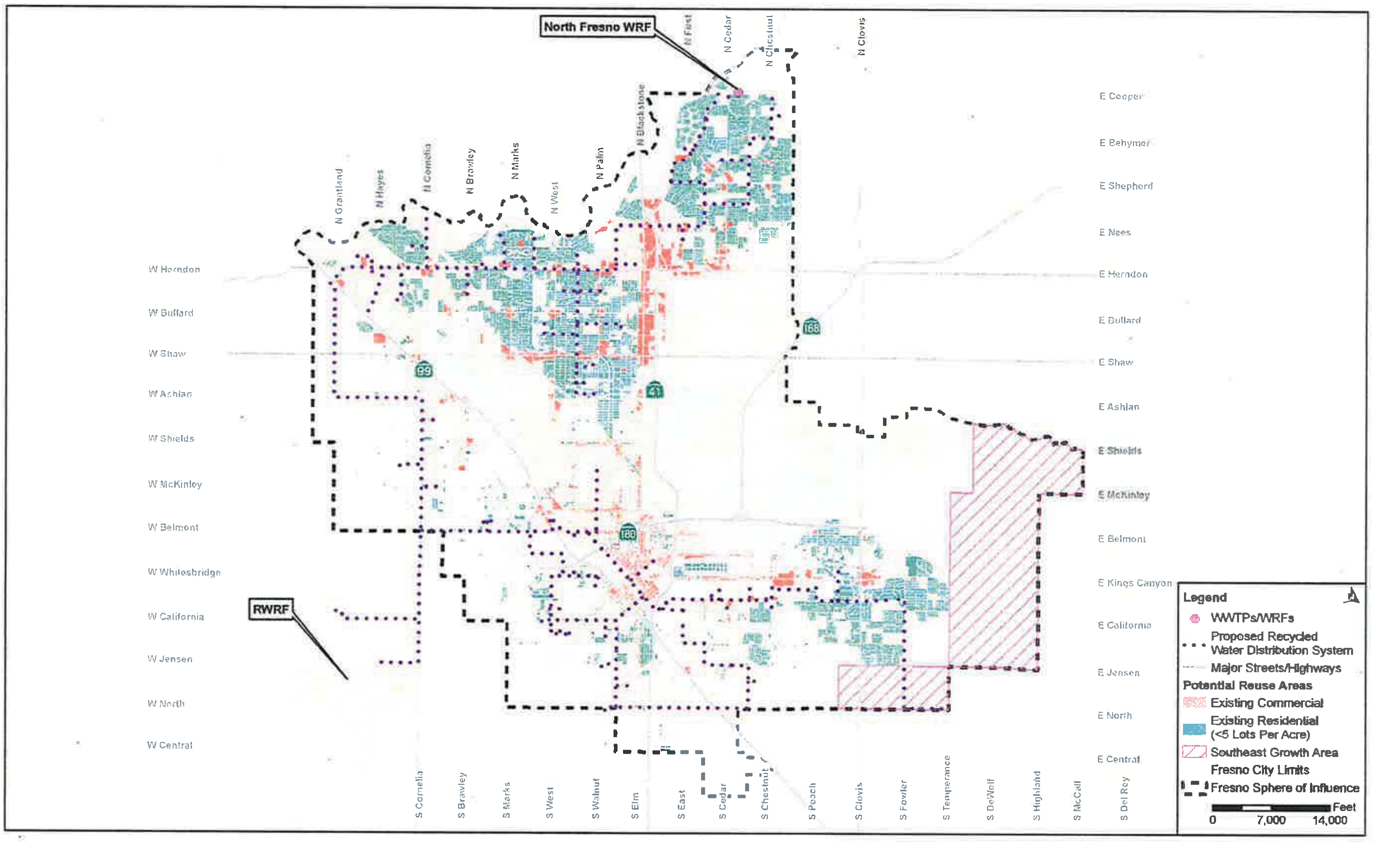

Figure 4.2
EXISTING RESIDENTIAL AND COMMERCIAL DEVELOPMENT
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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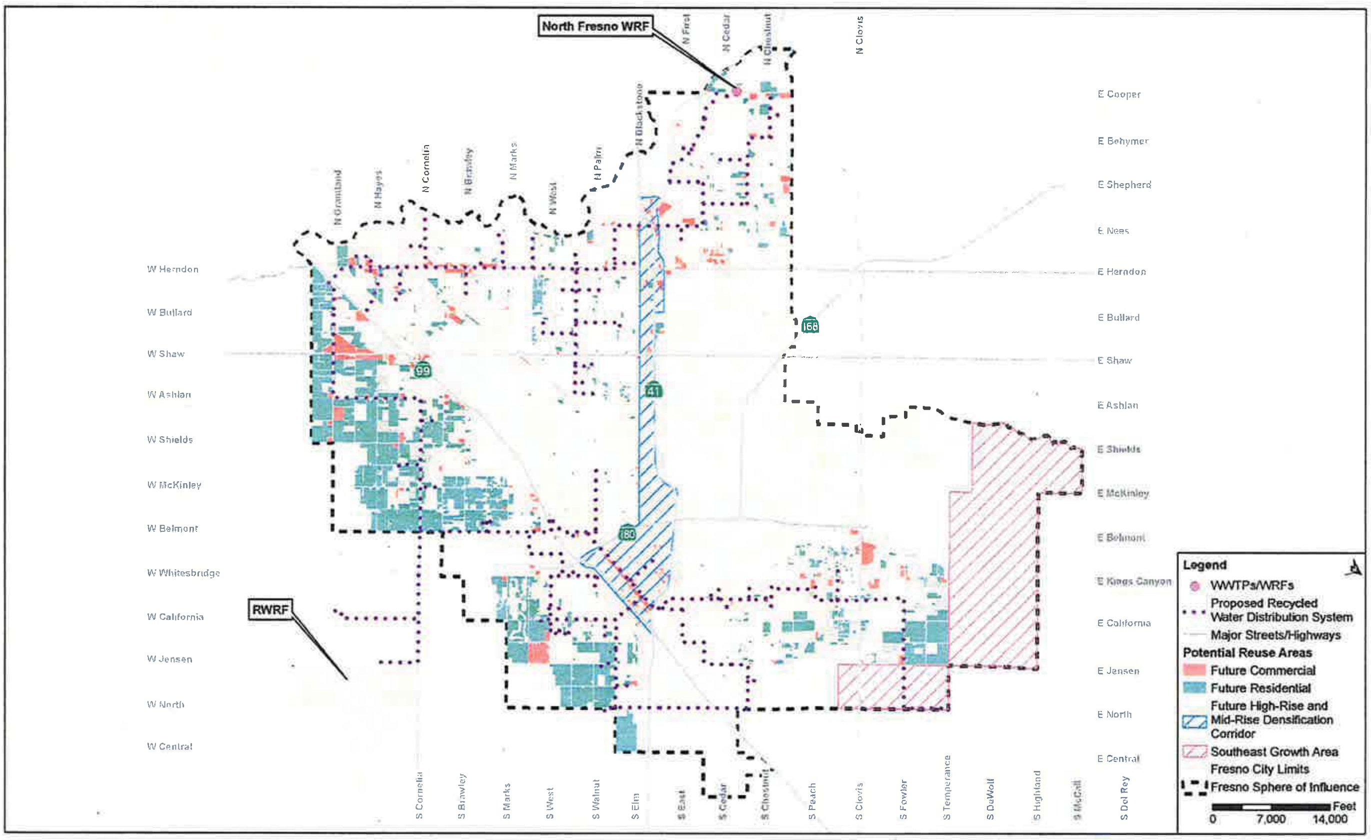

Figure 4.3
FUTURE RESIDENTIAL AND COMMERCIAL DEVELOPMENT
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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The agricultural alternatives presented were generally developed assuming separate pipeline systems for urban users and agricultural users. However, in those instances where potential agricultural customers can be served directly from the urban distribution system, they will be.

4.2.3 Groundwater Recharge Reuse Projects (GRRPs)

Groundwater recharge with recycled water presents a significant opportunity for the City to both implement reuse and improve regional water supplies. For these reason, GRRPs are a critical component of the City's Recycled Water Master Plan. The City already utilizes the strategy of recharging surface water and stormwater to recharge the groundwater basin. Including the addition of recycled water to recharge the groundwater basin is a natural extension of this existing strategy. Additional recharge basins will also better leverage the City's ability to recharge existing and future surface water supplies.

In general, GRRPs would be implemented in coordination with the urban reuse alternatives. Treatment requirements for recharge utilizing spreading basins are similar to urban reuse, except that GRRPs require reduction of total nitrogen through nitrification/denitrification.

The urban recycled water distribution system would be utilized to deliver recycled water to the GRRP basins primarily during the winter months when there is little to no urban irrigation demand. For this reason GRRPs are an ideal complement to an urban reuse system to provide year-round reuse and effluent diversification. Diluent water required for GRRPs (as described in Chapter 2) can be provided from surface water or stormwater at any time water is available.

There are challenges to implementing GRRPs including: 1) finding a site with space and adequate detention time to the nearest potable well, 2) identifying and managing diluent water sources, and 3) meeting the conditions required for permitting a GRRP.

The City is developed and has limited open areas of land available for siting recharge basins, with the exception of the outer edges of town, particularly to the west. The City's extensive network of drinking water wells throughout town also complicates the siting of recharge basins, as a six month "travel time" is required between any GRRP basin and the nearest potable well. As part of this Master Plan effort, a reconnaissance-level investigation was conducted to identify potential GRRP sites. The investigation focused on areas of undeveloped lands adjacent to FID canals and/or to existing FMFCD basins, for greater ease of delivering diluent water to the GRRP. A discussion of potential GRRP basin sites is provided in Section 4.5. Once a GRRP site is selected, permitting studies will be required, including tracer studies to demonstrate adequate hydraulic distance between the GRRP basin and the nearest drinking water well.

It is the recommendation of this Master Plan that the City begin acquiring land as soon as possible, develop recharge basins, and begin use of these basins to recharge surface water while the permitting studies are being conducted for approval to recharge recycled water.

4.3 URBAN ALTERNATIVE 1 – RECYCLED WATER SERVED BY RWRF

Urban Alternative 1 utilizes the RWRF to produce and distribute recycled water throughout the City. Figure 4.4 shows an overview of this alternative, including the pipe segments that are considered the system "backbone" and laterals that would serve individual users. The system requirements for serving each individual quadrant of the City are discussed further on in this chapter.

4.3.1 Treatment

Recycled water for urban reuse from the RWRF (or a SWRF) must meet tertiary Title 22 standards, as described in Chapter 2. At the RWRF this will require construction of filtration and disinfection facilities since secondary treatment is already provided. Additionally, projects that include a GRRP component would require nitrification and denitrification (NdN) to less than 10 mg/l total nitrogen. The facilities needed for NdN are discussed in Section 4.5 - Groundwater Recharge.

Alternatives for filtration for the RWRF include cloth filters, media filters or microfilters. Alternatives for disinfection at the RWRF include ultraviolet light (UV) and ozone. Chlorine was not considered a viable disinfectant alternative due to concerns of forming regulated disinfection by products, such as trihalomethanes. However, it is recommended that chlorine be used to maintain a residual in the distribution system for urban reuse, although it is not required. A range of treatment train costs were developed with media filtration paired with UV for a lower cost option, and membranes paired with ozone for a higher cost option. There is adequate room onsite for either of these treatment trains. For the purposes of cost estimates, media filtration + UV was considered the most probable treatment train.

The existing secondary treatment facilities at the RWRF are comprised of sides A, B and C. All three plants are activated sludge processes, with Plant A being the oldest (constructed in the 1970s) and Plant C being the newest (construction completed in 2009). The facilities include aeration basins and secondary clarifiers. Both the B and C plants were designed with the capability to provide nutrient removal. Figure 4.5 shows a potential location for tertiary and disinfection facilities that would draw from any of the secondary treatment trains at the RWRF.

4.3.1.1 <u>Expanding Treatment at the North Fresno WRF</u>

The North Fresno WRF currently serves users in the northeast quadrant of the City and is permitted (ORDER NO. R5-2006-0090-01; NPDES NO. CA0085189) for a discharge of 0.71 million gallons per day (mgd) average monthly flow and 1.07 mgd maximum daily flow. The plant is designed and permitted to produce a denitrified tertiary disinfected effluent with sequencing batch reactors (SBRs), disc filtration, and chlorination. The recycled water demand in the northeast quadrant exceeds the permitted capacity of the North Fresno WRF. Therefore, options to increase the capacity were evaluated.

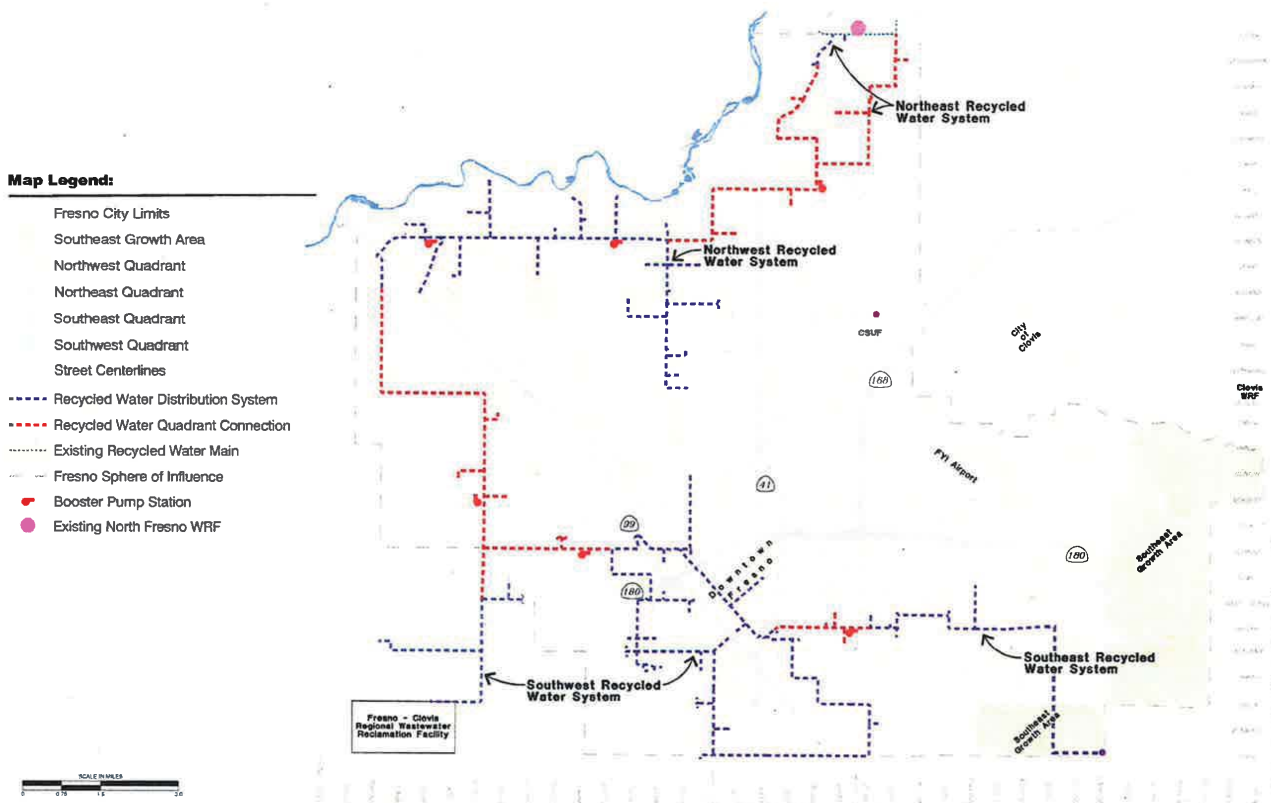

Figure 4.4
OVERVIEW OF ALTERNATIVE 1 DISTRIBUTION SYSTEM
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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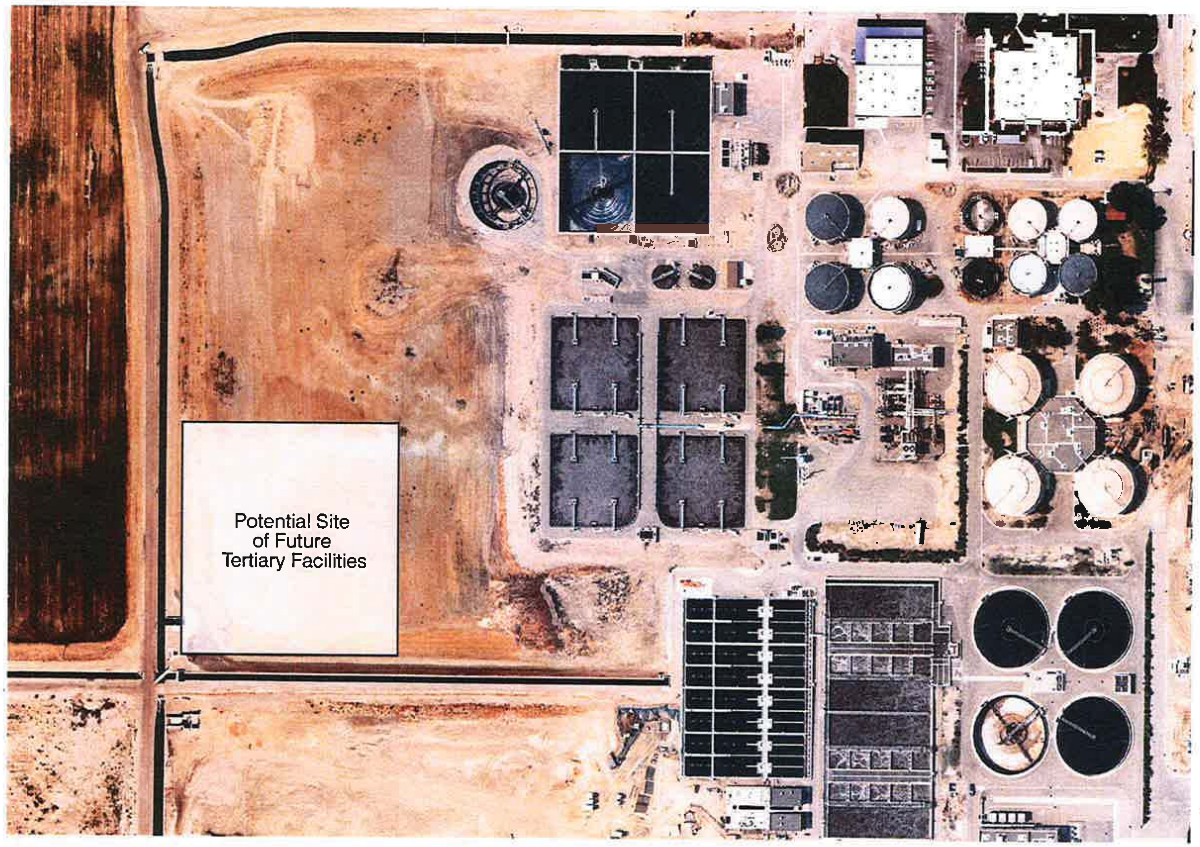

Figure 4.5
A-SIDE/B-SIDE TERTIARY FACILITIES SITE
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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In order to expand the average monthly treatment capacity to 1.07 mgd, the following facilities would be needed at the North Fresno WRF:

- A second channel grinder and screen at the headworks to match the current equipment.
- Two new SBR basins and associated mixers, decanters, piping, and pumps. (The basins would be built adjacent to SBR units on the north side of the SBR structure.)
- Two new aeration blowers (space is provided for the future blowers adjacent to the existing blowers.)
- An additional post-secondary equalization pump
- Two more filter discs within each package filtration tank.
- Two more effluent irrigation pumps in the existing pump station.
- All other ancillary equipment (piping, electrical, instrumentation, chemical feed, etc.) to make a complete system.

The above improvements assume the following:

- The existing influent lift pumps have adequate capacity to pump the increased flows.
- Peak flows greater than 1.07 mgd can be diverted away from the plant at the influent lift station, and sent to the RWRF.
- The standby generator is adequate for the additional equipment and their loads.

This analysis also assumed the chlorination system, which does not function well, would be replaced as the primary disinfectant with a UV or ozone system to minimize disinfection byproduct formation. Chlorine would likely still be used to maintain a residual in the distribution system for urban reuse, although it is not required.

4.3.2 Storage

Recycled water system storage is a key component of recycled water systems because of the difference in collection system flows, treatment capacity and distribution system demands. Adequate storage addresses the inconsistency of these flows/volumes to allow facilities to be optimally sized to convey and treat average flows as opposed to peak flows.

Influent storage of peak flows is required in cases were minimum sewer flows are below treatment plant capacity. Influent storage would not be required for tertiary facilities at the RWRF since the potential recycled water demands for urban reuse are much smaller than the RWRF's influent capacity.

Effluent storage can provide reliability for when treatment processes are down or can serve peak flow demands above the treatment capacity. Effluent storage needs could be provided by constructing dedicated recycled water storage tanks or by converting one of the existing RWRF percolation ponds to a storage pond with compacted clay or membrane liner. In either case, the RWRF site is a good location for storage due to the large amounts of available land. Additional storage facilities would also be provided in the distribution system on City-owned land where possible. This distribution system storage would allow flexibility to serve additional users without oversizing the distribution system. It is typical for recycled water distribution systems to have one maximum day of storage, which gives the system the flexibility to deliver peak day demand.

4.3.3 Southwest Alternative (SW1)

Users in the Southwest Quadrant would be served by recycled water generated at the RWRF. The users and distribution systems for this alternative are illustrated in Figure 4.6. Major users in this quadrant are City and County parks, cemeteries, schools, Highway 180, industrial users, and existing and future residential and commercial development. Recycled water for indoor dual plumbing in the Highway 41 mid- and high-rise intensification corridor would be supplied in the future as part of this alternative.

Treatment flows required for SW1 are 5.5 mgd for the identified large urban users, or up to 8.1 mgd if existing and future residential and commercial irrigation is implemented. These flows represent the combined maximum day demand for the users identified in this quadrant. As mentioned previously, because the capacity of the RWRF is greater than the recycled water demand of the system, influent storage would not be required.

The irrigation customers or industries in the Southwest quadrant do not have onsite storage, therefore effluent storage at the RWRF site or distribution system storage would need to be provided. Approximately one day at maximum month demand, or 8.1 million gallons (MG) of total storage would be required.

4.3.4 Northwest Alternative (NW1)

Alternative NW1 would extend the SW quadrant backbone pipeline north to serve users in the northwest quadrant. The distribution system would connect to major golf courses, schools, parks in the area, Highway 99 median landscaped areas, and existing and future residential and commercial development. Shown on Figure 4.7 are the users' locations and potential distribution system routes.

For NW1, all flows would be treated at the RWRF and no influent storage would be required. The recycled water demand identified for this quadrant was 5.3 mgd to serve large urban users, or up to 10.4 mgd if existing and future residential and commercial irrigation is implemented.

The golf courses identified as potential recycled water customers in the northwest region have onsite storage in the form of ponds. An additional 6.9 MG would need to be added to provide one day of storage for other users. The storage facilities would be divided between the RWRF and a new facility on City owned land near Herndon and Hayes.

Distribution System Summary

	Length of Pipe	Recycled Water Delivered*
Pipeline No. 1	13.15 mi	1,423 acre ft / yr
Pipeline No. 2	2.17 mi	368 acre ft / yr
Pipeline No. 3	1.44 mi	95 acre ft / yr
Pipeline No. 4	4.78 mi	1,129 acre ft / yr
Pipeline No. 5	3.08 mi	362 acre ft / yr
Pipeline No. 6	2.63 mi	194 acre ft / yr
Pipeline No. 7	3.28 mi	131 acre ft / yr
Pipeline No. 8	2.96 mi	140 acre ft / yr
Pipeline No. 9	2.79 mi	283 acre ft / yr
Total:	36.28 mi	4,125 acre ft / yr

*No agricultural or future demand included in calculations.

Map Legend:

- Airports
- Cemeteries
- Fresno City Limits
- Parks & Golf Courses
- Schools
- Water Bodies & Ponds
- Heavy Industrial User
- Light Industrial User
- Fresno Sphere of Influence
- Street Centerlines

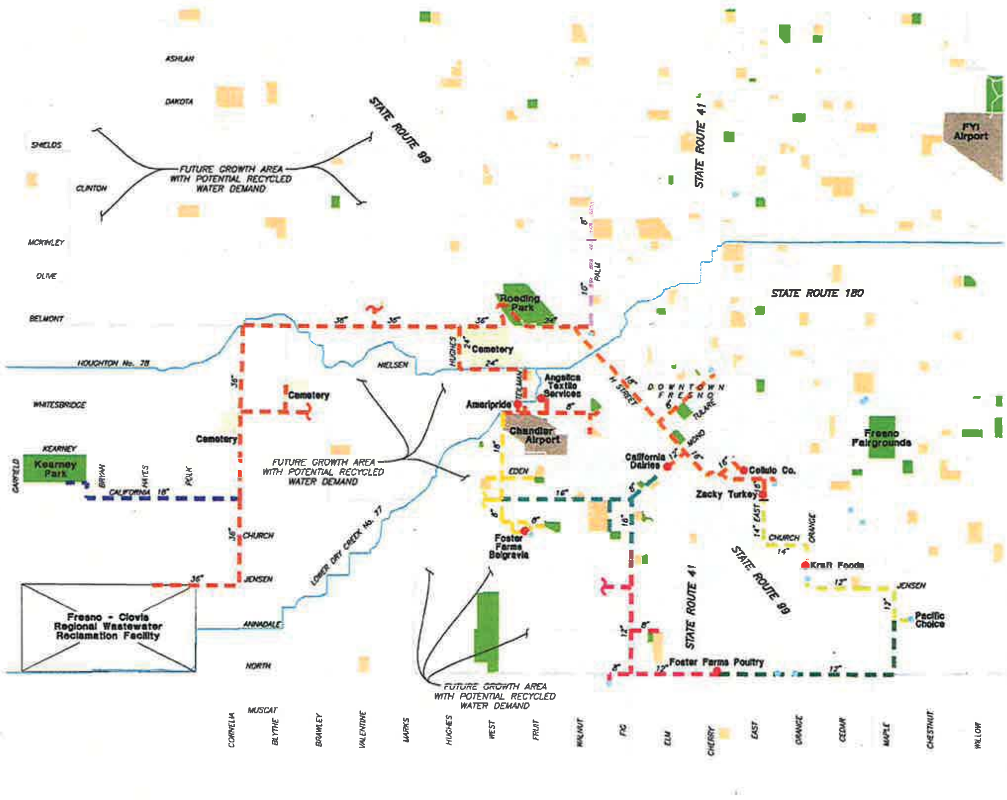

Figure 4.6
SOUTHWEST PROJECT ALTERNATIVE 1 DISTRIBUTION SYSTEM ALIGNMENT
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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Distribution System Summary

	Length of Pipe	Recycled Water Delivered*
Pipeline No. 1	11.11 mi	1,354 acre ft / yr
Pipeline No. 2	4.88 mi	210 acre ft / yr
Pipeline No. 3	3.90 mi	96 acre ft / yr
Pipeline No. 4	1.61 mi	49 acre ft / yr
Pipeline No. 5	6.60 mi	168 acre ft / yr
Total:	28.10 mi	1,877 acre ft / yr

*No agricultural or future demand included in calculations.

Map Legend:

- Airports
- Cemeteries
- Fresno City Limits
- Parks & Golf Courses
- Booster Pump Station
- Schools
- Water Bodies & Ponds
- Street Centerlines
- Fresno Sphere of Influence

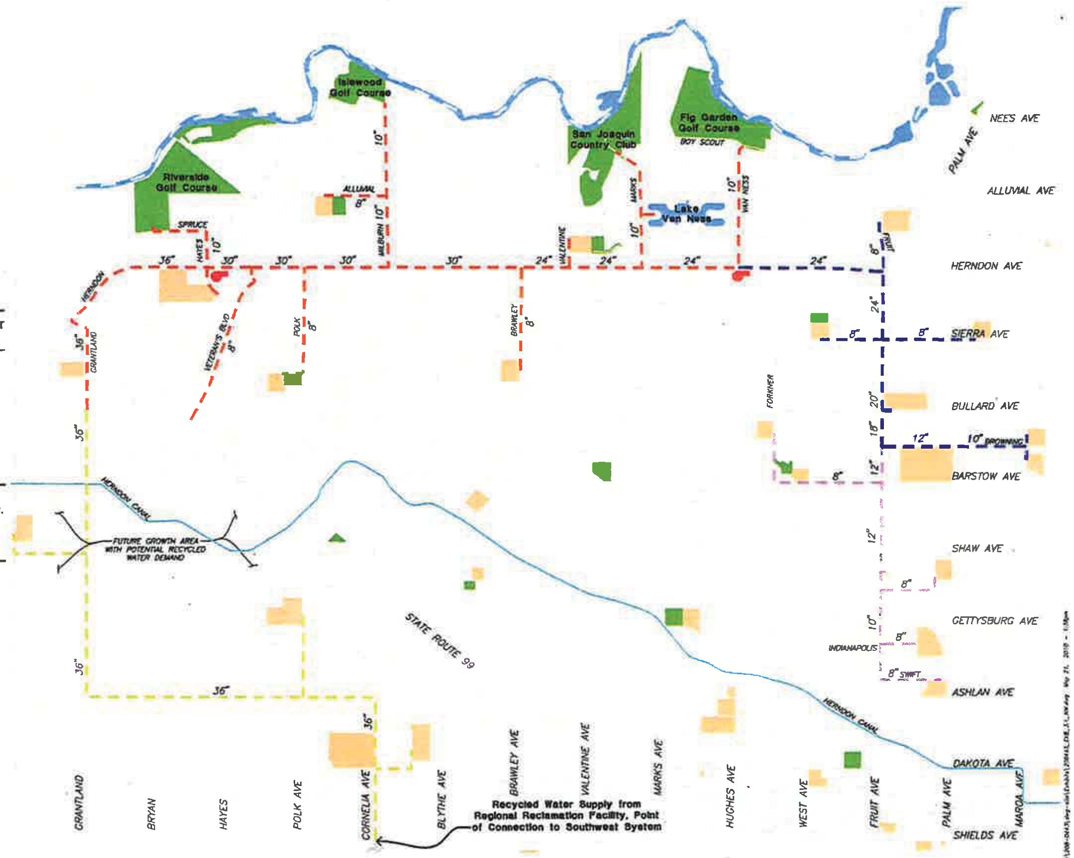

Figure 4.7
NORTHWEST PROJECT ALTERNATIVE 1 DISTRIBUTION SYSTEM ALIGNMENT
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

4.3.5 Northeast Alternative (NE1)

Alternative NE 1 would be a hybrid alternative that includes serving the NE quadrant from both the RWRF and the North Fresno WRF to supply larger users including Woodward Park, Highway 41 irrigated areas, golf courses, local schools, and existing and future residential and commercial development. Shown on Figures 4.8 are the users' locations and potential distribution system routes for this alternative.

The existing North Fresno WRF would be expanded from its existing permitted average monthly capacity of 0.71 mgd to an average monthly capacity of 1.07 mgd by expanding the existing SBR and disc filter treatment technologies. To increase the flows at the North Fresno WRF, sewer lift station #6 would be rerouted to direct more wastewater to the North Fresno WRF to increase its recycled water production capacity. It was assumed that existing storage facilities at the North Fresno WRF would be used, so no additional storage for influent or effluent would be required at that facility.

The RWRF would provide additional treatment of 3.7 mgd for the larger urban users not served by the North Fresno WRF, or up to 6.1 mgd if existing and future residential and commercial irrigation users are served. The backbone pipeline from the RWRF would be extended from the northwest quadrant east of Highway 41. Approximately 6.1 MG of additional effluent storage would be required in the northeast quadrant for the area served from the RWRF.

A backbone pipeline was initially proposed to extend down Herndon Avenue, from Palm Avenue to Cedar Avenue and south to serve the CSUF campus. This alternative was discarded due to dependency on the entire backbone pipeline, and length of time required to implement.

4.3.6 Southeast Alternative (SE1)

SE1 would extend the backbone pipeline from the Southwest Quadrant to serve users in the southeast. The distribution system would serve nearby parks, schools, Fresno Pacific University, the Sunnyside Golf Course, irrigated areas on Highways 41 and 99, and existing and future residential and commercial development. As discussed in Chapter 1, while SE 1 includes potential future users in the southeast quadrant of the City service area, it does not include recycled water delivery to the future SEGA development. The proposed SE distribution system is illustrated on Figure 4.9. The backbone piping system in the southeast quadrant was not extended to the north as all the identified larger users, such as Airways Golf Course and Palm Lakes Golf Course, have been abandoned or are no longer in use.

For SE 1, flows would be treated at the RWRF, so no influent storage would be required. The RWRF would provide additional treatment of 2.8 mgd for larger urban users, or up to 5.1 mgd if existing and future residential and commercial irrigation are served. These flows would be in addition to the demands in the other quadrants.

Distribution System Summary

	Length of Pipe	Recycled Water Delivered*
Existing Recycled Water Pipeline	1.75 mi	508 acre ft / yr
Pipeline No. 1	14.42 mi	2,212 acre ft / yr
Total:	16.17 mi	2,720 acre ft / yr

*No agricultural or future demand included in calculations.

Legend:

- Fresno City Limits
- Water Bodies & Ponds
- Parks & Golf Courses
- Schools
- Street Centerlines
- Fresno Sphere of Influence
- New Sewer Force Main
- North Fresno Water Reclamation Facility
- Booster Pump Station
- Sewer Lift Stations

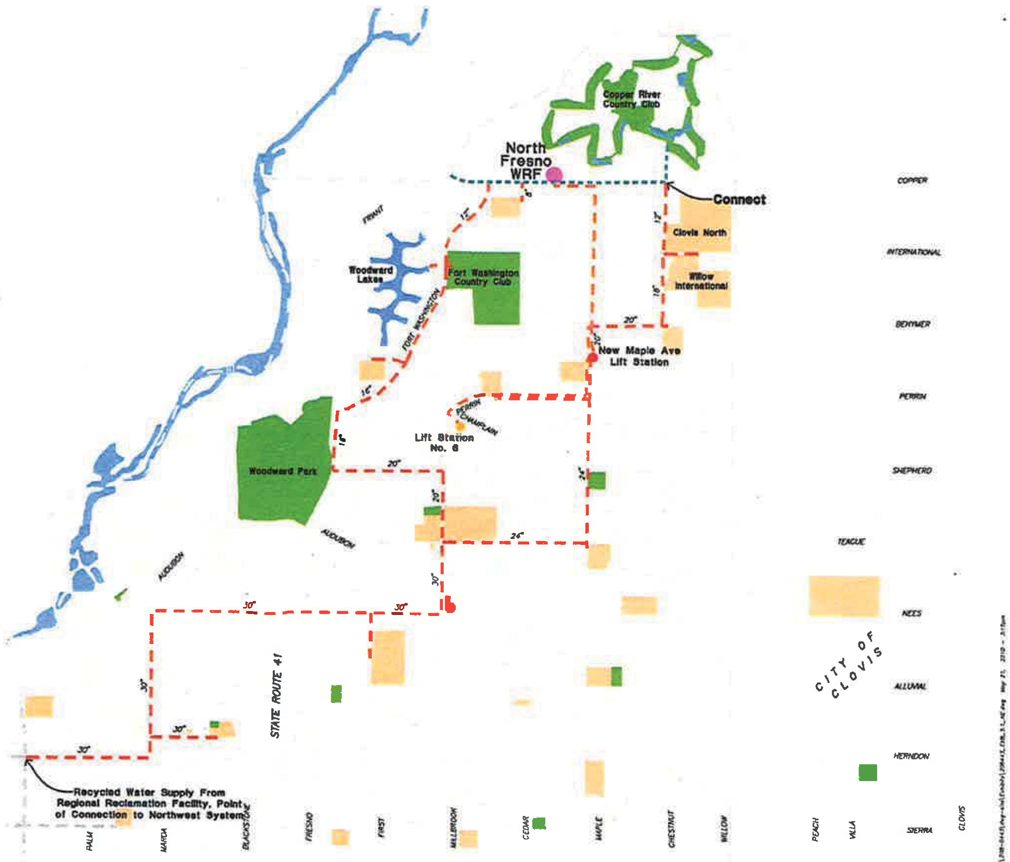

Figure 4.8
NORTHEAST PROJECT ALTERNATIVE 1
DISTRIBUTION SYSTEM ALIGNMENT
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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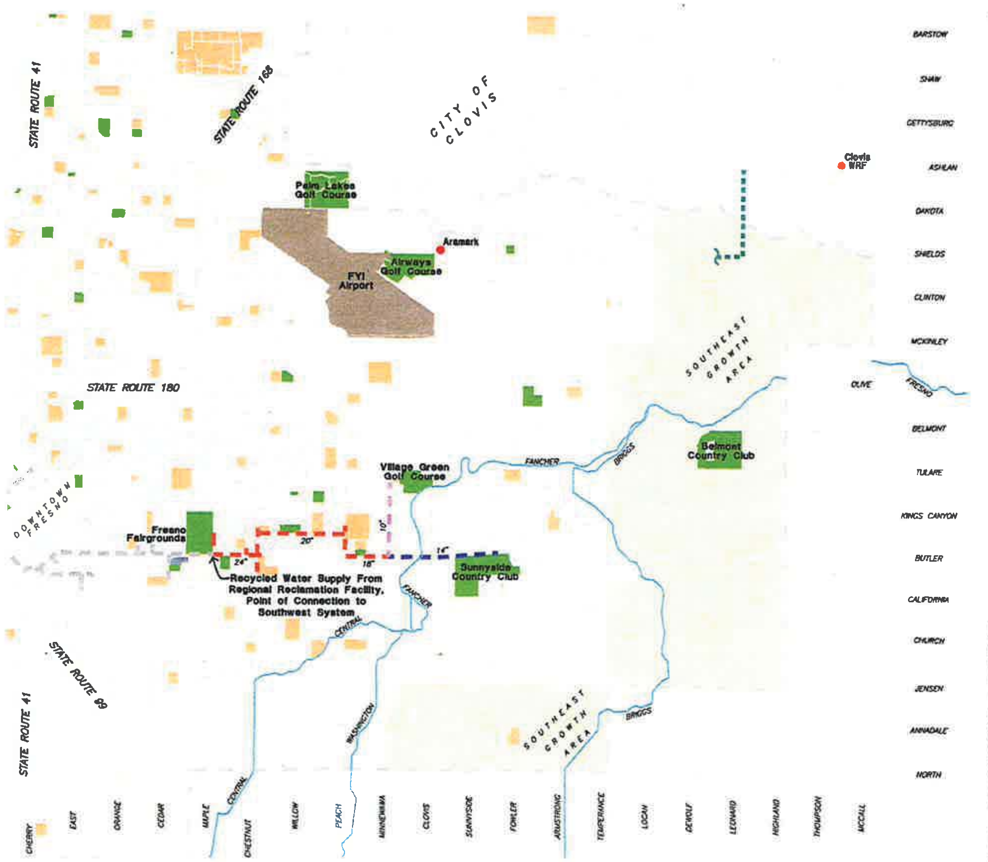

Distribution System Summary

	Length of Pipe	Recycled Water Delivered*
Pipeline No. 1	3.24 mi	554 acre ft / yr
Pipeline No. 2	1.26 mi	330 acre ft / yr
Pipeline No. 3	0.86 mi	111 acre ft / yr
Total:	7.35 mi	995 acre ft / yr

*No agricultural or future demand included in calculations.

Map Legend:

- Fresno City Limits
- Parks & Golf Courses
- Schools
- Southeast Growth Area
- Street Centerlines
- Booster Pump Station
- Clovis Water Reclamation Facility
- Heavy Industrial User
- Existing Recycled Water Pipeline
- Fresno Sphere of Influence

SCALE IN FEET
0 2500 5000 10000

Figure 4.9
SOUTHEAST PROJECT ALTERNATIVE 1
DISTRIBUTION SYSTEM ALIGNMENT
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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To serve the SE demands, approximately one day of effluent storage (approximately 5.1 MG) would be needed. This storage could be divided up between storage at the RWRF and distribution system storage on other City owned lands in the SE quadrant.

4.3.7 Costs for Urban Alternative 1 – Served by the RWRF

Conceptual level cost estimates for project alternatives served from the RWRF are presented in Table 4.4. These costs are construction costs which include an appropriate planning level contingencies for treatment facilities and the distribution system. Costs are presented in January 2010 dollars (ENR 8660).

Table 4.4 Cost Estimates for Urban Alternatives 1 Served from RWRF (in Millions)(1)
Recycled Water Master Plan
City of Fresno

		Distribution System			Treatment (2)	Storage (3)	
	Alternative	**Backbone**	**Spurs**	**Total**			**Total**
Capital Costs ($M)	SW1	22	27	49	12	7	68
	NW1	37	13	50	9	6	65
	NE1	24	12	40(4)	11	5	56
	SE1	13	4	17	6	4	27
O&M Costs ($M/yr)	SW1	-	-	0.3	0.4	0.2	0.9
	NW1	-	-	0.2	0.3	0.2	0.7
	NE1	-	-	0.2	0.7	0.2	1.1
	SE1	-	-	0.1	0.2	0.2	0.5

Notes:
(1) All costs presented in January 2010 dollars (ENR 8660).
(2) Low cost alternative is presented here, and is media filtration + UV. High cost alternative is microfiltration + ozone and is included in Appendix F. Treatment costs include feed pump station. Costs do not include treating flows for residential and commercial irrigation.
(3) Assuming half the storage is provided by a new facility on City-owned property outside of the RWRF land.
(4) Includes $4M to reroute lift station 6 and increase flow at North Fresno WRF.

Costs are based on the following assumptions:

- Except for the North Fresno WRF, costs are based on serving the City from the RWRF
- Distribution costs build on each other. For example, NW 1 assumes that the SW 1 distribution system and treatment facilities are already in place
- NW 1 and NE 1 are consecutive phases of the distribution system that are served from the SW 1 pipeline
- SE 1 also builds on the SW 1 distribution system but does not include service to SEGA

- Feed pump station is included in treatment cost estimate, and recycled water delivery pump station is included in distribution system pump station cost estimate.
- Storage costs at sites other than the RWRF are based on welded steel tanks. Costs do not include land acquisition.
- More detailed cost information is provided in Appendix F.

4.4 URBAN ALTERNATIVE 2 - SERVED BY SRWF

As an alternative to serving all users from the RWRF, Alternative 2 serves urban users through a combination of satellite facilities (or SRWFs), and tertiary treatment at the RWRF. Where possible, facilities will be sited on land already owned by the City to minimize land acquisition costs (approximately $45,000 per acre).An overview of the distribution system for Alternative 2 is shown in Figure 4.10. Figure 4.10 shows both the distribution system "backbone" and the spurs that will deliver recycled water to individual users.

Because sewer flows are lower in outlying areas compared to influent flows at the RWRF, fewer users can be served from the SRWFs. In general, there is insufficient flow to serve significant numbers of residential and commercial areas if larger users are prioritized. Because of these lower sewer flows, a SRWF in the southeast quadrant would be the only system that could potentially also serve residential and commercial irrigation users.

4.4.1 Treatment for SRWFs

Tertiary treatment at the RWRF was discussed under Alternative 1 (Section 4.3). In contrast to the RWRF options where only filtration and disinfection are required, for SWRFs new treatment plants are required. New SWRFs would include preliminary treatment (screening and grit removal), primary treatment, secondary treatment, disinfection, odor control, a distribution system pump station, and operations building. Other requirements would include: architecture/landscaping, standby power, SCADA (Supervisory Control and Data Acquisition) and site work/yard piping. It is proposed that solids from these satellite plants would be sent to the RWRF for treatment. As a result, the SRWFs would not provide solids treatment. Sewer flows beyond the capacity of the SRWFs would be sent to the RWRF. Also if the SRWF is not operated year round, sewer flows would be conveyed to the RWRF during non-operational periods.

Considerations for selection of treatment processes for SRWFs include:

- Selection of technologies with a small footprint to best fit into developed residential neighborhoods
- Use of alternative disinfection (other than chlorine - with the exception of providing a residual for the distribution system).
- Use of modular systems that allow future expansion.
- Selection of tertiary treatment that meets Title 22 standards.

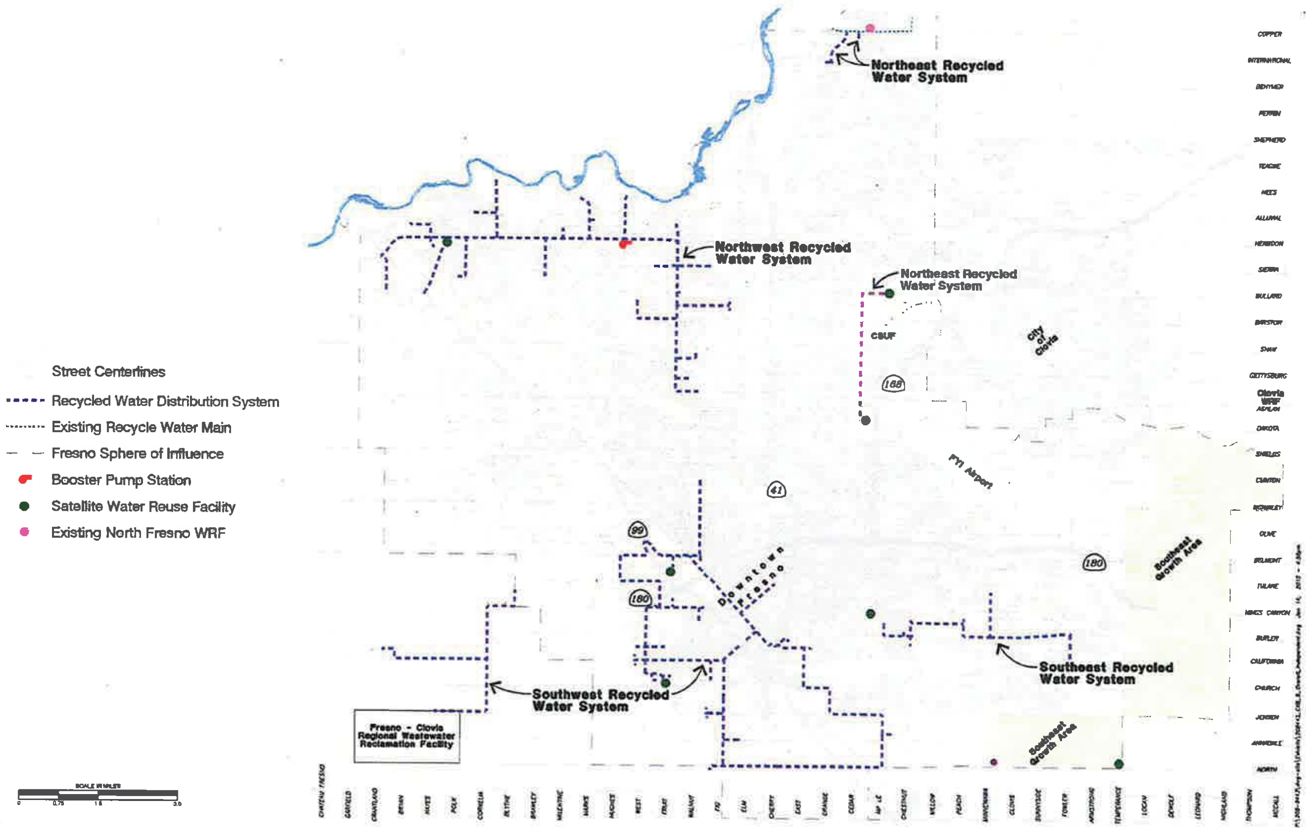

Figure 4.10
OVERVIEW OF ALTERNATIVE 2 DISTRIBUTION SYSTEM
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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- Use of nitrification and denitrification for potential groundwater recharge.
- Bypass of the SRWF when sewer flows exceed storage and treatment capacity.
- Storage and discharge back to the sewers of treated flows in excess of recycled water demand.

Using these criteria, a range of treatment trains was developed. A nitrifying/denitrifying (NdN) activated sludge process followed by media filtration and UV was selected as the lowest cost alternative, and a membrane bioreactor (MBR) followed by ozone was selected as the highest cost alternative. The MBR/ozone alternative produces a higher quality effluent that may be more suitable for meeting future regulations, but both alternatives produce tertiary water that meets current regulations. MBR treatment provides both secondary and tertiary treatment. The MBR alternative has significantly smaller footprint that would provide more flexibility for siting the plant in residential areas.

Treatment trains were selected for cost estimates of SWRF as follows:

- Where there is sufficient space to build an activated sludge facility, the most likely treatment train was considered to be activated sludge + media filtration + UV.
- Where space is constrained, the most likely treatment train was considered to be MBR + UV.

The improvements needed to expand the North Fresno WRF were discussed in Section 4.3.1.

4.4.1.1 Footprint for SRWFs

Footprint could be a major consideration when selecting treatment processes for SRWFs. While MBR facilities are more expensive than conventional wastewater treatment plants, they are often chosen for satellite facilities in urban areas due to their small footprint. If the footprint is small enough, it is desirable to minimize neighborhood impacts by building the facility below grade or in a contained building. While activated sludge with NdN is the lower-cost alternative for SRWF technology, it is more difficult to site and more difficult to contain because of its larger footprint.

Table 4.5 lists the area requirements for the two different technologies with respect to the different SRWF alternatives. These footprint requirements are planning level estimates. Actual area requirements will depend on the final site layout. Alternatives NE1 and NE2 utilize the existing North Fresno WRF site, and therefore, are not shown in Table 4.5.

4.4.2 Storage

Flow considerations for SRWFs include balancing variable sewer flows and recycled water demand; flow required for minimum recycled water flow conveyance; flow equalization to maintain biological processes; solids disposal; and effluent disposal during wet weather.

Table 4.5 Space Requirements for SRWFs
Recycled Water Master Plan
City of Fresno

Alternative	Capacity (mgd)	MBR footprint (acres)(1)	Activated Sludge with NdN footprint (acres)(2)
SW 2	4.1	2.2	8.1
NW 2	4.7	1.9	6.8
NE 3.A	0.7	1.0	1.6
NE 3.B	4.0	2.2	8.1
SE 2	3.0	1.7	6.0

Notes:
(1) Includes headworks, MBR, UV chamber, odor control facility, blower building, effluent pump station, electrical building, control building, influent storage, effluent storage.
(2) Includes headworks, primary clarifier, activated sludge with NdN, secondary clarifier, microfilters, UV chamber, odor control facility, blower building, effluent pump station, electrical building, control building, influent storage and effluent storage.

4.4.2.1 Flow Diversion from the Collection System

All of the alternatives with SRWFs involve scalping flow from the existing collection system. SRWFs must be carefully located to ensure that they have access to an existing sewer trunk with sufficient flow to supply recycled water demands of the users. In addition to meeting the recycled water demands, adequate flow must be maintained in the sewer to provide a scour velocity and to convey solids generated at the SRWF back to the RWRF. Alternatively solids from the SRWF could be trucked to the RWRF. Calculations for storage requirements at SRWFs were based on preliminary flow monitoring data and sewer models. Flow monitoring in the collection system near potential extraction points is currently ongoing to ascertain that there are sufficient flows in the collection system for scalping the desired recycled water flows.

The flow scalping for the alternative NE3.B will possibly have multiple benefits, including a relief from sewer surcharging in the Orange Avenue trunk sewer system. There will be avoided cost benefits from the future sewer improvements required along this trunk to prevent surcharging. The proposed alternative has the ability to scalp up to 4.0 mgd.

4.4.2.2 Influent Flow and Storage at SRWFs

For project alternatives SW 2, NW 2 and NE 3, estimated minimum sewer flows were less than the planned capacity for the SRWFs. Therefore, influent storage at the SRWFs or up-sizing the treatment plant and increased effluent storage would be necessary to maximize reuse. Influent storage is the preferred of these two options because it allows the SRWF to operate at capacity at night and serve the identified users. Figure 4.11 conceptually illustrates this SWRF operational concept.

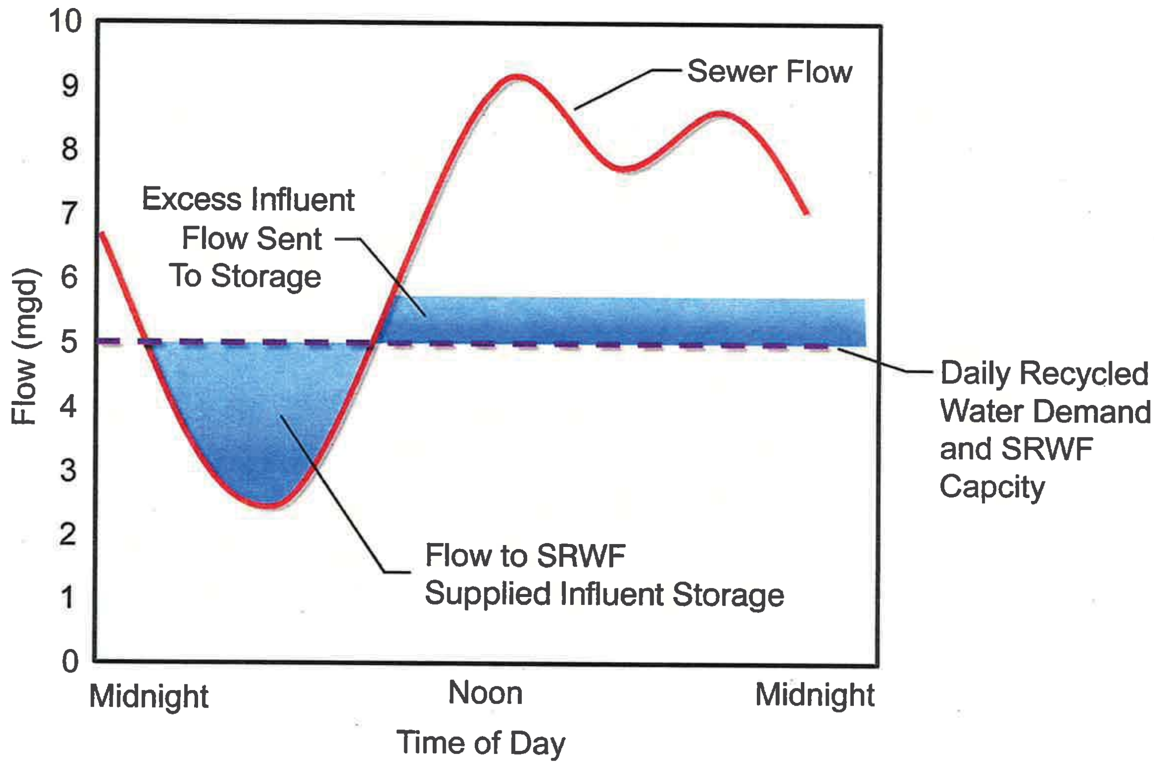

Figure 4.11
INFLUENT STORAGE TO MAXIMIZE REUSE AT SRWFs
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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Influent storage has the risk of producing odors and likely additional maintenance (regular cleaning). Any influent storage at a satellite facility would need to be covered to reduce impacts to adjacent neighbors. Sewer flows in each of the potential SWRF locations are being verified by ongoing flow monitoring, which will be used to determine storage requirements.

4.4.2.3 Effluent Flow and Storage at SRWFs

Typically, recycled water demand for irrigation is highest during times when wastewater flows are lowest (i.e., night-time hours). Therefore effluent storage is required to balance out the supply and demand. For the purpose of estimating effluent storage needs, it was assumed that recycled water would be produced constantly throughout the day, and used by irrigation users for eight hours/day during the night. Similarly it was assumed that industrial users would require recycled water for eight hours/day during the day. Some potential recycled water users have onsite storage that would reduce the storage needs at the SRWFs. It is typical for recycled water distribution systems to have one maximum day of storage, which gives the system the flexibility to deliver peak day demand.

During wet weather periods, the recycled water produced at the SRWF would exceed the recycled water demand. Alternate effluent disposal would be required during these periods. Disposal alternatives include discharge to the trunk sewer for re-treatment at the RWRF, groundwater recharge, discharge to the Fresno Irrigation District (FID) irrigation canals, or a combination of the same. Another alternative would be for the SRWF to be operated only during the irrigation season, in which case the plant would be required to be started up and reconditioned prior to the irrigation season each year.

4.4.3 Southwest Alternative (SW2)

Users in the Southwest Quadrant would be served by satellite facilities located either south of Roeding Park or at a parcel that is owned by the City at the intersection of Fruit Ave. and Church Ave. Larger users for this alternative are similar to users identified for SW1 and include parks, cemeteries, schools, industries, highway medians, City Hall and other government building, and redevelopment uses in the downtown area. The users and distribution systems for this alternative are illustrated on Figure 4.12.

SW2 requires a portion of the flow to be treated at the RWRF, and the remainder of flow to be treated at a SRWF. The total potential demand served in this quadrant is 4,340 AFY.

As illustrated in Figure 4.9, influent storage is required at SRWFs where minimum daily sewer flows are lower than the average daily flow to the treatment facility. Based on flow monitoring date, it is estimated that the daily minimum sewer flow is 3.0 mgd near the site south of Roeding Park, and 4.2 mgd near the Fruit Ave and Church Ave site, whereas the SWRF capacity would be 4.1 mgd in either location (based on the maximum day demand of identified users). Influent storage of approximately 370,000 gallons would be required for a SRWF south of Roeding Park, and no storage would be required for a SWRF at Fruit Ave.

Distribution System Summary

	Length of Pipe	Recycled Water Delivered*
Pipeline No. 1	3.84 mi	145 acre ft / yr
Pipeline No. 2	2.17 mi	368 acre ft / yr
Sub-total:	6.01 mi	513 acre ft / yr
Pipeline No. 3	5.49 mi	1,277 acre ft / yr
Pipeline No. 4	1.44 mi	95 acre ft / yr
Pipeline No. 5	4.78 mi	1,129 acre ft / yr
Pipeline No. 6	3.08 mi	362 acre ft / yr
Pipeline No. 7	2.63 mi	194 acre ft / yr
Pipeline No. 8	3.28 mi	131 acre ft / yr
Pipeline No. 9	2.96 mi	155 acre ft / yr
Pipeline No. 10	2.79 mi	283 acre ft / yr
Sub-total:	26.45 mi	3,626 acre ft / yr
Total:	32.46 mi	4,139 acre ft / yr

*No agricultural or future demand included in calculations.

Map Legend:

- Airports
- Cemeteries
- Fresno City Limits
- Parks & Golf Courses
- Schools
- New Satellite Recycled Water Facility
- Heavy Industrial User
- Light Industrial User
- Street Centerlines
- Fresno Sphere of Influence

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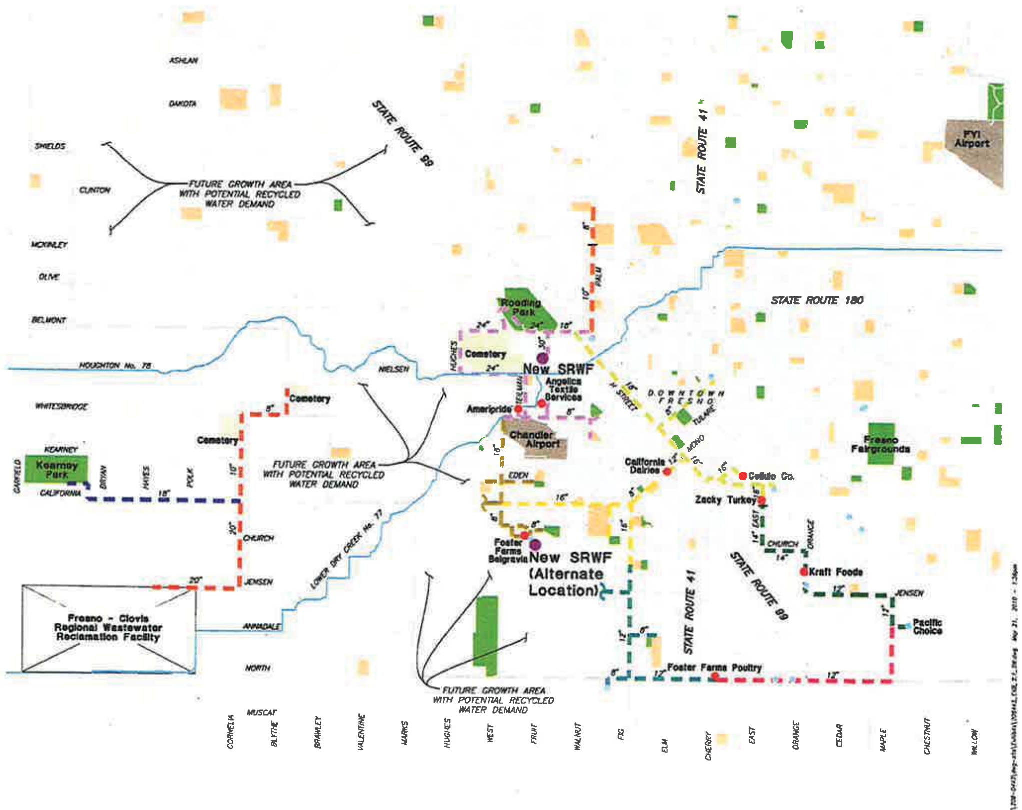

Figure 4.12
SOUTHWEST PROJECT ALTERNATIVE 2
DISTRIBUTION SYSTEM ALIGNMENT
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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and Church Ave. (since minimum sewer flows at that location are larger than the flows required at the SRWF). Sewer flow curves from monitoring data are presented in Appendix F.

Similar to SW1, a maximum day flow of 5.5 MG of effluent storage would be required for SW 2 to serve the identified larger urban users. 4.1 MG of new storage would need to be constructed in proximity to the distribution system served by the SWRF at either the site south of Roeding Park, or at the site at Fruit Ave. and Church Ave. The remaining 1.4 MG could be stored at the RWRF.

The City owns the site at Fruit and Church Ave., however, this site is not large enough for a satellite facility to treat the 4.1 mgd. Therefore, either more land (approximately 0.7 acres for an MBR facility) would need to be acquired, or the facility could be constructed underground in a "stacked" treatment configuration, which would greatly increase construction costs. Approximately 17.4 acres of land would need to be purchased if a SWRF was built at the site near Roeding park.

4.4.4 Northwest Alternative (NW2)

NW2 would serve the northwest quadrant from a new satellite facility, which could be located on a city-owned parcel to the southwest of Herndon Ave and Hayes Ave. The users served would be similar to NW 1, consisting of golf courses, parks and schools. Due to the lack of adequate sewer flows, no future or existing residential and commercial users would be served. Figure 4.13 shows the users' locations and potential distribution system routes for NW2.

Flows for NW2 would be treated at a SRWF sized for 4.7. This flow is less than flows identified for NW1 because for NW1 additional recycled water uses would be served by the backbone pipeline from the RWRF extending from the Southwest quadrant.

The peak day urban demand for the SWRF is 4.7 mgd, however, the daily minimum sewer flow near the proposed SRWF is only 2.7 mgd. As a result, influent storage of approximately 670,000 gallons would be required to run the SWRF at a steady rate. Sewer flow curves from monitoring data are presented in Appendix E.

The golf courses in the northwest region all have onsite storage in the form of ponds. Approximately one day of storage for users other than the golf courses, approximately 1.2 MG, would need to be supplied.

Since the City already owns the site at Herndon Ave and Hayes Ave, no additional land would be acquired for NW2. The site is approximately 16 acres, and although some of that area would be used for a new road alignment in the future, it would be adequate for either treatment alternative. However, if for aesthetic purposes the City wished to build a subsurface facility, the MBR process with its smaller footprint would be a more attractive alternative.

Distribution System Summary

	Length of Pipe	Recycled Water Delivered*
Pipeline No. 1	11.11 mi	1,354 acre ft / yr
Pipeline No. 2	4.88 mi	210 acre ft / yr
Pipeline No. 3	3.90 mi	96 acre ft / yr
Pipeline No. 4	1.61 mi	49 acre ft / yr
Total:	21.50 mi	1,709 acre ft / yr

*No agricultural or future demand included in calculations.

Map Legend:

- Airports
- Cemeteries
- Fresno City Limits
- Northwest Satellite Recycled Water Facility
- Booster Pump Station
- Parks & Golf Courses
- Schools
- Water Bodies & Ponds
- Street Centerlines
- Fresno Sphere of Influence

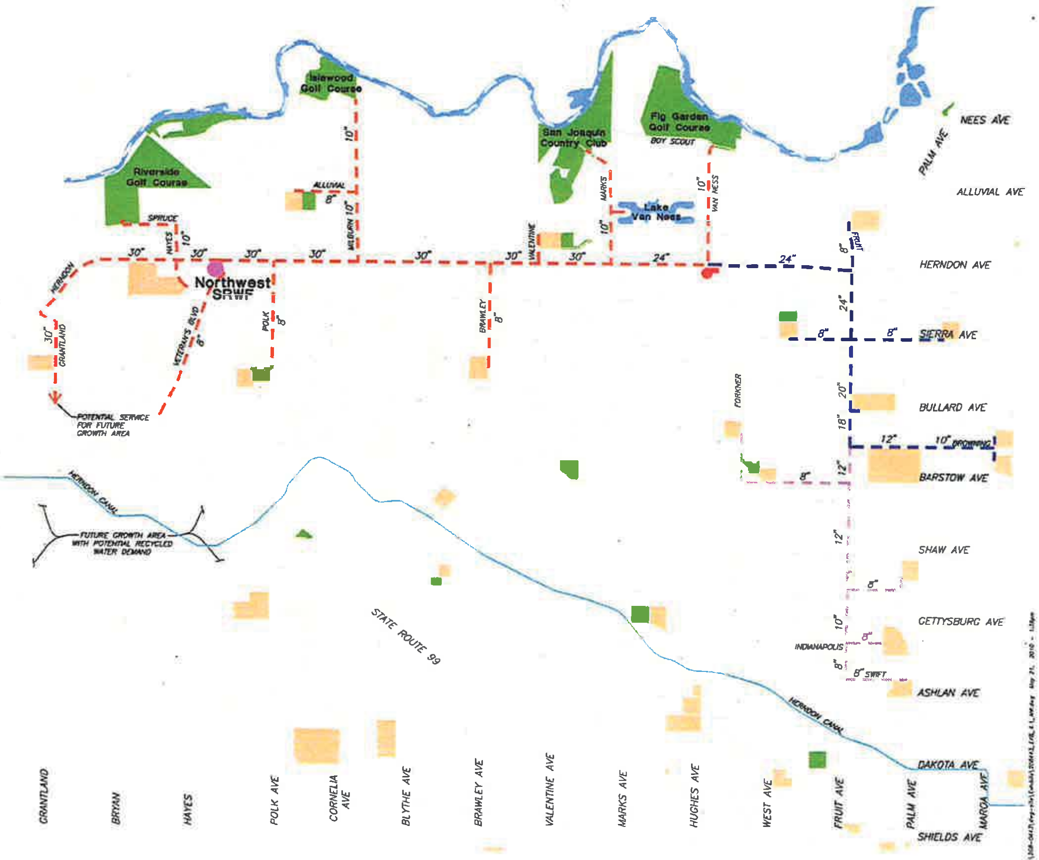

Figure 4.13
NORTHWEST PROJECT ALTERNATIVE 2
DISTRIBUTION SYSTEM ALIGNMENT
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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4.4.5 Northeast Alternatives (NE2 and NE3)

The two northeast alternatives served from SRWFs are NE2, where users are served by the North Fresno WRF which would be expanded to its full capacity; and NE3, where users in the central Fresno region would be served by one of two possible SRWFs.

The Northeast Quadrant is unique because of the existing North Fresno WRF. However, this existing facility was originally sized to serve the Copper River development and is now under consideration to serve as the primary SRWF for that quadrant of the City. A major limiting factor to this, however, is that the majority of influent supply for this quadrant is downgradient of the existing plant. Alternative NE2 would require rerouting flow from downgradient sewers. However, even with this rerouting of NE quadrant flow, the potential demand for this quadrant is higher than the potential volume of wastewater flow generated. As a result, not all potential users in the northeast quadrant would be served by the North Fresno WRF. Figure 4.14 shows the users' locations and potential distribution system routes for each alternative.

4.4.5.1 <u>NE 2</u>

Alternative NE 2 is similar to NE 1, except that fewer users can be served because the quadrant is served by the NFWRF as opposed to a backbone pipeline extension from the RWRF. The North Fresno WRF would be expanded to an average monthly capacity of 1.07 mgd. Sewer lift station 6 (located at Perrin and Chaplain) would be rerouted to supply the North Fresno WRF with sufficient flow to operate at 1.07 mgd.

Similar to NE 1, no additional influent or effluent storage would be required for this quadrant. No land acquisition would be necessary for this alternative, since new facilities would be on North Fresno WRF lands.

4.4.5.2 <u>NE 3</u>

For NE3, there are two alternatives to serve the areas around CSUF. The alternatives are independent of NE1 and NE2. In this alternative, a SRWF would be constructed at either the CSUF's campus (as a demonstration reuse project) or on the Granite Park site to serve nearby users and CSUF.

4.4.5.2.1 *NE 3.a*

The flow for the NE3 SRWF would be 0.7 mgd, which represents the maximum influent flow that can be supplied by the nearby sewer. Minimum sewer flows in this area are significantly reduced when school is not is session (summer and holidays), and as a result, approximately half a day's influent storage (or 350,000 gallons) would be necessary to maintain minimum flows through the SRWF. The campus has a one million gallon water storage tank for irrigation uses that could potentially be used for recycled water storage. Therefore distribution system storage may not be needed. It was also assumed that the project would also utilize the existing irrigation system onsite.

Wastewater Summary

- Buildout Wastewater Flow to Copper WRF: 1.08 MGD

Distribution System Summary

	Length of Pipe	Recycled Water Delivered
Existing Recycled Water Pipeline	1.75 mi	508 acre ft / yr

Legend:

- Fresno City Limits
- Parks & Golf Courses
- Schools
- Water Bodies & Ponds
- Street Centerlines
- North Fresno Water Reclamation Facility
- Sewer Lift Stations
- Fresno Sphere of Influence

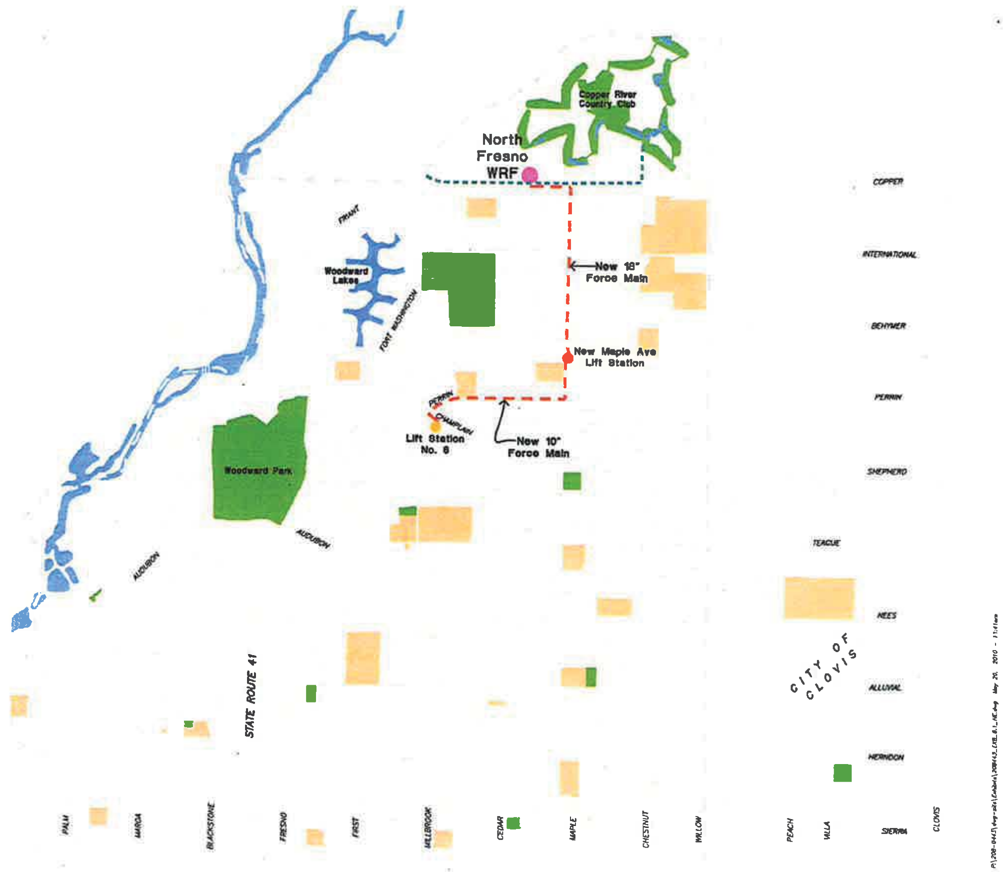

Figure 4.14
NORTHEAST PROJECT ALTERNATIVE 2
DISTRIBUTION SYSTEM ALIGNMENT
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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No land acquisition would be necessary for this alternative, since the SWRF would be constructed on CSUF property.

4.4.5.2.2 *NE 3.B*

Alternative NE3.B, constructed on City owned property at Granite Park, will serve the central area recycled water users including the CSUF campus and its agricultural areas. This SRWF will treat up to 4 mgd of sewer flow which represents the available flow in the Orange Avenue trunk line. Although there is no recent flow monitoring data for the Orange Avenue trunk line in this area, it is anticipated up to one million gallons of influent storage may be required to stabilize the treatment process during low flow periods. Based on estimated demand for recycled water in the central area, up to two million gallons of recycled water storage, (or half days storage) is anticipated. The distribution system supporting this SRWF will service surrounding parks, Freeway 168 landscaping and schools and the CSUF campus and agricultural areas. No land acquisition would be needed for this alternative.

4.4.6 Southeast Alternative (SE2)

Alternative SE 2 would serve the southeast quadrant from a new satellite facility, which could be located at the Fresno Fairgrounds (if the County is willing to cooperate with the project), at a City-owned park, or in the SEGA area on land owned by the City. The users served would be similar to SE 1, including golf courses, parks, schools, Fresno Pacific University, as well as some residential and commercial users. Figure 4.15 shows the users' locations and potential distribution system routes for each alternative, along with the potential locations of the SRWF.

For SE 2, flows are treated at a SRWF sized for 3.0 mgd. Because sewer flows in this quadrant are in excess of the demands of larger users, approximately 140 AFY of residential and commercial demand could also be served.

Based on recent flow monitoring results, the daily minimum sewer flow in the southeast quadrant is estimated to be 3.2 mgd near the proposed SRWF, not including future flows from the SEGA development. Therefore, no influent storage would be necessary for SE2. Approximately one day, or 2.6 MG, of effluent storage would be required as part of this alternative.

Since the SWRF and storage facilities would be built near the Fresno Fairgrounds, at a City-owned park, or in SEGA on land owned by the City, no land would be acquired. An activated sludge facility would occupy approximately 5.6 acres and a MBR would occupy 1.7 acres. Therefore, an MBR facility would be more feasible for small sites or developed areas such as the fairgrounds or a park. If the SRWF was built within SEGA, then a less expensive, more land intensive treatment technology could be used to serve the identified existing users, and expanded as future growth occurs in the SEGA area. Unlike the other

Distribution System Summary

	Length of Pipe	Recycled Water Delivered*
Pipeline No. 1	3.24 mi	488 acre ft / yr
Pipeline No. 2	1.26 mi	330 acre ft / yr
Pipeline No. 3	0.86 mi	111 acre ft / yr
Pipeline No. 4	3.73 mi	22 acre ft / yr
Total:	9.09 mi	951 acre ft / yr

*No agricultural or future demand included in calculations.

Map Legend:

- Fresno City Limits
- Parks & Golf Courses
- Schools
- Southeast Growth Area
- Street Centerlines
- Fresno Sphere of Influence
- New Satellite Recycled Water Facility
- Clovis Water Reclamation Facility
- Heavy Industrial User
- Existing Recycled Water Pipeline

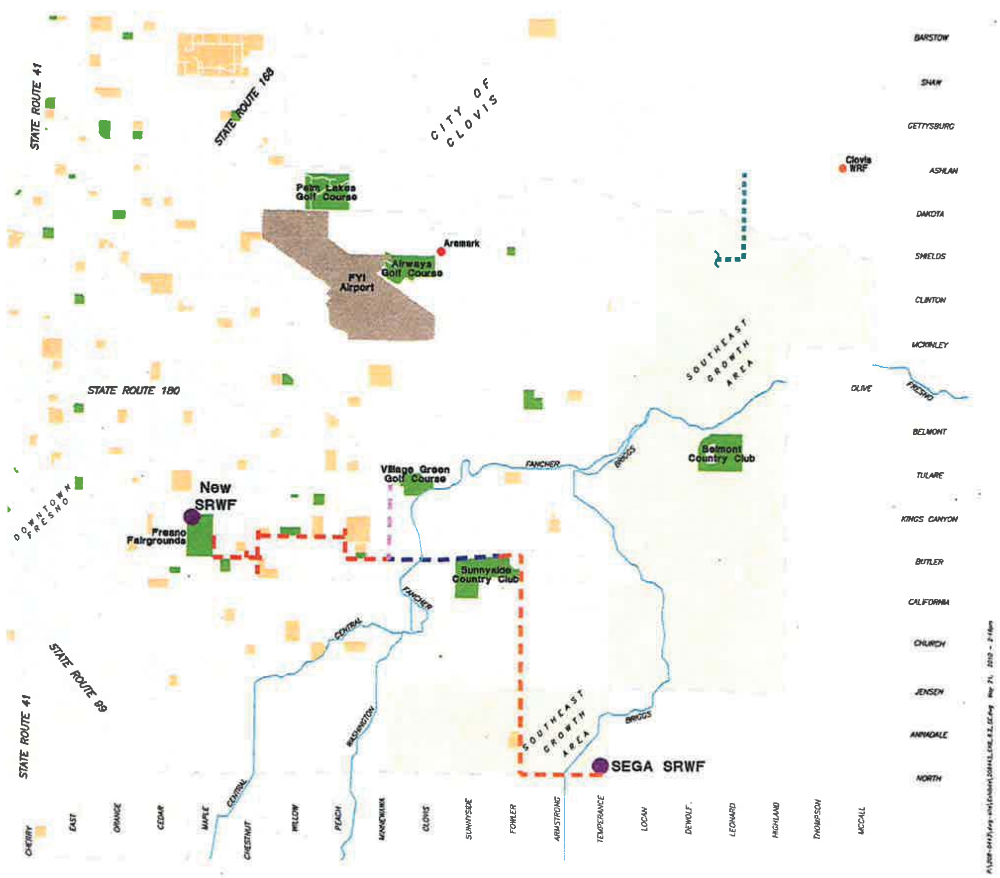

Figure 4.15
SOUTHEAST PROJECT ALTERNATIVE 2
DISTRIBUTION SYSTEM ALIGNMENT
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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quadrant SWRF alternatives, the SE quadrant alternative should consider future regional land development plans such as SEGA in its identification of the plant location, capacity, and technology for the proposed SWRF identified as part of this Master Plan.

4.4.7 Costs for Urban Alternative 2 – Served by SRWFs

A conceptual cost estimate for Southeast project alternatives is presented in Table 4.6. These costs are construction costs and include a 30 percent planning level contingency for treatment facilities and 25 percent for distribution system. Treatment costs are based on the most probably treatment trains, as presented in section 4.4.1. Costs are presented in January 2010 dollars (ENR 8660).

Costs are based on the following assumptions:

- Recycled water would serve the City from new SRWFs.
- Each quadrant is independent and SRWFs and distribution systems can be implemented in any order.
- Treatment costs are presented as a range from low to high costs which represent different treatment trains (Note 1 in Table 4.6).
- Feed pump station is included in treatment cost estimate, and recycled water delivery pump station is included in distribution system pump station cost estimate.
- Storage Costs are based on welded steel tanks.
- More detailed cost estimate information is provided in Appendix F.

4.5 GROUNDWATER RECHARGE PROJECT ALTERNATIVES

Groundwater Reuse Recharge Projects (GRRPs), provide a significant opportunity for improving the City's long term sustainable water supply. However, due to a lengthy permitting process, GRRPs will likely be phased in over time to supplement urban reuse projects. The reuse demand (and potable water offset) that can be achieved by implementing GRRPs would be above and beyond the estimated urban irrigation and industrial demand, and is dependent on the land area secured for recharge (discussed in Chapter 3).

Specific GRRP basin sites have not yet been identified. However, it is likely that GRRPs would be operated during the rainy season when there is little recycled water demand. This would take advantage of the distribution system and treatment capacity that would be constructed for urban reuse during the irrigation season while providing a winter discharge option. Therefore, GRRPs would not require significant specific capital investment for treatment or distribution of recycled water. Urban reuse and groundwater recharge reuse would utilize the same distribution system to the extent possible. Although the treatment

Table 4.6 Cost Estimates for Alternative 2 Served by SWRF (in Millions)
Recycled Water Master Plan
City of Fresno

	Alternative	Distribution System			Treatment[2]	Storage	Land Acquisition	Total
		Backbone	Spurs	Total				
Capital Costs ($M)	SW2	25	11	36	37-50	7	Up to 0.8	81-94
	NW2	16	9	25	35-51	3	Up to 0.04	63-79
	NE2	-[3]	1	5[4]	5[5]	-[6]	-	10
	NE3.A	-[3]	2	2	23[7]	-[6]	-	25
	NE3.B	-[3]	6	6	35-50	4	-	45-60
	SE2	3	3	6	26-36	4	-	36-46
O&M Costs ($M/yr)	SW2	-	-	0.2	0.9-1.7	0.2		1.3-2.1
	NW2	-	-	0.1	0.7-1.6	0.1		0.9-1.8
	NE2	-	-	0.06	0.5	-[6]		0.6
	NE3.A	-	-	0.03	0.2-0.3[7]	-[6]		0.2-0.3
	NE3.B	-	-	0.05	0.7-1.6	0.2		0.95-1.85
	SE2	-	-	0.05	0.5-1.0	0.2		0.7-1.2

Notes:
(1) All costs presented in January 2010 dollars (ENR 8660)
(2) High- and low-cost treatment alternatives are presented. Low cost alternative is activation sludge with NdN +media filtration + UV. High cost alternative is MBR + UV.
(3) Distribution system to small to have a segment considered a "backbone".
(4) Distribution system includes $4M for rerouting sewer lift station # 6 to North Fresno WRF.
(5) Includes expanding North Fresno WRF and replacing disinfection facilities with UV.
(6) Storage is provided in existing facilities.
(7) Only MBR+ UV was considered for CSUF SRWF

processes would require different operation with higher operating costs to meet the higher level of treatment required (e.g. nitrogen removal).

Approximately four times as much diluent water as recycled water is required by the DPH for GRRP operation. There are a couple of options for sources of diluent water required for a GRRP: surface water from FID or the US Bureau of Reclamation, and/or stormwater from the Fresno Metropolitan Flood Control District (FMFCD). Where possible, GRRP basins will be located adjacent to FMFCD basins or FID canals, so infrastructure to deliver diluent water would be minimal. The required 6 month travel time between the GRRP and nearest drinking water well also affects the siting of the GRRP basins. Land for potential GRRPs has been identified based on a brief review of empty lands adjacent to FID canals and flood control district facilities, in areas were soils are known to be generally suitable for recharge. These areas are mainly in the northwest and southwest quadrants.

4.5.1 Treatment

Recycled water from either the RWRF or a SWRF must meet Title 22 standards, including filtration and disinfection, as described in Chapter 2. Additionally, projects that include a GRRP component require nitrification/denitrification (NdN) to reduce total nitrogen to less than 10 mg/l. At the RWRF, this means changing the operational parameters of the existing secondary processes to achieve NdN in addition to providing filtration and disinfection.

Nitrogen removal at the RWRF for GRRPs can theoretically be achieved without construction of expensive end-of-pipe nitrification and denitrification filters by modifying existing secondary processes. Although the operation of the secondary treatment facilities is not currently aimed at nitrogen removal, significant removal is already being achieved.

The A Side treatment train at the RWRF has the capability of partially removing nitrogen through operation in simultaneous nitrification-denitrification (Sinn) mode. It will be difficult to implement a more advanced biological nitrogen removal process since this older activated sludge system was not originally designed for this purpose, and therefore lacks the operational flexibility required to reduce nitrogen concentration.

The best opportunity for providing NdN through operational changes is to use the newer activated sludge facilities in Plant B or C. Both the B and C facilities were designed with the flexibility to be operated in a variety of advanced biological nutrient removal processes and were designed to achieve 10 mg/L total effluent nitrogen.

Plant B consists of four aeration basin (Nos. 5 through 8) and eight secondary clarifier (Nos. 6 through 13). The rated capacity is 38 mgd during the summer (9.5 mgd per aeration basin) and 33 mgd during the winter (8.25 mgd per aeration basin). Aeration basin No. 5 was designed to be able to run in a NdN mode, separate from the rest of the basins. This basin could be dedicated to providing denitrified effluent for groundwater recharge (up to

9.5 mgd) with relatively modest changes to piping and the addition of a stop plate in the effluent channel.

Plant C consists of two aeration basin (Nos. 9 through 10) and four secondary clarifier (Nos. 14 through 17). The rated capacity is 19 mgd during the summer (9.5 mgd per aeration basin) and 17 mgd during the winter (8. 5 mgd per aeration basin). If the groundwater recharge demand exceeds the capacity of aeration basin No. 5, then the entire Plant C could be used to provide up to 19 mgd for groundwater recharge. Piping would be required to convey the Plant C effluent to the filtration facilities.

If groundwater recharge demand exceeded the Plant C 19 mgd capacity, the entire Plant B could be operated in NdN mode for a capacity of up to 38 mgd. The operation of any of the existing facilities in NdN mode will require an increase in operating costs for the additional air required.

4.5.2 Southwest GRRP Basins

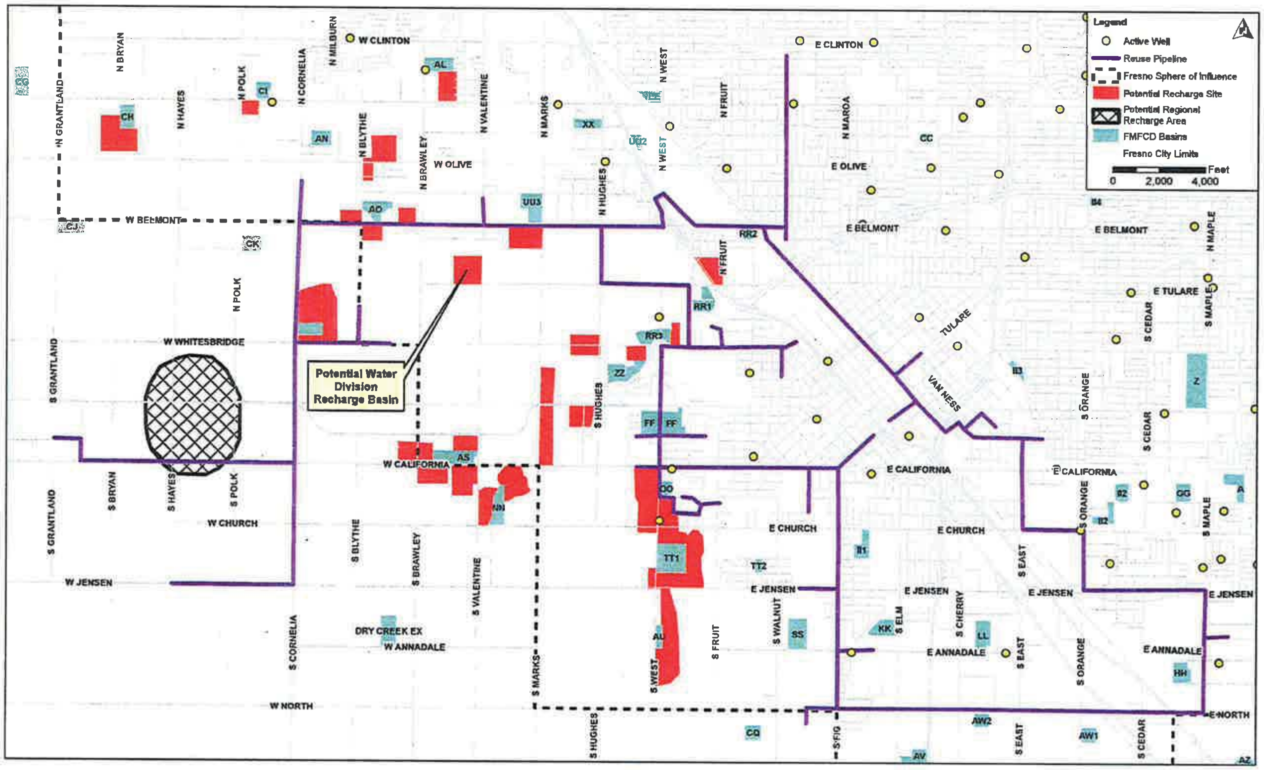
Potential future GRRP basin sites were located through a preliminary identification of empty parcels adjacent to existing flood control basins or near FID supply channels. These potential sites, as well as possible future super-recharge basin sites (identified by the City water division as areas for potential future recharge of surface water) that could receive recycled water in the southwest quadrant are shown in Figure 4.16.

There are 839 acres of land identified for potential recharge in the SW quadrant (not including super-recharge basins), or 1,244 acres including the super-recharge basins. Based on FMFCD data, recharge rates are estimated to be 1.2 to 4.8 inches/day. Using an intermediate value of 2.4 inches/day, and assuming the diluent water is delivered at the same time that recharge is occurring, the potential for recycled water recharge is conservatively estimated to be 13 AFY/acre. Therefore, if all sites identified in the SW quadrant were developed into GRRPs, 10,900 AFY of recycled water could be recharged without the super-recharge basins, or 16,180 AFY with the super-recharge basins.

4.5.3 Northwest GRRP Basins

The potential locations for GRRP recharge basins in the Northwest Quadrant, as well as that of a possible future super-recharge basins that could receive recycled water, are shown in Figure 4.17.

There are 303 acres of land identified for potential recharge in the NW quadrant, not including super-recharge basins, or 883 acres including the super-recharge basins. Using the estimated potential for recycled water recharge of 13 AFY/acre, if all sites identified in the NW quadrant were developed into GRRPs, 3,940 AFY recycled water could be recharged without the super-recharge basins, or 11,480 AFY with the super-recharge basins.



Alternative 1 Pipeline Alignments

Figure 4.16
POTENTIAL FUTURE GRRP BASINS, SOUTHWEST QUADRANT
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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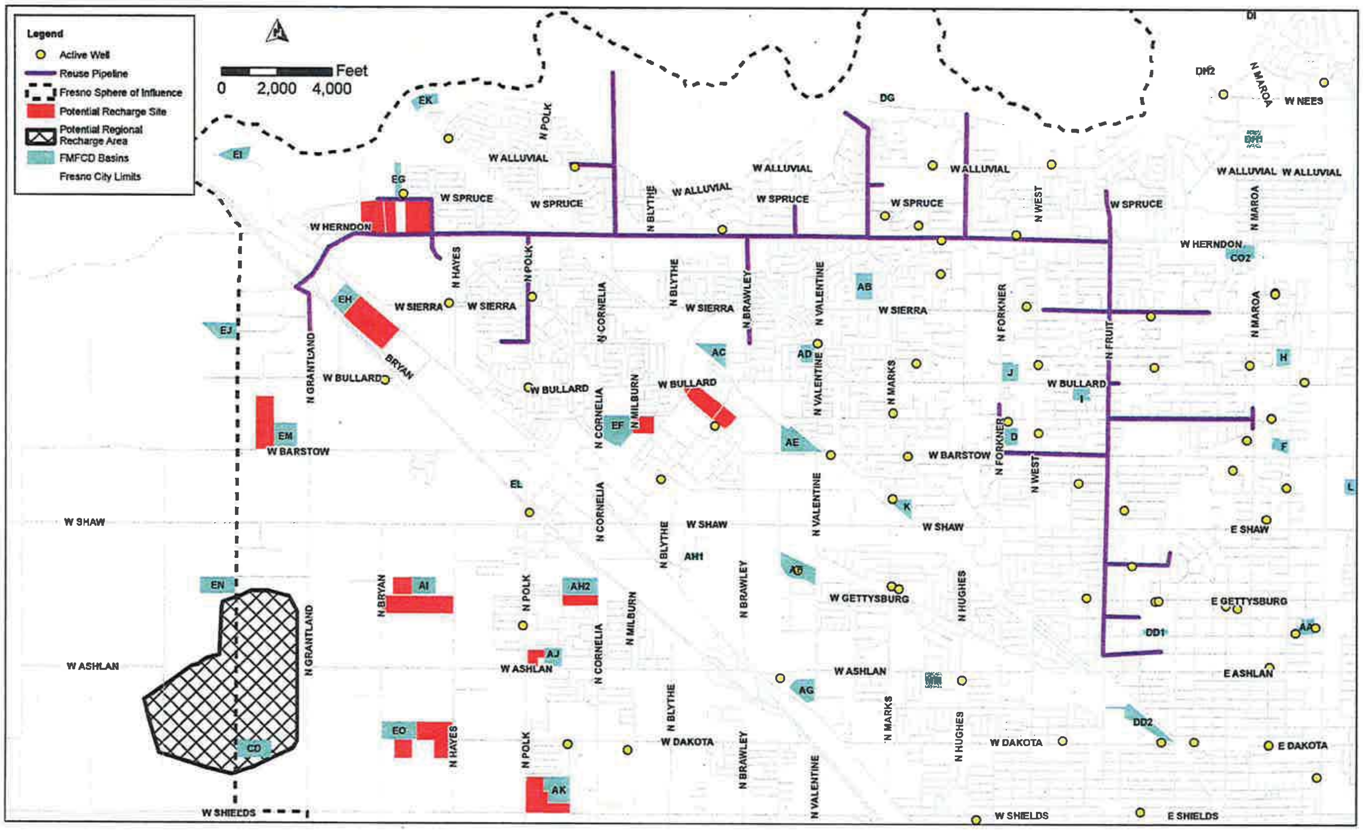

Alternative 1 Pipeline Alignments

Figure 4.17
POTENTIAL FUTURE GRRP BASINS, NORTHWEST QUADRANT
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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4.5.4 Northeast and Southeast GRRP Basins

The NE quadrant is densely developed. As a result of this, no viable recharge sites were identified in this quadrant.

The City currently recharges surface water at Leaky Acres in the southeast quadrant. The ability to add recycled water to Leaky Acres was considered and dismissed as there are drinking water wells located within a 6-month travel time of the Leaky Acres site. Therefore, hydraulic detention time between recycled water recharge and the nearest well could not be met without abandoning the highly productive existing wells. The City has identified one 320 acre potential future super-recharge basin southeast of the City limits. This basin could also potentially recharge recycled water. Using the estimated potential for recycled water recharge of 13 AFY/acre, 4,160 AFY of recycled water could be recharged at this site.

Many of the undeveloped areas surrounding the southeast quadrant of town have soils that are not amenable to percolation, which leads to difficulty in locating a recharge basin in this quadrant. Additionally, there are known contaminant plumes in the SE quadrant that must be avoided. As a result, other than the super-recharge basin, groundwater recharge was not identified as part of the southeast reuse alternatives, although further investigation may be warranted..

4.5.5 Costs of GRRP

A conceptual cost estimate of a typical 20-acre GRRP basin is presented in Table 4.7. Land acquisition costs assume a land value of $45,000/acre. This value was obtained by gathering the 2009/10 assessed land and improvement values of several of the proposed basin and determining the 90th percentile value. Therefore, using $45,000/acre is a conservative land value estimate. Basin construction costs include an appropriate planning level contingency and are presented in January 2010 dollars (ENR 8660).

Table 4.7 Project Cost Estimate for Example 20-acre Recharge Basin
Recycled Water Master Plan
City of Fresno

Element	Capital Cost ($M)	O&M Cost ($/yr)
Basin	1.5	25,000
Land Acquisition	0.9	-
Total	**$2.4**	**$25,000**

Note:
(1) Assuming basins are excavated to a depth of three feet, with berm height of six feet. This allows a water depth of seven feet with two feet of freeboard. Excess dirt would be hauled to the RWRF. Unit costs for excavation and hauling were verified with FMFCD.

If all 1,142 acres of identified GRRP basins (not including the super-recharge basins) were developed as part of the City's Recycled Water Program (this would be equivalent to fifty seven (57) 20-acre basins), the construction cost is estimated to be $137 million.

4.6 AGRICULTURAL ALTERNATIVES

There were three alternatives carried forward to increase water reuse for agricultural irrigation. They were:

- AG 1 - Expand the existing system to deliver additional undisinfected secondary effluent to growers of non-food crops.
- AG 2 - Expand deliveries of extracted percolated effluent to FID.
- AG 3 - Upgrade to tertiary treatment and directly deliver recycled water for unrestricted reuse.

These alternatives could each be implemented in addition to the urban reuse alternatives discussed earlier. All of these alternatives involve supplying recycled water from the RWRF, (rather than SRWFs), since only the RWRF is expected to have excess flow above the demands of urban users during the summer time.

4.6.1 Direct Delivery of Undisinfected Secondary Effluent (AG 1)

The RWRF currently delivers approximately 10,000 AFY of undisinfected secondary effluent to nearby growers of non-food crops. City staff conducted a preliminary evaluation of the potential to expand the direct reuse system to new growers in the vicinity of the RWRF able to accept recycled water. Two farms with 1,400 acres, representing an additional 4,200 AF of demand, could be served with undisinfected secondary effluent, provided that piping was available to convey the water. While this alternative would not provide an exchange benefit, it would provide diversification of the City's reuse and effluent management systems and would reduce the hydraulic loading on the percolation ponds. Figure 4.18 shows a conceptual schematic of this alternative.

Increasing deliveries of undisinfected secondary effluent to growers would not require additional treatment or storage, however, a new pipeline to convey recycled water to growers would be necessary.

4.6.2 Delivery of Extracted Percolate to FID (AG 2)

The RWRF currently pumps approximately 30,000 AFY of percolated effluent from extraction wells to FID canals. This alternative would require increasing pumping from the groundwater beneath the percolation ponds from 30,000 AFY to 50,000 AFY, depending on the level of reuse that is agreed upon. This increase in extracted percolate being delivered to FID canals would require the existing agreement with FID to be negotiated to include provisions for increased deliveries to the FID canals. To take advantage of any exchange agreement with FID of recycled water for raw surface water, additional facilities may be

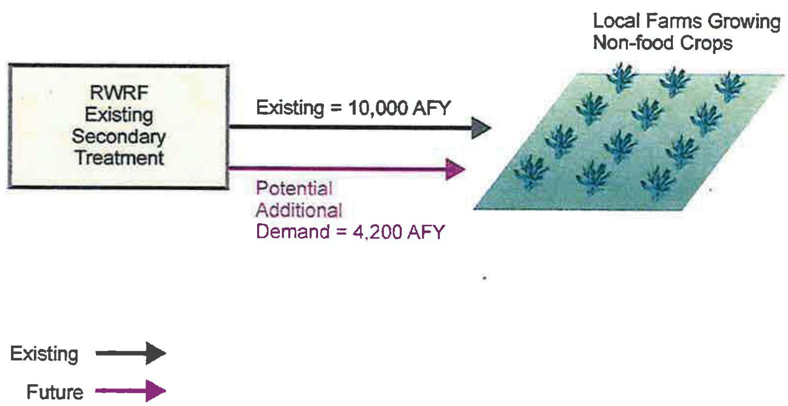

Figure 4.18
DIRECT DELIVERY OF
UNDISINFECTED SECONDARY EFFLUENT (AG 1)
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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needed within the city to convey and treat FID's surface water for potable use, or to recharge it to the groundwater aquifer. A conceptual schematic of this alternative is shown in Figure 4.19.

FID's irrigation season is typically a six-month period between March and August, but can vary from year to year based on rainfall . During the irrigation season, flow rates in FID canals and pipelines are typically lowest during the months of March and April and then peak during the months of June and July. Lower Dry Creek, the Houghton and Herndon Canals have large flow capacity and could provide recycled water to agricultural users downstream of the points of discharge. The City of Fresno currently discharges extracted percolated effluent to both Lower Dry Creek and Houghton Canal.

Expanding the delivery of extracted percolate to the canals would require a number of improvements at the RWRF. A series of new wells would be required to increase extraction pumping. Over the last ten years, the City reused (through direct delivery or extraction) between 25,000 and 40,000 AFY. Based on an effluent flow of 80,000 AFY, between 40,000 to 55,000 AFY may be available for additional reuse. For the purposes of determining facility needs and costs, it was assumed an additional extraction of 20,000 AFY would occur over a nine month period for delivery of extracted percolated effluent. Approximately 12 new wells, each with a capacity of about 1,400 gpm, would be needed. These wells would need to be carefully located to limit impacts on groundwater quality, and to limit extraction of low-quality groundwater. In addition to new wells at the RWRF, a pipeline would be required to convey the additional flows.

4.6.3 Delivery of Tertiary Effluent (AG 3)

This alternative provides treatment for direct delivery of unrestricted reuse water to agricultural users instead of using extracted water. The City would need to upgrade to tertiary treatment at the RWRF for this alternative. While the City could invest in an agricultural distribution system to take the tertiary treated water directly to individual users, a comprehensive agricultural distribution system already exists with the FID canal system and could continue to be utilized for delivery of tertiary treated water.

Delivery to FID also has the advantage of potentially exchanging recycled water for surface water. In order to use the FID canal system for delivery of recycled water, the City would need to renegotiate its agreement with FID to allow delivery of tertiary treated effluent directly to the canals (without percolation and extraction). Also to take advantage of any exchange agreement with FID of recycled water for raw surface water, additional facilities may be needed within the city to convey and treat FID's surface water for potable use, or to recharge it to the groundwater aquifer.

For tertiary effluent deliveries to FID canals, new tertiary treatment facilities, a new pump station and a new recycled water pipeline would be required. The pump station would be located near the tertiary facilities at the RWRF, and the pipeline would extend from the

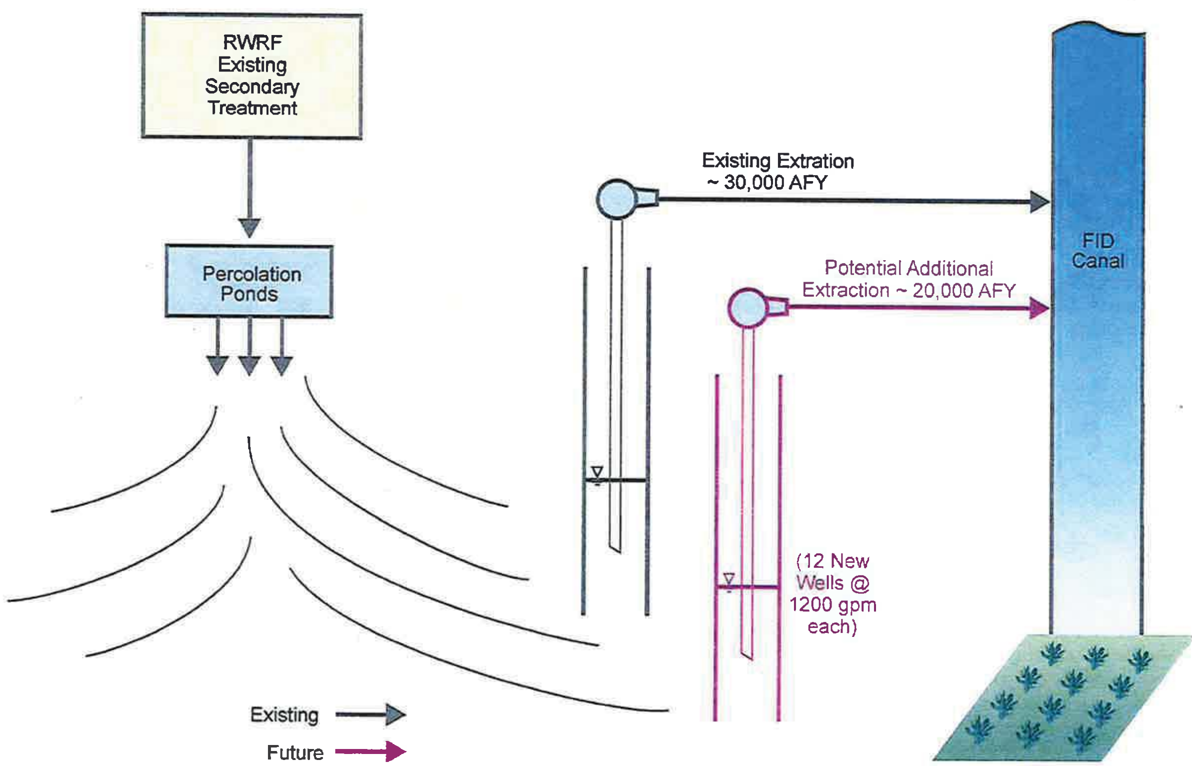

Figure 4.19
DELIVERY OF EXTRACTED PERCOLATE TO FID (AG 2)
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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pump station to each canal. A conceptual schematic of this alternative is shown in Figure 4.20.

The City could invest in developing their own agricultural distribution system to serve tertiary treated recycled water directly to potential users, however it is less likely that the City could get an exchange of recycled water for surface water as individual farmers typically do not possess surface water rights.

This alternative is more expensive than increased pumping of percolated effluent to the FID canal system (AG 2). The two alternatives (AG 2 and AG 3) provide the same amount of additional reuse (approximately 20,000 AFY in the near term), at the same conveyance cost, but AG 3 incurs additional capital and O&M costs associated with construction and operation of a tertiary WWTP. However, it was carried forward in the Master Plan in case the RWQCB does not recognize percolation as equivalent to tertiary treatment in the future (see Chapter 3).

4.6.4 Costs Estimates

A conceptual cost estimate for the agricultural project alternatives is presented in Table 4.8. These costs are project costs which include construction costs (with an appropriate planning level contingency) plus a 20 percent factor for engineering, legal and administration costs. Costs are presented in January 2010 dollars (ENR 8660).

Table 4.8 Cost Estimates for Agricultural Project Alternatives
Recycled Water Master Plan
City of Fresno

	Alternative	Distribution System	Treatment	Storage	Total
Capital Costs ($M)	AG 1	6	-	-	6
	AG 2(1)	18(2)	-	-	18
	AG 3(1)	13	28(3)	-	41
O&M Costs ($/yr)	AG 1	0.06	-	-	0.06
	AG 2	0.6	-	-	0.6
	AG 3	0.3	1.1(3)	-	1.4

Notes:
(1) Assuming 20,000 AFY agricultural reuse program (above current practices).
(2) Distribution system costs include new extraction wells (based on costs from City of existing extraction wells)
(3) Treatment train is assumed to be media filtration + UV.

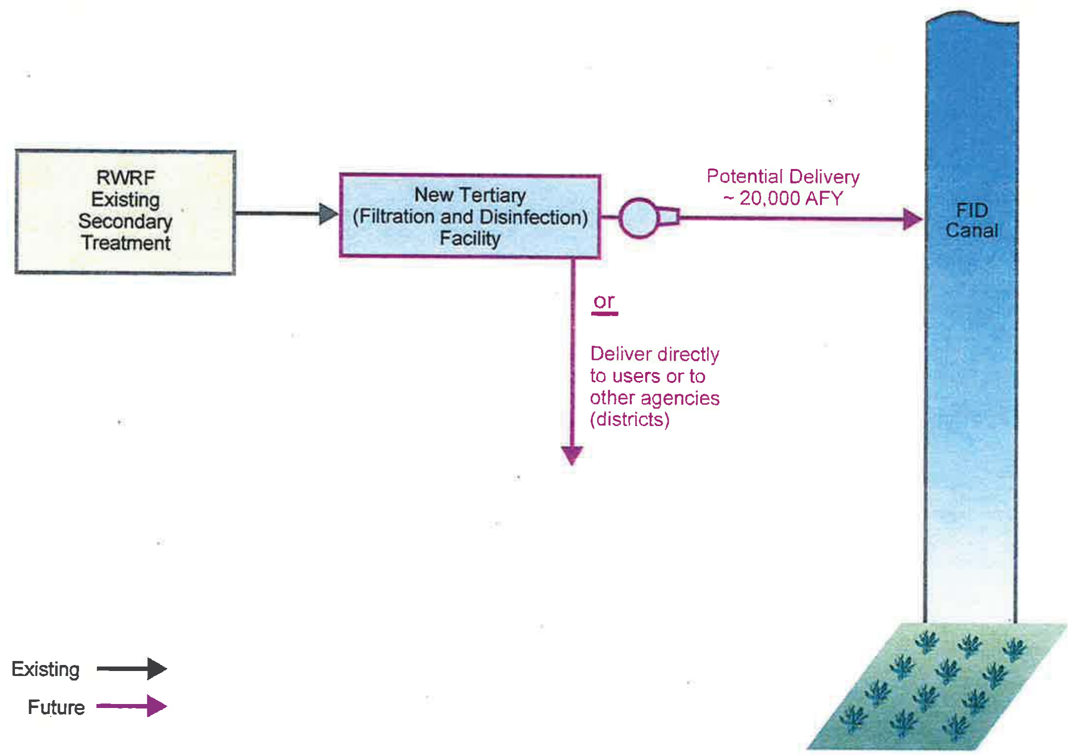

Figure 4.20
DELIVERY OF TERTIARY EFFLUENT TO FID (AG 3)
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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Costs are based on the following assumptions:

- AG 1 is independent of AG 2 and AG 3.
- Only one of either AG 2 or AG 3 would be implemented.
- Distribution system costs for AG 1 include piping secondary effluent directly to farmers, and do not include connections to existing irrigation systems.
- Distribution system costs for AG 2 include installing and operating new extraction wells and piping tertiary disinfected effluent to Dry Creek and Houghton Canals.
- Distribution system costs for AG 3 include piping tertiary disinfected effluent to Dry Creek and Houghton Canals.
- Feed pump station is included in treatment cost estimate.
- More detailed information is provided in Appendix F.

4.7 SUMMARY OF COSTS FOR PROJECT ALTERNATIVES

Table 4.9 presents a summary of the cost information provided in this Chapter. More detailed information about the estimates is provided in Appendix F.

The costs presented in Table 4.9 for the satellite treatment alternatives (Urban Alternative 2) do not reflect the difficulty in siting these types of facilities. The higher cost shown for Alternative 2 represent a more compact and covered treatment train (MBRs) and would likely be required for mitigation of neighbor impacts if siting (area requirements) is an issue.

4.7.1 Cost Model

A spreadsheet cost model was prepared using the costs presented in this chapter for each of the pipeline segments identified. The model allows for selection of pipe segments in creation of a "project". The output is the cost for the selected distribution system and treatment needed to provide flow for the existing large users along the selected pipe segments. This tool was developed for the purpose of CIP planning and can be used by the City to help prioritize implementation of the recycled water distribution system. Figure 4.21 shows a screen capture of the cost model spreadsheet.

Table 4.9 Summary of Costs for Project Alternatives
Recycled Water Master Plan
City of Fresno

Alternative	Demand (AFY)	Capital Costs ($M)					O&M Costs ($M/yr)			
		Distribution System	Treatment	Storage	Land Acquisition[1]	Total	Distribution	Treatment	Storage	Total
Urban Alternative 1 (RWRF)										
SW 1	4,140	49	12[2]	7	-	68	0.3	0.4	0.2	0.9
NW 1	1,951	50	9[2]	6	-	65	0.2	0.3	0.2	0.7
NE 1	2,720	40	11[2,3]	5	-	56	0.2	0.7	0.2	1.1
SE 1	995	17	6[2]	4	-	27	0.1	0.2	0.2	0.5
Existing residential and commercial users[4]	2,984	86	10[2]	-[5]	-	96	0.4	0.3	-	0.7
Future Residential and commercial users[4]	1,586	-[6]	6[2]	-[5]	-	6	-	0.2	-	0.2
Urban Alternative 2 (SRWF)										
SW 2	4,140	36	37-50[2,7,8]	7	Up to 0.8	81-94	0.2	0.9-1.7	0.2	1.3-2.1
NW 2	1,709	25	35-51[7]	3	Up to 0.04	63-79	0.1	0.7-1.6	0.1	0.9-1.8
NE 2	508	5[2]	5[3]	-	-	10	0.06	0.5	-	0.6
NE 3.A	263	2	23[9]	-	-	25	0.03	0.2-0.3	-	0.2-0.3
NE 3.B	4,900	6	35-50	4	-	45-60	0.05	0.7-1.6	0.2	0.95-1.85
SE 2	951	6	26-36[7]	4	-	36-46	0.05	0.5-1.0	0.2	0.7-1.2
Groundwater Reuse Recharge										
20 acre basin	260	-	-	1.5	0.9	2.4	-	-	0.03	0.03
Agricultural Alternatives										
AG 1	4,200	6	-	-	-	6	0.06	-	-	0.06
AG 2	20,000	18[10,11]	-	-	-	18	0.6	-	-	0.6
AG 3	20,000	13[11]	28[2]	-	-	41	0.3	1.1	-	1.4

Notes:
(1) Land acquisitions costs depend on the treatment technology used, and are $45,000 per acre.
(2) Treatment train for RWRF is media filtration + UV. Costs are additive and assume that prerequisite system has already been constructed. (For example, NW 2 assumes that SW 2 already exists)
(3) NE1 includes treatment at the RWRF and the North Fresno WRF.
(4) For serving residential and commercial users, it is assumed that distribution piping backbone, storage facilities, and initial treatment facilities are already in place. Costs include adding 120 miles of distribution laterals and expanding tertiary treatment and disinfection at the RWRF. Future users include indoor dual plumbing along Hwy 41 mid- and high-rise intensification corridor.
(5) Storage for residential/commercial use is accounted for as part of Urban Alternative 1 (SW 1, NW 1, NE 1 and SE 1)
(6) It is assumed that developers will carry the cost for purple pipe for future growth and infill, and build laterals off of existing distribution system.
(7) Low cost alternative for SRWF treatment is activation sludge with NdN +media filtration + UV. High cost alternative for SRWF treatment is MBR + UV.
(8) SW 2 includes treatment at the RWRF and at a new SRWF.
(9) Only MBR was considered for secondary treatment.
(10) Costs include 12 new extraction wells and pumps.
(11) Costs include piping to Dry Creek and Houghton Canals.

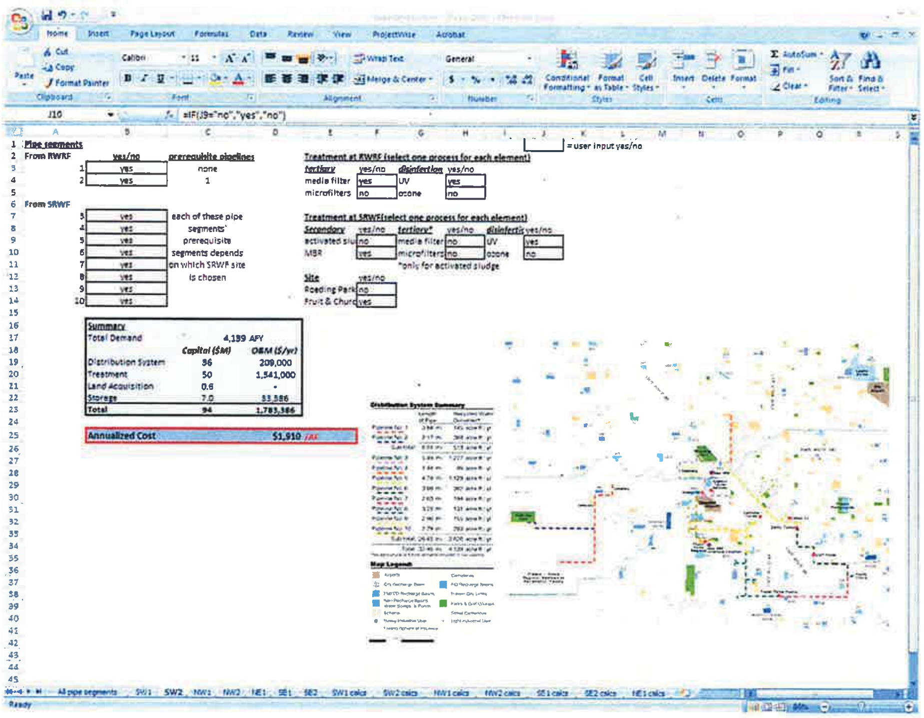

Figure 4.21
COST ESTIMATING TOOL
FOR PIPE SEGMENTS
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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SUMMARY AND RECOMMENDATIONS

5.1 INTRODUCTION

The City of Fresno (City) has embarked on a Recycled Water Master Plan (Master Plan) to serve as a basis to support the City's decision-making process in selecting recycled water projects. The expansion of the recycled water system will enable the City to lessen the burden on the wastewater treatment plant percolation ponds that are currently used for effluent discharge, offset potable water use, and enhance the sustainability of the water supply.

The City currently treats nearly 80,000 AFY of wastewater at the Regional Wastewater Reclamation Facilities (RWRF). Some of this water is directly recycled, but most of it is percolated into the ground via percolation ponds at the RWRF. The City and Fresno Irrigation District (FID) have an agreement whereby the City is contracted to extract 30,000 AFY of percolated effluent for delivery to FID canals for use downstream by local farmers. The remaining effluent is available for other beneficial uses.

The City is required by the Central Valley Regional Water Quality Control Board (RWQCB) to evaluate the quality of the groundwater beneath the percolation ponds. Reducing the hydraulic and constituent loading burden on the percolation ponds by implementing a significant reuse program would minimize salt and nitrogen loading and metals mobilization in the alluvium, lowering the concentrations of these constituents in the groundwater.

In 2009, the State of California adopted a Recycled Water Policy establishing a mandate to increase the use of recycled water in California by 200,000 acre-feet per year by 2020 and by an additional 300,000 acre-feet per year by 2030. The City's expansion of recycled water use is in support of these state-wide goals.

The City relies heavily on groundwater for potable supply. As identified by ongoing water planning efforts, the City needs to diversify its water supply portfolio for long- term sustainability of its water supply. The use of recycled water for non-potable water uses will help meet a significant part of the City's existing and future water supply demands.

Therefore, the intent of the Master Plan is to plan and implement a phased recycled water treatment and distribution system that:

- Protect and improve groundwater quality by reducing the use of percolation ponds currently used as part of the RWRF effluent disposal process;
- Increases the use of recycled water through urban reuse, groundwater recharge and agricultural reuse to help meet State's objectives to increase recycled water use and to meet the increasing water demands in the region;
- Expand the recycled water system to enable the City to offset potable water use, thereby enhancing the sustainability of the water supply;

- Puts into practice a recycled water plan and ordinance that will support implementation of recycled water use in the City for existing and future users.

5.2 SUMMARY OF FINDINGS

The findings presented herein reflect the detailed materials presented in Chapters 1 through 4 of this Master Plan. This chapter presents the recommended projects and project phasing. Factors considered in selection and phasing of project alternatives included:

- Project costs
- Implementation issues and timing
- Institutional considerations such as permitting and environmental review

The City has several key opportunities for implementing reuse, namely:

- Urban reuse
- Unrestricted agricultural reuse/exchange
- Groundwater recharge

Urban reuse provides an opportunity for near-term implementation of recycled water projects and would offset existing uses of the City's potable supplies and some private wells. Unrestricted agricultural reuse and exchange with FID are also near-term opportunities that would provide the City with credit for additional potable water supply. Groundwater recharge with recycled water is a longer-term program that would supplement potable water supplies and provide a barrier to prevent groundwater migration away from the City. A summary of the potential volumes of reuse identified for each type of use is shown in Table 5.1. A schematic of the recommended master plan recycled water elements is shown in Figure 5.1.

Table 5.1 Summary of Potential Reuse Volumes
Recycled Water Master Plan
City of Fresno

	Recycled Water Use (AFY)
Urban Irrigation and Industrial Reuse by Existing Large Users	14,700
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.

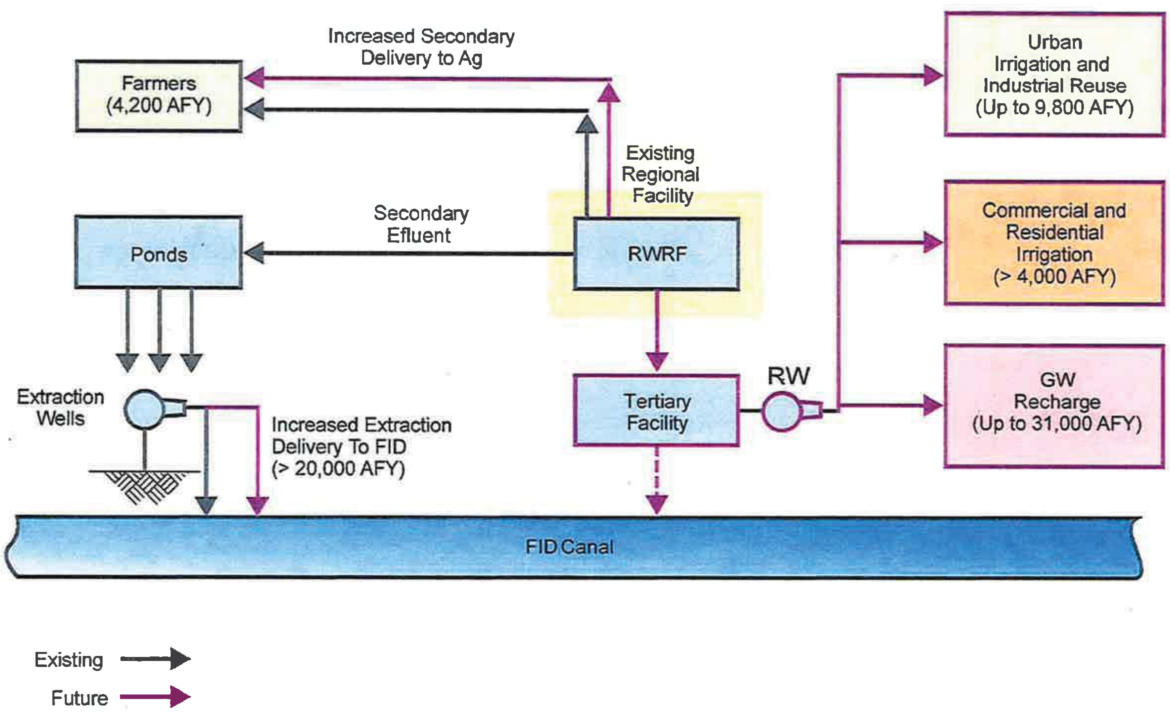

Figure 5.1
SUMMARY OF RECOMMENDED ALTERNATIVES AND POTENTIAL REUSE VOLUMES
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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5.2.1 Urban Reuse Opportunities

Urban reuse provides an opportunity to implement recycled water projects that directly offset potable water and are highly visible to the community. Urban reuse, however, requires the most intensive distribution system since users are spread out across the City. The recycled water distribution system alignments shown in Chapter 4 were selected based on prioritizing delivery to customers with an estimated demand of 100 AFY or more. These larger users are generally land-intensive parks, cemeteries and golf courses that are located around the outskirts of the City. Smaller users and future development areas were also identified to be served directly off the main distribution pipelines or from "laterals" off the main distribution system pipelines. The proposed distribution system forms a ring around the City, with laterals towards the City center that can be used to serve future infill development. If all the users identified by this strategy are served, the potential urban reuse opportunity for existing large users is over 9,000 AFY. If lateral are constructed to serve existing and future residential and commercial users, more than an additional 4,000 AFY can be served.

There were two major alternatives considered for serving urban users:

1. Delivery of recycled water from at the RWRF, or
2. Delivery of recycled water from at Satellite Recycled Water Facilities (SRWFs) located in each quadrant of the city (near the users).

The advantages and disadvantages of each tertiary treatment siting alternative are presented in Table 5.2. In general, treatment and delivery of recycled water from SRWFs is more expensive than treatment and delivery from the RWRF (particularly where small footprint technologies are required for siting in a densely developed community). Satellite facilities are more likely to generate community opposition due to treatment facilities being constructed in residential areas.

It is the recommendation of this Master Plan to proceed with the first concept, serving customers from the RWRF, for the following reasons:

- Less costly
- Less operationally challenging (North Fresno WRF has been a considerable challenge)
- Less dependant on flows in separate sewer sheds
- Eliminates solids handling concerns (don't have to transport solids away from satellite locations)
- Eliminates need for influent storage
- Minimizes community disruption both during construction and operation

Table 5.2	Comparison of Regional versus Satellite Treatment and Delivery Recycled Water Master Plan City of Fresno	
	Advantages	**Disadvantages**
Regional Treatment and Delivery	• Centralized operations • Existing plant site requires little effort for siting • Greater ability to serve residential/commercial users due to access to greater flows	• Long pipelines required to deliver throughout the City • Multiple booster pump stations and recycled water storage facilities required
Satellite Treatment and Delivery	• Treatment close to point of use reduces piping • Recycles at the point of use and achieves localized groundwater basin benefits	• Multiple treatment plants to site and construct • Potential neighborhood resistance and land use impacts associated with satellite plant site • Less ability to serve residential and commercial users due to lower sewer flows • Potential for odor impacts due to need to provide influent storage • SRWFs are more expensive where low-footprint technologies such as MBR must be implemented to accommodate limited land area

- Utilizes treatment site property already available (is consistent with current land uses)
- Provides more flexibility for meeting diurnal flows (greater capacity to meet daily peaks without storage

5.2.2 Agricultural Reuse and Exchange Opportunities

Agricultural reuse provides the largest opportunity for recycled water use (in terms of volume), since demand is nearly unlimited. The benefit of potable water offset, however, can only be achieved if FID (or another agency) is willing to increase its recycled water use and trade recycled water for substituted surface water. Whether the City can realize this benefit depends on negotiations with FID, and the City having adequate facilities to take advantage of the surface water made available through the exchange.

5.2.3 Groundwater Reuse Recharge Opportunities

Groundwater recharge is an opportunity to directly augment the City's potable supply, and provide a use for recycled water during the winter. Groundwater recharge locations will be influenced by the City's ability to identify and purchase sites for recharge basins that have six-months of hydraulic separation from drinking water wells. At this time, the west side of the City, closest to the RWRF, appears best to serve recharge opportunities as there are sites available with soils that are conducive to recharge, and there are relatively few wells located nearby. A source of diluent water would be required (at a contribution ratio of 4:1 diluent to recycled water). Diluent water sources include US Bureau of Reclamation (USBR) surface water, FID surface water, or stormwater provided by Fresno Metropolitan Flood Control District (FMFCD). Percolation rates are highest on the west side of town, where it is also cheapest to supply water from the RWRF.

At least 2,450 acres of land were identified through a preliminary site survey as possible sites for recharge basins. If all sites were implemented and an average percolation rate of 2.4 inches/day was assumed (based on experience of FMFCD), approximately 31,850 AFY of recycled water could be percolated. This recharge volume would need to be confirmed with future evaluation of 1) potential available percolations sites; 2) measured percolation rates for those sites; and 3) availability of adequate diluents water volumes.

5.3 COST BENEFIT ANALYSIS

An economic analysis was conducted to explore the environmental, social and economic benefits that may accrue to the City and potential users from implementing a recycled water program. Although recycled water is often more expensive than some traditional options for providing water, recycled water provides some benefits that these other alternatives do not. Therefore, it is important to go beyond cost comparisons by also considering how the benefits of reuse compare to its cost. To do this, a clear distinction must be made between financial and economic analysis:

- A financial analysis of water reuse is based solely on the cash flows of expenses and revenues in and out of the agency
- An economic analysis provides a benefit/cost perspective by considering a broader view of the value of the reclaimed water.

By focusing solely on revenues, a financial analysis provides an overly narrow perspective of the "value" of the waters provided. For example, a financial analysis does not include benefits to the environment and social costs avoided when reuse enables a community to forgo developing alternative water supply options. Therefore, it is important to consider the benefits and costs of each option, rather than considering only costs.

Stratus Consulting was hired for this economic evaluation using a triple bottom line (TBL) approach looks at relevant options and explores how the benefits and costs compare to each other, providing a method of evaluating financial, social and environmental impacts of the project. Table 5.3 summarizes the result of the analysis, including monetized and qualitative benefits, and the stakeholders that accrue those benefits. This table shows that monetized benefits for the project are estimated to outweigh the monetized costs when a 2.5% real discount rate is used. Net monetized benefits are estimated to be $9.4 million,

Table 5.3 BCA Overview – Using 2.5% Real Discount Rate (millions, 2010 USD)
Recycled Water Master Plan
City of Fresno

Benefit or Cost Category	Present Value	Stakeholder Accruing Cost or Benefit
Costs – Total		
Capital and O&M costs[(1)]	335.8	City of Fresno
Monetized Benefits		
Avoided alternative water supply costs	77.4	City of Fresno
Avoided water quality treatment costs	252.5	City of Fresno
Avoided agricultural water supply costs	1.7	Farmers
Avoided fertilizer costs for agriculture	8.9	Farmers
Avoided fertilizer costs for urban irrigation	4.7	Urban irrigators
Total monetizable benefits	345.2	
Qualitative Benefits and Costs	**Relative Magnitude***	
Long-term gain in wildlife habitat	++	Public
Demonstration of "green" water use ethic	+	City of Fresno
Improved diversification of water supply portfolio	+	City of Fresno
Public perception of recycled water	–	Public
Short-term construction impacts	–	Public
Total Net Benefits (Monetizable Benefits – Costs)	**9.4**	

All values in millions of dollars.
Assume 2.5% real discount rate and 30-year analysis period.
(1) Costs are based on Alternative 1 costs (not including residential and commercial users) and construction of half the identified areas for groundwater recharge.
O&M = operations and maintenance.
* Magnitude of likely effect on net benefits:
++ = Likely to increase net benefits significantly.
+ = Likely to increase net benefits relative to quantified estimates.
U = Uncertain effect on net benefits relative to quantified estimates.
– = Likely to decrease net benefits.
– – = Likely to decrease benefits significantly.

and total net benefits are believed to be much higher than that when non-monetized benefits and costs are considered. A report detailing the assumptions of the evaluation is in Appendix G.

Major benefits of a recycled water program include avoided costs of alternative water supply, avoided water quality improvements (to reduce salinity at the RWRF for existing percolation ponds), avoided agricultural water supply costs, and avoided fertilizer costs. Other benefits that were not easy to quantify include a gain in bird habitat by creating groundwater recharge areas, promoting a "green," and improved diversification of the water supply.

5.4 PROJECT RECOMMENDATIONS

5.4.1 Conclusions of Technical Advisory Group

One of the key components for the development of this recycled water Master Plan was to build upon lessons learned by other agencies that have successfully implemented recycled water programs. To accomplish this, a Technical Advisory Group (TAG) was formed to provide input as to "lessons learned" and implementation considerations from other programs. The TAG for this project included:

- Dave Requa – Dublin San Ramon Services District
- James Crook – California Department of Public Health (retired)
- Bob Jaques – Monterey Regional Water Pollution Control Agency (retired)
- Ron Young – Elsinore Valley Municipal Water District
- Robin Saunders – Water and Sewer Utilities, City of Santa Clara (retired)

In August, 2009, members of the TAG convened at the RWRF to discuss options and opportunities for the City of Fresno. The preliminary recycled water demands and use types were presented. The conclusion of the TAG was that agricultural irrigation represented the greatest opportunity for beneficial reuse, with the least amount of regulatory hurdles, process technology or distribution system investment. It was also recognized that this reuse alternative depended on new exchange agreements with FID to optimize the full water supply benefit (i.e. gain agreement for additional raw water in exchange for recycled water).

Other conclusions of the TAG were:

- Regulators and potential users should be involved in project planning.
- Future projects can be funded with fees on development.
- Consideration should be given to a flat charge for recycled water to provide incentive for recycled water use.
- Going to a higher-than-necessary level of treatment helps with public perception of the projects.
- Public outreach should start early.

All the discussion and comments provided by the TAG during the August 2009 meeting are summarized in a meeting memorandum included Appendix H.

5.4.2 Urban Alternatives

As discussed in Section 5.2.1, production and distribution of recycled water from the RWRF offers many advantages over the satellite recycled water facilities. The following are recommendations for implementation of recycled water for existing large users in each quadrant. These recommendations are also summarized in Table 5.4: Pipeline segments are identified in the figures in Chapter 4 along with the demands to be served from each segment.

- ***Southwest*** – The construction of the recycled water distribution system in the Southwest quadrant would begin with the pipeline segments 1 and 2 (Figure 4.6). These two segments mostly serve primarily irrigation customers and some industrial users for a total demand of approximately 1,800 AFY. Pipelines to high-priority visible sites such as City Hall (pipeline 4) and the proposed redevelopment "intensity corridor" in the downtown area should also be implemented in an early phase. Pipeline 1 also sets the stage for expansion into the northwest quadrant.

  The remainder of the southwest pipelines largely deliver recycled water to potential industrial users. After an outreach effort to determine willingness to participate in the recycled water program, the City should choose additional pipe segments to serve industries who wish to participate in the program.

  Northwest – The majority of pipeline segments in the northwest quadrant can be constructed following the construction of the first segments of the southwest quadrant system. Although the majority of the water use in the quadrant is served by pipeline segment 1 north of Herndon Avenue, building the additional pipelines south from Herndon Avenue will facilitate future expansion of the recycled water distribution system to serve infill development and the proposed "intensity corridors" along Highway 41.

- ***Northeast*** –The distribution pipeline from the Northwest Quadrant should be extended to serve users in the Northeast Quadrant as this allows serving a significantly greater reuse demand (Figure 4.8). It is also recommended that sewer flows in the northeast quadrant be diverted from downstream of the North Fresno WRF to supplement flows to that plant and improve its operability and service capabilities.

  Implementing the 0.7 mgd satellite facility at CSUF does not appear practical at this time due to the high cost and small demand for landscape irrigation associated with this alternative.

  Constructing a SRWF at Granite Park will be a more serviceable solution to serve the CSUF campus and agricultural area and the central area. The additional sewer flows in the Orange Avenue trunk will provide greater capacity and allow more reuse possibilities. The distribution system is separate from the backbone pipeline and can be implemented in any phase pending appropriate funding.

Table 5.4 Recommendations for Urban Reuse
Recycled Water Master Plan
City of Fresno

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	

- ***Southeast*** – It is recommended that the pipeline from the southwest quadrant be extended eastwardly into the southeast quadrant to serve recycled water customers there (Figure 4.9). If the General Plan allocates growth in SEGA within the time frame of this Master Plan, then the City should consider building a SRWF in the westerly portion of the SEGA area that would link up with and extend the southeast distribution system. Siting a SRWF in SEGA would allow the City considerable flexibility in choosing a lower-cost treatment process, and land could be set aside to expand the facility in the future when sewer flows and potential recycled water demand increase due to growth. A SRWF in SEGA would also allow the area to be self-sustaining with respect to water management.

Providing recycled water to existing and future residential and commercial customers will be implemented following the adoption of the recycled water ordinance. New developments will be required to implement recycled water. Existing residential areas and home owners associations will be encouraged to use recycled water, but the implementation will likely take more time due to the education and outreach required. Once the "back bone" of the distribution system is established for the larger recycled water users, the City will have the flexibility to extend laterals up existing residential streets and through commercial areas to serve these users.

5.4.3 Agricultural Alternatives

Consistent with the TAG discussions, it is recommended that the City expand delivery of undisinfected secondary effluent to willing farmers adjacent to the RWRF. Delivery of undisinfected secondary effluent would help reduce the burden on the percolation ponds in the short term and requires minimal permitting and investment in infrastructure. Implementation of the reuse alternative would provide up to 4,200 AFY of recycled water supply.

The second agricultural alternative that should be considered is an agricultural exchange with FID. An agricultural exchange with FID would consist of delivery of either increased delivery of extracted percolate water or tertiary water from the RWRF in order to gain the full water supply benefit from an exchange with agricultural users, the City could begin negotiations with FID to establish the details of an updated (revised) exchange agreement. If negotiations are successful, the City could expand deliveries of extracted percolated effluent to FID (beyond the current limitation of 30,000 AFY). Little to no additional treatment would be required for this option. If the RWQCB for some reason revised its current policy of allowing extracted percolated effluent deliveries to FID canals, the plant effluent would have to be filtered and disinfected prior to delivery for unrestricted agricultural reuse.

For a successful potable water exchange agreement with FID, the City would need to have adequate recharge or treatment facilities to take advantage of the raw water "exchange". Additional facilities would be needed within the city to convey and treat FID's surface water for potable use, or to recharge it to the groundwater aquifer. The City has master planned the expansion of the northeast water treatment plant and construction of another southeast water treatment plant for this purpose.

5.4.4 Groundwater Reuse Recharge Alternatives

It is recommended that groundwater recharge be implemented in the southwest, northwest and southeast quadrants of the City to the extent practical. The first step is to acquire lands for recharge and develop basins that can accept diluent water. These facilities could then be used immediately to take advantage of the City's allotted volume of FID and USBR water (or FMFCD water), even before recharge with recycled water begins. There should be continued coordination with the water division on the potential to recharge recycled water in the super recharge basins as they are developed.

5.4.5 Treatment, Management, and Administration of Recycled Water Program

It is recommended that the Wastewater Management Division of the Department of Public Utilities manage the recycled water system and provide the following services:

- treatment and compliance with Waste Discharge Requirements
- operation
- maintenance
- monitoring and inspection of customer connections
- distribution and sales
- billing and administration

The Wastewater Management Division operates and manages the Regional Wastewater Reclamation Facilities (RWRF). The RWRF will produce the majority of the recycled water that will be distributed city-wide. RWRF staff also operates and maintain the North Fresno WRF and oversee its recycling program. Staff will also operate and maintain any other future satellite plants that may be constructed to implement the recycling program.

Distribution and sales of recycled water should be assigned to the Wastewater Management Division. The costs for the current level of treatment (undisinfected secondary) are covered by the Wastewater Management Division's enterprise fund. This enterprise fund is also funding the RWRF's tertiary treatment upgrades and the recycled water distribution facilities. The Division invoices customers for sewer service. Rates will be set to cover capital and annual expenses. Planned sewer rate increases are intended to support the recycled water project. Billings for the use of recycled water could be administered by the Wastewater Division's current industrial billing group and charges included through the city's existing utility billing system.

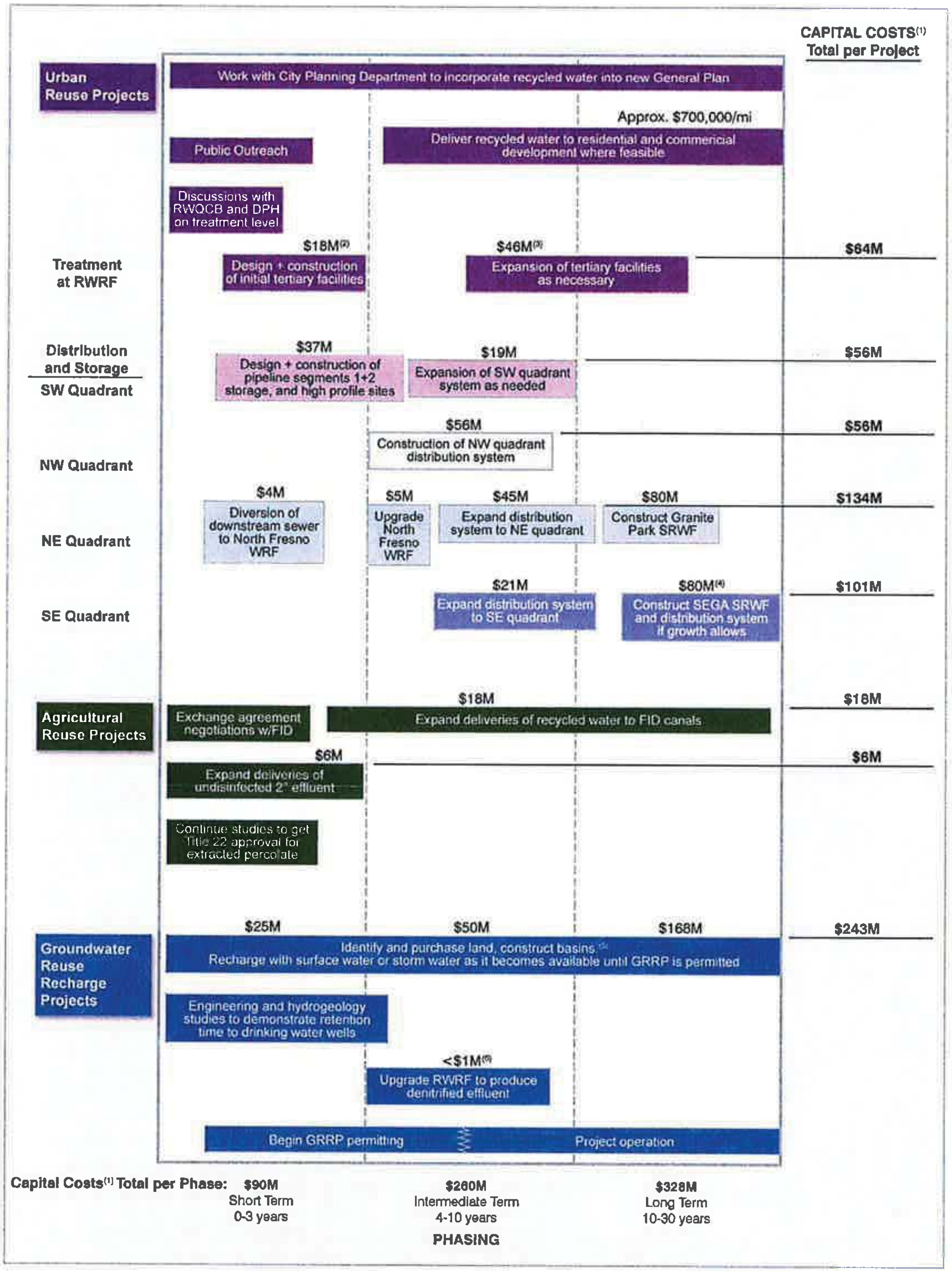
Other considerations that support the above recommendations to consolidate all elements of the recycled water program into the Wastewater Management Division are:

- The Division has a full time reclamation coordinator on staff to oversee implementation, distribution, and sales;
- The Division provides professionals skilled in other services similar to those needed to carry out the program. Customer connections, customer service, and O&M can be assimilated by the Division's staff and crews;
- The Division has developed a set of construction standards for recycled water service connections. Conformance to standards and construction oversight can be assimilated by the Division's staff and crews.
- The Division is responsible for complying with and carrying out the provisions of Waste Discharge Requirements for both the RWRF and the North Fresno WRF;
- The Division will be responsible for future WDRs for possible future satellite plants;
- The Division will be responsible for future Water Reclamation Requirements for the recycling program as well as issuing and administering permits for individual users;
- The Division provides a certified laboratory for water quality analyses of the recycled water;
- The Division is responsible for public outreach and education to promote the program.

5.5 PHASING RECOMMENDATIONS

Included in the section are the phasing recommendations for the recommended alternatives. A schedule for the recommended alternatives was developed based on three implementation periods: 1) short-term (zero to three years); 2) intermediate-term (four to ten years); and 3) long-term (10 to 30 years).

The phasing of the elements of the recommended project alternatives along with the associated costs are presented in Figure 5.2. Figure 5.3 shows a map of the phased pipeline construction for delivery to urban users, including the order in which the pipelines would be installed.



Notes:

(1) Costs are construction costs and are exclusive of design or administrative/legal costs, negotiations and agreements with other agencies, and costs for hydrology studies.

(2) Assume media filters and UV disinfection, 8-mgd initial facilities sized to serve SW segments 1 and 2 and NW quadrant.

(3) Expanded to 32-mgd (assuming tertiary treatment not needed for agricultural reuse).

(4) Assuming a 15-mgd activated sludge w/NdN facility, no pipeline costs included. See 2006 Satellite Plant Study Update.

(5) Basin acquisition and construction rate of 70 acres/yr.

(6) Minimal cost since facilities were designed to nitrify/denitrify.

Figure 5.2
RECYCLED WATER PROJECT PHASING AND CAPITAL PROGRAM
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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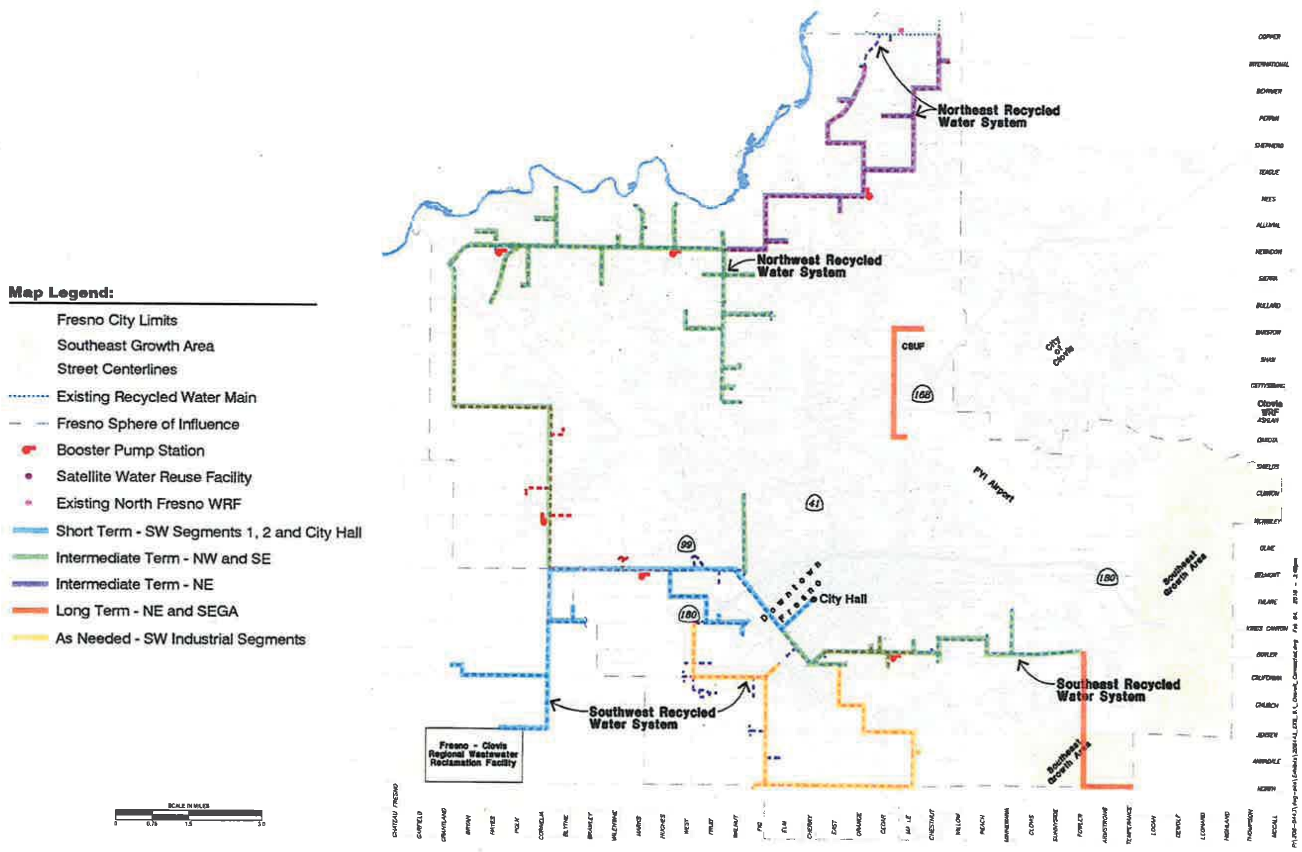

Note:
Distribution is primarily to serve urban users.
GRRP opportunities will be served from urban distribution system.
System does not accommodate agricultural reuse of exchange projects.

Figure 5.3
SCHEMATIC OF DISTRIBUTION SYSTEM PHASING
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

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5.5.1 Short-Term – 0 to 3 Years

The following project elements are recommended to be implemented in the short term:

Urban Reuse Projects

- Adopt program level environmental impact report (EIR) for city recycled water program.
- Adopt recycled water ordinance and rules and regulations to encourage and/or require existing and new users to use recycled water.
- Plan, design and begin construction for three parallel short-term projects.
  - Add tertiary facilities to RWRF
  - Segments 1 and 2 of southwest quadrant distribution system
  - Increase sewer diversion to NFWRF to provide adequate supply for reuse in northeast quadrant
- Irrigate freeways in the vicinity of the Highway 180/99 interchange from pipe segment 1.
- Continue public outreach and education for public and potential users to increase community acceptance of recycled water for irrigation and industrial use.
- Pipeline to high-profile areas such as City Hall. Begin an industrial outreach program to bring industries into the recycled water program, and build additional pipeline segments to serve these industries.
- Tertiary/disinfection facilities should be sized for the short-term projects at 8 million gallons per day (mgd) with a modular approach for future expansion in 4-mgd increments.
- Work with City Planning and Water Division to coordinate efforts for implementing recycled water in the General Plan Update and ongoing water planning documents. .

5.5.2 Agricultural Reuse/Exchange Projects

- Expand deliveries of undisinfected secondary to effluent willing local farmers for restricted use.
- Conduct negotiations with FID on exchange agreement to increase raw water deliveries to City recharge sites.
- Continue studies and discussions with the DPH to obtain approval for extracted percolated effluent as equivalent to Title 22 recycled water.

Groundwater Reuse Recharge Projects

- Identify and purchase land, which in the short term will be used to percolate raw water from FID (under the current agreement).

- Retain the services of a hydrogeologist to help select sites for GRRPs.
- Begin studies necessary for the permitting process and public hearings.
- Begin tracer studies to determine potential basins' hydraulic retention time to drinking water wells.
- Identify diluent water sources.

5.5.3 Intermediate-Term – 4 to 10 Years

The following project elements are recommended to be implemented in the intermediate term:

Urban Reuse Projects

- Expand the recycled water distribution system into the northwest quadrant and southeast quadrant, followed by the northeast quadrant. Begin building laterals for residential and commercial users where feasible.
- Expand the recycled water distribution system to new users in the southwest quadrant.
- Continue to work with City Planning and Water Division for delivery of recycled water to infill growth where feasible.
- Expand the RWRF's tertiary facilities in 4 mgd increments as necessary to serve additional users.

Agricultural Reuse/Exchange Projects

- If negotiations with FID for raw water exchange are successful and DPH and RWQCB allows the continued practice of percolated water extractions, expand deliveries of extracted percolate to FID canals.
- Deliver tertiary disinfected water to FID canals if feasible.

Groundwater Reuse Recharge Projects

- Continue to recharge surface water in the new basins until the recharge project is permitted.
- Continue GRRP permitting and begin project operation.
- Continue to acquire more land for more basins as opportunities arise.

5.5.4 Long-Term – 10 to 30 Years

The following project elements are to be implemented in the long term:

Urban Reuse Projects

- Construct a new SRWF at Granite Park.
- If SEGA is to be developed during this time frame, construct a new SRWF in SEGA.
- Continue to expand the recycled water distribution system to deliver recycled water to residential and commercial development where feasible.

Agricultural Reuse/Exchange Projects

- Continue deliveries and exchange with FID.

Groundwater Reuse Recharge Projects

- Continue to operate and expand the City's GRRP system.

APPENDIX A – CDPH DRAFT REGULATIONS

This draft reflects the California Department of Public Health (CDPH) Drinking Water Program's current thinking on the regulation of recharge of groundwater with recycled municipal wastewater.

Any comments you have on this draft can be emailed to Jeff Stone at Jeffrey.Stone@cdph.ca.gov and Mike McKibben at Michael.McKibben@cdph.ca.gov .

Title 22, CALIFORNIA CODE OF REGULATIONS

DIVISION 4. ENVIRONMENTAL HEALTH

CHAPTER 3. RECYCLING CRITERIA

August 5, 2008

ARTICLE 1. DEFINITIONS

Section 60301.080. 24-hour Composite Sample.

"24-hour composite sample" means an aggregate sample derived from no fewer than eight discrete samples collected at equal time intervals or collected proportional to the flow rate over the compositing period. The aggregate sample shall reflect the average source water quality covering the composite of sample period.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60301.190. Diluent Water.

"Diluent water" means water used to dilute recycled municipal wastewater in a groundwater recharge reuse project.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60301.370. Groundwater.

"Groundwater" means water below the land surface in the saturated zone.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60301.390. Groundwater Recharge Reuse Project (GRRP)

"Groundwater Recharge Reuse Project (GRRP)" means a project that uses recycled municipal wastewater, has been planned and is operated for the purpose of recharging a groundwater basin designated in the Water Quality Control Plan [defined in Water Code section 13050(j)] for use as a source of domestic water supply, and has been identified as a GRRP by the RWQCB.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Sections 13520, 13521, and 13050(j), Water Code.

Section 60301.670. Project Sponsor.

"Project sponsor" means any agency that receives water recycling requirements for a GRRP from a RWQCB and is, in whole or part, responsible for the GRRP meeting the requirements of this Chapter.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60301.680. Public Water System.

"Public Water System" has the same meaning as defined in section 116275(h) of the Health and Safety Code.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 116275(h), Health and Safety Code.

Section 60301.685. Recharge Water.

"Recharge Water" means either recycled municipal wastewater or the combination of recycled municipal wastewater and diluent water that is applied at a GRRP facility.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 116275(h), Health and Safety Code.

Section 60301.690. Recycled Municipal Wastewater.

"Recycled Municipal Wastewater" means the effluent from the treatment of a wastewater of municipal origin, suitable for a direct beneficial use or a controlled use.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13050, Water Code.

Section 60301.705. Recycled Water Contribution (RWC).

"Recycled water contribution (RWC)" means the quantity of recycled municipal wastewater applied at the GRRP, divided by the sum of the recycled municipal wastewater applied at the GRRP and diluent water meeting the requirements of section 60320.035.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60301.770. RWQCB.

"RWQCB" means Regional Water Quality Control Board.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60301.780. Saturated Zone.

"Saturated zone" means an underground region in which all interstices in, between, and below natural geologic materials are filled with water, with the uppermost surface of the saturated zone being the water table.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60301.810. Spreading Area.

"Spreading area" means a natural or constructed impoundment with a depth equal to or less than its widest surface dimension used by a GRRP to recharge a groundwater basin with recharge water infiltrating and percolating through an otherwise (i.e. without the presence of recharge water) unsaturated zone.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60301.840. Subsurface Application.

"Subsurface Application" means the controlled application of recharge water to a groundwater basin by a means other than surface application.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60301.850. Surface Application.

"Surface Application" means the controlled application of recharge water to a spreading area resulting in the recharge of a groundwater basin.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60301.860. Total Nitrogen.

"Total nitrogen" means the sum of concentrations of nitrogen in ammonia, nitrite, nitrate, and organic nitrogen-containing compounds, expressed as nitrogen.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60301.870. Total Organic Carbon (TOC).

"Total organic carbon (TOC)" means the concentration of organic carbon present in water that is able to be oxidized to carbon dioxide.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60301.910. Unsaturated Zone.

"Unsaturated Zone" means the volume between the land surface and the saturated zone.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

ARTICLE 5.1. GROUNDWATER RECHARGE

~~Section 60320. Groundwater Recharge.~~

~~(a) Reclaimed water used for groundwater recharge of domestic water supply aquifers by surface spreading shall be at all times of a quality that fully protects public health. The State Department of Health Services' recommendations to the Regional Water Quality Control Boards for proposed groundwater recharge projects and for expansion of existing projects will be made on an individual case basis where the use of reclaimed water involves a potential risk to public health.~~

~~(b) The State Department of Health Services' recommendations will be based on all relevant aspects of each project, including the following factors: treatment provided; effluent quality and quantity; spreading area operations; soil characteristics; hydrogeology; residence time; and distance to withdrawal.~~

~~(c) The State Department of Health Services will hold a public hearing prior to making the final determination regarding the public health aspects of each groundwater recharge project. Final recommendations will be submitted to the Regional Water Quality Control Board in an expeditious manner.~~

Note: ~~Authority cited: Section 208, Health and Safety Code; and Section 13521, Water Code. Reference: Sections 13520 and 13521, Water Code.~~

Section 60320. General Requirements.[1]

(a) Recycled municipal wastewater used for a GRRP shall be from a wastewater management agency that:

(1) administers an industrial pretreatment and pollutant source control program;

(2) implements and maintains a source control program that includes at a minimum:

(A) an assessment of the fate of Department-specified contaminants through the wastewater and recycled municipal wastewater treatment systems,

(B) contaminant source investigations and contaminant monitoring that focus on Department-specified contaminants,

(C) an outreach program to industrial, commercial, and residential communities within the sewage collection agency's service area for the purpose of managing and minimizing the discharge of contaminants of concern at the source, and

(D) an up-to-date inventory of contaminants discharged into the wastewater collection system so that new contaminants of concern can be readily evaluated.

(3) is compliant with the effluent limits established in the RWQCB permit for the GRRP.

[1] The Department is considering the inclusion of a provision for operator certification and/or training.

(b) Prior to operation of a new GRRP, or during the first year of operation after [*insert effective date*] for an existing GRRP, the GRRP shall have a Department approved plan that provides an alternative source of domestic water supply, or a Department approved treatment mechanism, to any user of a producing drinking water source that, as a result of the GRRP;

(1) violates California drinking water standards,

(2) has been degraded to the degree that it is no longer a safe source of drinking water, or

(3) receives water that fails to meet subsection 60320.010(c)..

(c) A public hearing for a GRRP shall be held prior to the Department's submittal of its recommendations for the GRRP's initial permit to the RWQCB and any time an increase in maximum RWC has been proposed but not addressed in a prior public hearing. Prior to a public hearing, the project sponsor shall provide the Department, for review and approval, the information the project sponsor intends to present at the hearing and on the Internet. Following the Department's approval of the information, the project sponsor shall place the information on the Internet and in a repository that provides at least thirty days of public access to the information prior to the public hearing.

(d) Prior to placing the information required pursuant to subsection (c) in a repository, the GRRP shall:

(1) Notify the public of the following;

(A) the location and hours of operation of the repository,

(B) the Internet address where the information may be viewed,

(C) the purpose of the repository and public hearing,

(D) the manner in which the public can provide comments, and

(E) the date, time, and location of the public hearing.

(2) At a minimum, notify the first downgradient potable water well owner and well owners whose drinking water source is within 10 years from the GRRP based on groundwater flow directions and velocities.

(e) Unless directed otherwise by the Department, the public notification made pursuant to subsection (d)(2) shall be by direct mail and the notification made pursuant to (d)(1) shall be by one or more of the following methods delivered in a manner to reach persons whose source of drinking water may be impacted by the GRRP:

(1) Local newspaper(s) publication;

(2) Mailed or direct delivery of a newsletter;

(3) Conspicuously placed statement in water bills; or

(4) Television and/or radio.

(f) Prior to operation, a new GRRP shall have an Operations Plan submitted to and approved by the Department. An existing GRRP shall maintain, and make available to the Department or RWQCB for review when requested, an

Operations Plan. An Operations Plan shall describe the operations, maintenance, and monitoring necessary for the GRRP to meet the requirements of this chapter. The project sponsor shall be responsible for ensuring that the Operations Plan is, at all times, representative of the current operations, maintenance, and monitoring of the GRRP.

(g) Prior to operating a new GRRP, the project sponsor shall collect at least two samples from each monitoring well approved pursuant to section 60320.070. The samples shall be representative of water in each aquifer, taking into consideration seasonal variations, and be analyzed for the constituents and characteristics in sections 60320.020, 60320.030, 60320.045 and 60320.47.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60320.005 Alternatives.

(a) A GRRP may use an alternative to a requirement in this chapter if the GRRP has:

(1) demonstrated to the Department that the proposed alternative would assure at least the same level of protection to public health;

(2) received written approval from the Department prior to implementation of the alternative; and

(3) conducted a public hearing, disseminated information to the public, and received public comments, pursuant to subsections 60320(c) and (d), on the proposed alternative.

(b) Surface application GRRPs that provide reverse osmosis treatment as well as subsequent advanced oxidation treatment to the entire recycled municipal wastewater may apply to the Department for less frequent monitoring than that required in sections **XXXX**[2]. The advanced oxidation treatment shall provide, at minimum, a level of treatment equivalent to a 1.2 log N-nitrosodimethylamine (NDMA) reduction and a 0.5 log 1,4-dioxane reduction.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60320.007 Laboratory Analyses.

(a) Analyses for contaminants having primary or secondary MCLs shall be performed by laboratories approved to perform such analyses by the Department utilizing Department-approved drinking water methods and,

[2] The applicable reduced monitoring is under discussion.

(b) Analyses for constituents other than those having primary or secondary MCLs shall be described in the GRRP's Operations Plan prepared pursuant to subsection 60320(f).

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60320.010. Control of Pathogenic Microorganisms.

(a) For each GRRP, the wastewater to be used as recycled municipal wastewater shall be treated to meet the following:

(1) The definition of filtered wastewater, pursuant to section 60301.320[3]; and

(2) The definition of disinfected tertiary recycled water, pursuant to section 60301.230[3].

(b) If the recycled municipal wastewater being used for surface or subsurface application has not been treated to meet the criteria in sections 60301.230 and 60301.320, pursuant to section 60321 (Sampling and Analysis), the GRRP shall:

(1) Suspend surface or subsurface application of the recycled municipal wastewater until the criteria are met; and

(2) Inform the Department and the RWQCB in the next quarterly report submitted pursuant to section 60321[3].

(c) For each GRRP, the recycled municipal wastewater shall be retained underground for a minimum of six months prior to extraction for use as a drinking water supply.

(d) To demonstrate that the minimum retention time in subsection (c) has been met, prior to the end of the third month of operation (including prior to initial operation), under hydraulic conditions representative of normal GRRP operations the GRRP shall initiate a tracer study utilizing an added tracer (e.g. sulfur hexafluoride). Based the time for two percent of the tracer concentration to arrive at its endpoint from the GRRP location (T_2), the results of the tracer study shall provide evidence of;

(1) A minimum retention time of six months, with the nearest downgradient drinking water well as the endpoint or,

(2) A minimum retention time of three months, with the monitoring well sited pursuant to paragraph 60320.070(a)(1) as the endpoint.

(e) If the retention time to nearest downgradient drinking water well is less than twelve months based on the extrapolation of the results of the tracer study performed pursuant to paragraph (d)(2), the GRRP shall monitor the tracer, with

[3] Refers to existing regulations not shown in this document.

the nearest downgradient drinking water well as the endpoint, until compliance with paragraph (d)(1) has been demonstrated.

(f) Until a GRRP has demonstrated compliance with subsection (c) pursuant to subsection (d), i.e. for the purpose of siting a GRRP location during project planning, each GRRP shall be located at a distance from drinking water supply wells that ensures that one of the estimated retention times in Table 60320.010-A is met, as indicated by the corresponding method used to determine the estimated retention times.

Table 60320.010-A

Method used to estimate the retention time to the nearest downgradient drinking water well	Minimum Estimated Retention Time
Tracer study utilizing an intrinsic tracer based on T_{10} (i.e. the time for 10% of tracer concentration to reach the endpoint) conducted under hydraulic conditions representative of normal GRRP operations.	9 months
Numerical modeling (i.e. calibrated finite element or finite difference models using verified computer codes such as Modflow, Feflow, Sutra, Femwater, etc.)	12 months
Analytical modeling (i.e. Using existing equations such as Darcy's Law to estimate groundwater flow conditions based on simplifying aquifer assumptions)	24 months

(g) A method used to establish the retention times in subsections (d) or (f) shall be approved by the Department.

(h) A GRRP shall provide the Department and RWQCB a map of the GRRP site at a scale of 1:24,000 or larger (1 inch equals 2,000 feet or 1 inch equals less than 2,000 feet) or, if necessary, a site sketch at a scale providing more detail, that clearly indicates;

(A) The location and boundaries of the GRRP,

(B) The boundary representing the six-month retention time required in paragraph (c) as determined in paragraph (d) or (f), whichever is most recent, and

(C) The location of all drinking water supply wells and monitoring wells within three years of the GRRP based on groundwater flow directions and velocities expected under GRRP operating conditions.

(i) The Department may require the GRRP to demonstrate that the underground retention times required in this section are being met if changes in hydrogeological or climatic conditions have occurred since the most recent demonstration.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60320.020. Control of Nitrogen Compounds.

To demonstrate control of the nitrogen compounds in the recycled municipal wastewater, the project sponsor shall meet the requirements of one of the methods in subsections (a), (b), or (c). Method 3, described in subsection (c), may only be utilized by a GRRP that has been in operation for a minimum of twenty years. (These requirements are summarized in a table at the end of this document, see ENDNOTE 7)

(a) Method 1:

(1) Each week, at least three days apart as specified in the GRRP's Operation Plan, two samples (grab or 24-hour composite) representative of the recycled municipal wastewater or recharge water applied throughout the spreading area or subsurface application area shall be collected. Samples may be collected before or after surface or subsurface application.

(2) Samples collected pursuant to subsection (a)(1) shall be analyzed for total nitrogen, with the laboratory being required to complete each analysis within 72 hours and have the result reported to the project sponsor within the same 72 hours if the result of any single sample exceeds 5 mg/L.

(A) If the average of two consecutive samples exceeds 5 mg/L total nitrogen, the cause shall be investigated, appropriate actions to reduce the total nitrogen levels shall be taken, and the Department and the RWQCB shall be notified within 48 hours of the GRRP being notified by the laboratory.

(B) If the average of all samples collected during any consecutive four weeks exceeds 5 mg/L, the surface or subsurface application of recycled municipal wastewater shall be suspended. Surface or subsurface application shall not resume until appropriate corrective actions are made and two consecutive total nitrogen samples are less than 5 mg/L.

(b) Method 2:

(1) At a frequency approved by the Department and specified in the operations plan prepared pursuant to section 60320(f):

(A) samples shall be collected and analyzed for dissolved oxygen (DO) in the groundwater that has been blended with the recharge water and;

(B) samples (grab or 24-hour composite) representative of the recycled municipal wastewater or recharge water shall be collected and analyzed for nitrate, nitrite, ammonia, organic nitrogen, DO, and BOD.

(2) The GRRP shall ensure that the laboratory completes each analysis in (b)(1) within 72 hours (one week for BOD) and report the result(s) to the project sponsor within the same 72 hours (one week for BOD) if:

(A) the total nitrogen exceeds 10 mg/L, or

(B) the concentration of any constituent exceeds the respective limit identified in the engineering report and approved by the Department.

(3) If the average of two consecutive samples exceeds 10 mg/L total nitrogen or a limit identified in the engineering report for another constituent, the cause shall be investigated, appropriate actions to meet the limit(s) shall be taken, the Department and the RWQCB shall be notified within 24 hours of the GRRP being notified by the laboratory, and surface or subsurface application of recycled municipal wastewater shall be suspended until an average of two consecutive samples meets the limit(s).

(c) Method 3:

(1) In the engineering report prepared pursuant to section 60323, evidence shall be provided that:

(A) it is possible to track the movement of recharge water from the GRRP surface or subsurface application facility to downgradient potable water wells located within 20 years of the GRRP based on groundwater flow directions and velocities,

(B) the most recent year's total nitrogen levels in the recycled municipal wastewater is not greater than the most recent 10 years of historical data, and

(C) surface or subsurface application has not resulted in, and would not result in, an exceedance of the nitrate or nitrite MCLs at any downgradient potable water wells located within 20 years of the GRRP based on groundwater flow directions and velocities. At a minimum, the evidence shall consist of at least the most recent 10 years of historical data, and shall demonstrate that no potable water well, as a result of the operation of the GRRP:

1. exceeded the nitrate or nitrite MCLs or

2. has had a trend of increasing concentrations of nitrate or nitrite that would lead to a nitrate or nitrite MCL exceedance utilizing the GRRP's current operations.

(2) At the frequency specified in the operations plan prepared pursuant to subsection 60320(f), two grab samples of groundwater at each sampling location downgradient of the GRRP's surface or subsurface application facility shall be collected and analyzed for nitrite and nitrate. The GRRP shall ensure that the laboratory completes each analysis within 72 hours and shall report any result exceeding the nitrate or nitrite MCL to the project sponsor within the same 72 hours.

(A) If the average of two consecutive samples exceeds an MCL at any sampling location, the Department and RWQCB shall be notified and, unless the GRRP demonstrates to the Department and RWQCB that the groundwater no longer exceeds the MCL, the surface or subsurface application of recycled municipal wastewater shall be suspended.

(d) The GRRP may apply for reduced total nitrogen or nitrate/nitrite monitoring frequencies if all results for the previous two years did not exceed;

(1) 5 mg/L total nitrogen and one-half the nitrate and nitrite MCL for Method 1, or

(2) 10 mg/L total nitrogen and one-half the nitrate and nitrite MCL for Method 2.

(e) If a GRRP implementing reduced monitoring pursuant to subsection (d) exceeds the total nitrogen, nitrate, or nitrite concentrations in (d)(1) or (d)(2), the GRRP shall revert to the monitoring frequencies for total nitrogen, nitrate, and nitrite prior to the frequency being reduced.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60320.030. Control of Regulated Chemicals and Physical Characteristics.

(a) Each calendar quarter, as specified in the GRRP's operations plan, the GRRP shall collect grab samples representative of the applied recycled municipal wastewater and have the samples analyzed for the contaminants listed below.

(1) The inorganic chemicals in Table 64431-A, except for nitrogen compounds;

(2) The radionuclide chemicals in Tables 64442 and 64443;

(3) The organic chemicals in Table 64444-A;

(4) The disinfection byproducts in Table 64533-A; and

(5) Lead and copper.

(b) Recharge water may be monitored in lieu of recycled municipal wastewater to satisfy the monitoring requirements in paragraph (a)(4) if the fraction of recycled municipal waste water in the recharge water is equal to or greater than the average fraction for the quarter. If the fraction of recycled municipal waste water in the recharge water being monitored is less than the average fraction applied for the quarter, the reported value shall be adjusted to account for any dilution.

(c) Each year, the GRRP shall collect at least one representative grab sample of the recycled municipal wastewater and have the sample(s) analyzed for the secondary drinking water constituents in Tables 64449-A and 64449-B.

(d) If a result of the monitoring performed pursuant to subsection (a) exceeds a contaminant's MCL or action level (for lead and copper), the GRRP shall collect another sample and have it analyzed for the contaminant as confirmation within 72 hours.

(1) For a contaminant whose compliance with its MCL is not based on a running annual average (see Endnote 1), if the average of the initial and confirmation sample exceeds the contaminant's MCL, or the confirmation sample

is not collected and analyzed pursuant to this subsection, the GRRP shall notify the Department and RWQCB within 24 hours and initiate weekly monitoring until four consecutive weekly results are below the contaminant's MCL.

(A) If the running four-week average exceeds the acute contaminant's MCL, the GRRP shall notify the Department and RWQCB within 24 hours and, if directed by the Department or RWQCB, suspend application of the recycled municipal wastewater.

(2) For a contaminant whose compliance with its MCL is based on a running annual average, if the average of the initial and confirmation sample exceeds the contaminant's MCL or action level, or a confirmation sample is not collected and analyzed pursuant to this subsection, the GRRP shall initiate weekly monitoring for the contaminant until the running four-week average no longer exceeds the contaminant's MCL or action level.

(A) If the running four-week average exceeds the contaminant's MCL or action level, the GRRP shall describe the reason(s) for the exceedance and provide a schedule for completion of corrective actions in the next quarterly report submitted to RWQCB pursuant to section 60321, with a copy provided to the Department.

(B) If the running four-week average exceeds the contaminant's MCL or action level for sixteen weeks, the GRRP shall notify the Department and RWQCB within 24 hours and, if directed by the Department or RWQCB, suspend application of the recycled municipal wastewater.

(e) With the exception of color, if an annual result of the monitoring performed pursuant to (c) exceeds a constituent's secondary MCL in Table 64449-A or the upper limit in Table 64449-B, the GRRP shall initiate quarterly monitoring of the municipal wastewater for the constituent and, if the running annual average of quarterly results exceeds a constituent's secondary MCL or upper limit, describe the reason(s) for the exceedance and any corrective actions taken in the next quarterly report submitted to RWQCB pursuant to section 60321, with a copy provided to the Department. The annual monitoring in (c) may resume if the running annual average of quarterly results does not exceed a constituent's secondary MCL or upper limit.

(f) If four consecutive quarterly results for asbestos are below the detection limit for asbestos, monitoring for asbestos may be reduced to one sample every three years. Quarterly monitoring shall resume if asbestos is detected.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60320.035. Diluent Water Requirements.

To be credited with diluent water to be used in calculating an RWC to meet the requirements of section 60320.041, the GRRP shall comply with the requirements of this section. For diluent water that is a Department approved drinking water source, the GRRP is exempt from subsections (a) and (b). The GRRP shall:

(a) Monitor the diluent water quarterly for nitrate and nitrite and, within 72 hours of being informed by the laboratory of a nitrate or nitrite result exceeding an MCL, collect a confirmation sample. If the average of the two samples is greater than an MCL;

(1) notify the Department and the RWQCB within 48 hours of receiving the confirmation sample result,

(2) investigate the cause(s) and implement corrective actions, and

(3) each week, collect and analyze two grab samples at least three days apart as specified in an operations plan. If the average of the results for a two-week period exceeds the MCL, surface or subsurface application of the diluent water shall not be used in the calculation of RWC until corrective actions are made. Quarterly monitoring may resume if four consecutive results are below the MCL.

(b) Conduct a source water evaluation per California-Nevada Section of American Water Works Association watershed sanitary survey handbook, or other Department approved evaluation, of the diluent water for Department review and approval that includes, but is not limited to:

(1) a description of the source of the diluent water,

(2) delineation of the origin and extent of the diluent water,

(3) the susceptibility of the diluent water to contamination,

(4) the identification of known or potential contaminants, and

(5) an inventory of the potential sources of diluent water contamination.

(c) Implement a Department-approved water quality monitoring plan for the purpose of demonstrating that the diluent water meets Department specified primary MCLs and notification levels based on the source water evaluation performed in (b). The plan shall also include:

(1) Monitoring of any constituents listed in section 62320.047, based on the source water evaluation performed in (b), and;

(2) Actions to be taken in the event of non-compliance with a primary MCL or failing to meet a notification level.

(d) Develop a method for accurately determining the volume of diluent water to be credited, including consideration of any temporal variations, and demonstrate that the diluent water will be applied in a manner such that temporal variations in the diluent water volume will not lead to an exceedance of the maximum RWC. The method shall be submitted to the Department for review and approval and be conducted at the frequency specified in the engineering report prepared pursuant to section 60323.

(e) For credit not to exceed 60 months prior to the operation of the GRRP:

(1) demonstrate that the diluent water has met the nitrate and nitrite MCLs and the water quality requirements in sections 60320.030 and 60320.047(a)(1)(A),

(2) provide evidence that the quantity of diluent water has been accurately determined and was distributed such that the proposed or permitted maximum RWC will not be exceeded, and

(3) conduct a source water evaluation of the diluent water pursuant to subsection (c).

(f) In the operations plan prepared pursuant to 60320(f), include a description of:

(1) How the diluent water will be distributed in a manner that ensures that the maximum RWC will not be exceeded during normal operations; and

(2) The actions to be taken in the event the diluent water is curtailed or is no longer available.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60320.041. Recycled Water Contribution (RWC) Requirements

(a) Each month, for each surface or subsurface application facility used for replenishing a groundwater basin, the GRRP shall calculate its running monthly average (RMA) RWC based on the total volume of the recycled municipal wastewater and diluent water for the preceding 60 calendar months. For GRRPs in operation less than 60 months, calculation of the RMA RWC shall commence after 30 months of operation, based on the total volume of the recycled municipal wastewater and diluent water for the preceding months.

(b) The GRRP's RMA RWC, as determined in (a), shall not exceed the maximum RWC specified by the Department.

(c) The initial maximum RWC will be based on the Department's review of the engineering report and information obtained as a result of the public hearing, but shall not exceed;

(1) 0.50 for subsurface application GRRPs;

(2) 0.50 for surface application GRRPs that provide reverse osmosis treatment as well as subsequent advanced oxidation treatment to the entire recycled municipal wastewater, if the advanced oxidation[4] treatment provides, at minimum, a level of treatment equivalent to a 1.2 log NDMA reduction and a 0.5 log 1,4-dioxane reduction or;

(3) 0.20 for surface application GRRPs not meeting the criteria in paragraph (2).

[4] The requirement for advanced oxidation for all subsurface application GRRPs is under discussion.

(d) A GRRP may increase its maximum RWC, provided that:

(1) the increase has been approved by the Department and RWQCB,

(2) for the previous 52 consecutive weeks, the TOC 20-week running average, as monitored pursuant to section 62320.045, has not exceeded the following:

$$TOC_{max} = \frac{0.5 mg/L}{RWC_{proposed}},$$

Where,
$RWC_{proposed}$ is the proposed maximum RWC

(3) the GRRP has received a permit from the RWQCB that allows operation of the GRRP at the increased maximum RWC, and

(4) the GRRP meets the requirements in subsections (e) and (f).

(e) Prior to operating a GRRP in any of the RWC ranges in Table 60320.041 exceeding the GRRP's initial RWC, the GRRP shall meet the corresponding requirements in Table 60320.041-A or B sequentially, beginning with the range of the approved initial maximum RWC. The approval in subsection (d)(1) will be based on the Department's and the RWQCB's review of the information submitted pursuant to the corresponding RWC range in Table 60320.041-A or B and the GRRP's history of compliance with this chapter.

Table 60320.041-A
Surface Application Projects

GRRP RWC Operating Range Requirements For Operating Ranges A through E, where $A = 0.00 \le RWC < 0.20$ $B = 0.20 \le RWC < 0.35$ $C = 0.35 \le RWC < 0.50$ $D = 0.50 \le RWC < 0.75$ $E = 0.75 \le RWC \le 1.00$	**RWC Operating Range**				
	A	B	C	D	E
1. Provide documentation that a groundwater monitoring well located between the GRRP and a drinking water well has received recharge water from the GRRP for at least six months such that the fraction of the GRRP's recycled municipal wastewater in the monitoring well equals a value of at least 0.5 multiplied by $RWC_{proposed}$.		✓	✓	✓	✓
2. The groundwater impacted by a GRRP from a monitoring well and a drinking water well meets all drinking water standards and the requirements of section 60320.020 (Control of Nitrogen Compounds).		✓	✓	✓	✓
3. Provide a proposal to the Department prepared and signed by an engineer licensed in California with at least three years experience in wastewater treatment and public water supply. The proposal shall include:	✓	✓	✓	✓	✓
A. GRRP operations, monitoring, and compliance data;	✓	✓	✓	✓	✓
B. Evidence that a groundwater monitoring well located between the GRRP and a drinking water well has received recharge water from the GRRP for at least one year such that the fraction of the GRRP's recycled municipal wastewater in the monitoring well equals a value of at least 0.8 multiplied by $RWC_{maximum}$.;		✓	✓	✓	✓
C. Validation of appropriate construction and siting of monitoring wells pursuant to section 60320.070.	✓	✓	✓	✓	✓
D. A scientific peer review by an independent advisory panel that includes, as a minimum, a toxicologist, a registered engineering geologist or hydrogeologist, an engineer licensed in California with at least three years experience in wastewater treatment and public water supply., a microbiologist, and a chemist.				✓	✓
E. Submittal of an updated engineering report and operations plan.		✓	✓	✓	✓
4. At a minimum, for that portion of the recycled municipal wastewater stream needing additional treatment to meet the TOC limit in section 60320.045, provide reverse osmosis[5]	✓	✓	✓	✓	✓

[5] Performance criteria for reverse osmosis treatment is under discussion.

treatment as well as subsequent advanced oxidation treatment. The advanced oxidation treatment[6] shall provide, at minimum, a level of treatment equivalent to a 1.2 log NDMA reduction and a 0.5 log 1.4-dioxane reduction, whether NDMA or 1,4-Dioxane are present or not.					

Table 60320.041-B
Subsurface Application Projects

GRRP RWC Operating Range Requirements For Operating Ranges A through C, where A = 0.00 ≤ RWC < 0.50 B = 0.50 ≤ RWC < 0.75 C = 0.75 ≤ RWC ≤ 1.00	**RWC Operating Range**		
	A	B	C
1. Provide documentation that a groundwater monitoring well located between the GRRP and a drinking water well has received recharge water from the GRRP for at least six months such that the fraction of the GRRP's recycled municipal wastewater in the monitoring well equals a value of at least 0.5 multiplied by $RWC_{proposed}$.		✓	✓
2. The groundwater impacted by a GRRP from a monitoring well and a drinking water well meets all drinking water standards and the requirements of section 60320.020 (Control of Nitrogen Compounds).		✓	✓
3. Provide a proposal to the Department prepared and signed by an engineer licensed in California with at least three years experience in wastewater treatment and public water supply.. The proposal shall include:	✓	✓	✓
A. GRRP operations, monitoring, and compliance data;	✓	✓	✓
B. Evidence that a groundwater monitoring well located between the GRRP and a drinking water well has received recharge water from the GRRP for at least one year such that the fraction of the GRRP's recycled municipal wastewater in the monitoring well equals a value of at least 0.8 multiplied by $RWC_{maximum}$.;		✓	✓
C. Validation of appropriate construction and siting of monitoring wells pursuant to section 60320.070.	✓	✓	✓
D. A scientific peer review by an independent advisory panel that includes, as a minimum, a toxicologist, a registered engineering geologist or hydrogeologist, an engineer licensed in California with at least three years experience in wastewater treatment and public water supply., a microbiologist, and a chemist.		✓	✓
E. Submittal of an updated engineering report and operations plan.		✓	✓
4. For the entire recycled municipal wastewater stream, provide	✓	✓	✓

reverse osmosis treatment as well as subsequent advanced oxidation treatment[6]. The advanced oxidation treatment shall provide, at minimum, a level of treatment equivalent to a 1.2 log NDMA reduction and a 0.5 log 1.4-dioxane reduction.			

(f) If the RMA RWC exceeds its maximum RWC, the GRRP shall:

a. Notify the Department and RWQCB in writing within 7 days of exceedance and,

b. Within 60 days, implement corrective action(s) and submit a report to the Department and RWQCB describing the reason(s) for the exceedance and the corrective action(s) taken to avoid future exceedances.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60320.045. Total Organic Carbon Requirements

(a) For each surface or subsurface application facility used for replenishing a groundwater basin, the GRRP shall monitor TOC as follows:

(1) For filtered wastewater, unless subsequently treated with reverse osmosis, two 24-hour composite samples a week, taken at least three days apart. Based on the Department's review of the previous 12 months' results, with approval from the Department, monitoring may be reduced to one 24-hour composite sample each week, and

(2) For recycled municipal wastewater, at least one 24-hour composite sample each week prior to recharge, or

(3) For surface application, at least one sample each week in a manner yielding TOC values representative of the recycled municipal wastewater TOC after infiltration and percolation, and not influenced by diluent water, native groundwater, or other source of dilution as determined by:

(A) measuring undiluted percolating recycled municipal wastewater,

(B) measuring diluted percolating recycled municipal wastewater and adjusting the value for the diluent water effect, or

(C) using recharge demonstration studies to develop a soil treatment factor that can be applied weekly to recycled municipal wastewater measurements leaving the treatment plant.

(b) Grab samples may be taken in lieu of the 24-hour composite samples required in subsection (a) if:

(1) the GRRP demonstrates that a grab sample is representative of the water quality throughout a 24-hour period, or

(2) the entire recycled municipal wastewater stream has been treated by reverse osmosis.

[6] The requirement for advanced oxidation for **all** subsurface application GRRPs is under discussion.

(c) Analytical results of the monitoring performed pursuant to subsection (a) shall not exceed the following TOC limits:

(1) For filtered wastewater, 16 mg/L, based on:

(A) two consecutive samples and

(B) the average of the last four results and,

(2) For recycled municipal wastewater or recharge water, with the running monthly average (RMA) RWC determined pursuant to section 60320.041(a),

$$TOC_{max} = \frac{0.5 mg/L}{RWC}$$, based on:

(A) a 20-week running average of all TOC results and

(B) the average of the last four results.

(d) The TOC_{max} limit specified in subsection (c)(2) may be increased if:

(1) The increased TOC_{max} limit is approved by the Department and RWQCB,

(2) The GRRP has been in operation for the most recent ten consecutive years,

(3) The project sponsor submits a proposal to the Department prepared and signed by an engineer licensed in California and experienced in the fields of wastewater treatment and public water supply. The proposal shall include the following, based on the most recent ten consecutive years of operation:

(A) GRRP operations, monitoring, and compliance data;

(B) Evidence that the GRRP has a history of compliance with the requirements of their RWQCB permit;

(C) Evidence that the water collected at all downgradient drinking water wells and monitoring wells impacted by the GRRP has met all the primary drinking water standards for the parameters specified pursuant to section 60320.070(b)(2);

(D) Analytical or treatment studies requested by the Department to make the determination in subsection (C);

(E) Validation of appropriate construction and siting of monitoring wells pursuant to section 60320.070;

(F) A study defining the water quality changes, including organic carbon characterization, as a result of the impact of the GRRP;

(4) The GRRP has performed a health effects evaluation that assesses the health risks to consumers of water impacted by the GRRP, including any anticipated water quality changes resulting from the proposed increased TOC_{max} limit. The evaluation shall include the following:

(A) An exposure assessment that characterizes the quality of the water consumed and the quantity of contaminants and constituents consumed.

(B) All available human epidemiologic studies of the population that has consumed water impacted by the GRRP.

(C) The results of laboratory animal studies and health risk assessments available in peer-reviewed literature pertaining to water impacted by the GRRP and anticipated water quality changes resulting from the proposed increased TOC_{max}, including studies or assessments where extrapolation of data may be relevant.

(D) A health risk assessment of the potential individual and cumulative effects of the regulated contaminants described in section 62320.030 and the constituents monitored pursuant to subsections 60320.047(a) and (c), in a manner that includes;

(1) lifetime risks of cancer and

(2) risks of non-cancer effects.

(E) A report detailing comments, questions, concerns, and conclusions of a review by an independent scientific peer review advisory panel that includes, as a minimum, a toxicologist, an epidemiologist, an engineering geologist or hydrogeologist registered in California, an engineer licensed in California with at least three years of experience in wastewater treatment and public water supply, a microbiologist, and a chemist.

(e) If the GRRP exceeds the limit in (c)(1)(A), (c)(2)(A), or its approved increased TOC_{max} limit obtained pursuant to subsection (d) based on a 20-week running average, the GRRP shall:

(1) immediately suspend the addition of recycled municipal wastewater until at least two consecutive results, 3 days apart, are less than the limit,

(2) notify the Department and RWQCB within 7 days of suspension,

(3) revert back to the semi-weekly monitoring in (a)(1), if the GRRP had been approved for reduced monitoring, and

(4) within 60 days, submit a report to the Department and RWQCB describing the reasons for the exceedance and the corrective actions to avoid future exceedances. At a minimum, the corrective actions shall include:

(A) a reduction of RWC sufficient to comply with the limit, and/or

(B) the treatment of the filtered wastewater with reverse osmosis.

(f) If the GRRP exceeds the limit in (c)(1)(B), (c)(2)(B), or its approved increased TOC_{max} limit obtained pursuant to subsection (d) based on the last four results, the GRRP shall, within 60 days, submit a report to the Department and RWQCB describing the reasons for the exceedance and the corrective actions taken to avoid future exceedances.

(g) To use one or more wastewater constituents in lieu of TOC, approval from the Department shall be obtained. At a minimum, the constituent(s) used in lieu of TOC shall (see Endnote 6):

(1) Be quantifiable in the wastewater, recycled municipal wastewater, groundwater, and throughout the treatment processes,

(2) Have identifiable treatment performance standards as protective of public health as the TOC standards in this Chapter.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60320.047. Additional Constituent Monitoring

(a) Each quarter, the GRRP shall sample and analyze the recycled municipal wastewater and the downgradient monitoring wells specified by the Department for the following (see Endnote 2):

(1) Priority Toxic Pollutants [chemicals listed in the Water Quality Standards, Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, and 40 CFR Part 131, Federal Register 65(97), May 18, 2000, p. 31682] specified by the Department, based on the Department's review of the GRRP's engineering report;

(2) Chemicals with state notification levels that the Department has specified (see Endnote 3), based on a review of the GRRP engineering report and the affected groundwater basin(s); and

(3) Chemicals that the Department has specified (See Endnote 4), based on a review of the GRRP's engineering report, the affected groundwater basin(s), and the results of the assessment performed pursuant to subparagraph 60320(a)(2)(A).

(b) The GRRP may reduce monitoring for the constituents in (a) to once each year following Department approval based on the Department's review of the results of the monitoring in (a).

(c) Annually, the GRRP shall monitor the recycled municipal wastewater for constituents indicating the presence of municipal wastewater, as specified by the Department (See Endnote 5) based on the following:

(1) a review of the GRRP's engineering report,

(2) the contaminant list developed pursuant to section 60320(a)(2)(D),

(3) the affected groundwater basin(s),

(4) a constituent's ability to characterize the presence of pharmaceuticals, endocrine disrupting chemicals, personal care products, and other indicators of the presence of municipal wastewater, and

(5) the availability of a test method for a constituent.

(d) A constituent detected as a result of monitoring conducted pursuant to this section shall be reported to the Department and RWQCB no later than the quarter following the quarter in which the results are received by the GRRP.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60320.065. Operation Optimization.

(a) During the first year of operation for new GRRP's, or during the first year of operation after the effective date of this section for existing GRRP's, and at all times thereafter, all treatment processes shall be operated in a manner providing optimal reduction of all contaminants including:

(1) microbial contaminants,

(2) regulated contaminants identified in section 60320.030 and the nitrogen compounds in section 60320.020, and

(3) nonregulated contaminants identified in section 60320.047.

(b) Within six months of optimizing treatment processes pursuant to (a) and anytime thereafter operations are optimized resulting in a change in operation, each GRRP shall update their operations plan to include such changes in operational procedures and submit the operations plan to the Department for review.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60320.070. Monitoring Between a GRRP and Downgradient Drinking Water Supply Wells.

(a) Prior to operating a GRRP, each GRRP shall site and construct monitoring wells, as follows:

(1) At a location where the GRRP's recharge water has been retained in the saturated zone for 1-3 months but will take at least three months before reaching the nearest domestic water supply well,

(2) At an additional point or points between the surface or subsurface application facility and the nearest downgradient domestic water supply well, and

(3) Such that samples can be obtained independently from each aquifer that will receive water that was recharged by the GRRP.

(b) Monitoring shall be conducted as follows:

(1) Two samples prior to GRRP operation and at least one sample each quarter thereafter, shall be collected at each monitoring well;

(2) Each sample shall be analyzed for TOC, total nitrogen, nitrate, nitrite, the constituents in tables 64449-A and B of section 64449, total coliform bacteria, and any water quality constituents specified by the Department based on the results of the recycled municipal wastewater monitoring conducted pursuant to this chapter; and

(c) Analytical results of monitoring performed pursuant to paragraph (b) shall be reported to the Department and the RWQCB by the GRRP, as follows:

(1) For all chemical analyses completed in a calendar month, the GRRP shall ensure the laboratory submits results no later than the end of the following month using the Electronic Deliverable Format as defined in the Electronic

Deliverable Format (EDF) Version 1.2i Guidelines & Restrictions dated April 2001 and Data Dictionary dated April 2001.

(2) For any results exceeding an MCL or at anytime coliform bacteria are present, within 48 hours of receiving the results.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

Section 60320.090. Annual and Five-Year Reporting.

(a) By the date specified in the GRRP's RWQCB permit, the project sponsor shall provide a report to the RWQCB and the Department. Public water systems having downgradient sources potentially affected by the GRRP shall be notified by direct mail of the availability of the report. The report shall be prepared by an engineer licensed in California and experienced in the fields of wastewater treatment and public water supply. The report shall include the following:

(1) A summary of compliance with the applicable monitoring requirements and criteria of this Chapter for the previous calendar year;

(2) For any violations of this Chapter during the previous calendar year;

(A) the date, duration, and nature of the violation

(B) a summary of any corrective actions and/or suspensions of surface or subsurface application of recycled municipal wastewater resulting from a violation

(C) if uncorrected, a schedule for and summary of all remedial actions

(3) Any detections of monitored constituents and any observed trends in the monitoring wells, as well as diluent water supplies,

(4) Information pertaining to the vertical and horizontal migration of the recharge water plume,

(5) A description of any changes in the operation of any unit processes or facilities,

(6) A description of any anticipated changes, along with an evaluation of the expected impact of the changes on subsequent unit processes, and

(7) The estimated quantity and quality of the recycled municipal wastewater and diluent water to be utilized for the next twelve months.

(b) Every five years from the date of the initial approval the engineering report required pursuant to section 60323, the project sponsor shall update the report to address any project changes and submit the report to the RWQCB and the Department. The update shall include, but not be limited to:

(1) Anticipated RWC increases, a description of how the RWC requirements in section 60320.041 will be met, and the expected impact the increase will have on the GRRP's ability to meet the requirements of this Chapter,

(2) Evidence that the minimum retention time requirement in subsection 60320.010(c) has been met, and

(3) A description of any inconsistencies between previous groundwater model predictions and the observed and/or measured values, as well as a description of how subsequent predictions will be accurately determined.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

ARTICLE 7. ENGINEERING REPORT AND OPERATIONAL REQUIREMENTS

Section 60323[7]. Engineering Report

(a) No person shall produce or supply ~~reclaimed water~~recycled municipal wastewater for direct reuse from a ~~proposed~~ water reclamation plant ~~unless he files an~~ without a Department approved engineering report.

(b) The report shall be prepared by a properly qualified engineer ~~registered~~ licensed in California and experienced in the field of wastewater treatment, and shall contain a description of the design of the proposed reclamation system. The report shall clearly indicate the means for compliance with these regulations and any other features specified by the regulatory agency.

(c) The report shall contain a contingency plan which will assure that no untreated or inadequately treated wastewater will be delivered to the use area.

NOTE: Authority cited: Section 100275, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

[7] Section 60320 is an existing section. The text reflects the proposed amendments.

Endnotes for Draft Groundwater Recharge Reuse Regulations

These Endnotes accompany the draft recharge regulations currently being developed by the California Department of Public Health's Drinking Water Program, *but are not expected to be part of the proposed regulatory package*. The draft recharge regulations address the supplementation of groundwater by surface or subsurface application of treated municipal wastewater prior to eventual extraction via drinking water wells for potable use.

The latest draft is here:

http://www.cdph.ca.gov/healthinfo/environhealth/water/Pages/Waterrecycling.aspx

ENDNOTE 1.

§60320.030. Control of Regulated Chemicals and Physical Characteristics

Examples of contaminants whose MCL compliance is not based on a running annual average include; nitrate, nitrite, and perchlorate.

ENDNOTE 2.

§60320.047. Additional Constituent Monitoring

Analytical Methods for Unregulated Chemicals

Subsection (a) states that the GRRP shall conduct the following and report any detections.

Some of the chemicals will have analytical methods that are available. Some may not.

CDPH views the use of drinking water methods as most appropriate, since they are generally more sensitive than wastewater methods. However, this may not always be possible, since there may be characteristics of the wastewater (e.g., high total dissolved solids) that may make the use of drinking water methods difficult.

GRRPs should select methods for non-regulated chemicals according to the following approach.

1. Use CDPH-approved drinking water methods, when available.

2. Use CDPH-recommended methods for chemicals if no CDPH-approved drinking water method is available (e.g., 1,2,3-TCP).

3. If there is no CDPH-recommended drinking water method for a chemical, and more than a single EPA-approved method is available, consult with CDPH to determine the appropriate EPA-approved method.

4. If there is no EPA-approved method for a chemical, and more than one method is available from the scientific literature (e.g., peer-reviewed journals), consult with CDPH to determine an appropriate method.

5. If no approved method is available for a specific chemical, the GRRP's laboratory may develop or use its own methods and should provide the analytical methods to CDPH for review.

6. If the only method available for a chemical is for wastewater analysis (e.g., a chemical listed as a priority pollutant only), sample and analyze for that chemical in the treated wastewater immediately prior to reverse osmosis treatment to increase the likelihood of detection. Use this approach until the GRRP's laboratory develops a method for the chemical in drinking water, or until a CDPH-approved or -recommended or EPA-approved drinking water method is available.

7. If no method is available for a specific contaminant, as may be the case for certain endocrine disrupting chemicals, pharmaceuticals, personal care products, or other chemicals indicating the presence of wastewater (see Endnote 5), the GRRP should propose an alternative contaminant that might be used as an indicator or surrogate for the contaminant of interest, or an alternate sampling program that addresses the contaminant of concern, or the category of the contaminant of concern.

ENDNOTE 3.

§60320.047. Additional Constituent Monitoring

Selected chemicals with CDPH notification levels for possible analysis.

Paragraph (a)(2) refers to chemicals with state notification levels that CDPH has specified. These chemicals are selected from CDPH's chemicals with notification levels; chemicals already included in analysis required under other subsections are not included here.

These chemicals have either been detected at least once in drinking water supplies over the past few years, or if not detected, they are of interest for some specific reason [e.g., formaldehyde is of interest because in may be a byproduct of certain treatment processes]. These would likely include boron, chlorate, 1,4-dioxane, formaldehyde, N-nitrosodimethylamine (NDMA), 1,2,3-trichloropropane, and vanadium.

ENDNOTE 4.

§60320.047. Additional Constituent Monitoring

Additional chemicals for analysis

Paragraph (a)(3) refers to other chemicals that CDPH has specified. These chemicals would likely include: chromium-6, diazinon, and nitrosamines for which US EPA has developed analytical methods.

ENDNOTE 5.

§60320.047. Additional Constituent Monitoring

Pharmaceuticals, endocrine disruptors, and other wastewater indicator chemicals

Subsection (c) refers to pharmaceuticals, endocrine disruptors and other indicators of the presence of municipal wastewater as specified by CDPH.

CDPH is interested in collecting information that relates to the presence of the listed categories of contaminants in municipal wastewater that may be found in recycled municipal wastewater.

The specific contaminants targeted for monitoring will likely vary among GRRPs, depending on their individual engineering reports and characteristics of their groundwater basins, as well as the GRRP's efforts that have been taken to address the presence of endocrine disrupting chemicals, pharmaceuticals, and personal care products in recycled municipal wastewater, and its efforts to assure that their presence in recycled municipal wastewater is at levels that are protective of the public health.

Monitoring for these chemicals—or categories of chemicals—is a diligent way of assessing and verifying recycled municipal wastewater quality characteristics, which can be useful in addressing issues of public perception about the safety of recharge projects.

Further, should there be positive findings of these types of chemicals, the recharge agency and CDPH can give the result due consideration as to whether it is of concern or not. Just what such consideration might entail would depend on

what is known and what is not known about the particular chemical, including its potential health effects at the given concentration, the source of the chemical, as well as possible means of better control to limit its presence, treatment strategies if necessary, and other appropriate actions.
Such monitoring is not for compliance purposes, but for informational use only.

If a GRRP has additional reports for its own project using prior data that address the types of chemicals discussed in this Endnote, or reports for its own project addressing the effectiveness of the treatment processes in limiting the release of endocrine disruptors, pharmaceuticals, or personal care chemicals into recharge water, those reports should be made available to CDPH to assist in developing an approach that would build upon or supplement the already available information.

A GRRP that has little monitoring information should plan on collecting more analytical data related to endocrine disrupting chemicals, pharmaceuticals, personal care products and other chemicals that are indicators of wastewater in its recharge water.

A GRRP that can demonstrate a history of sampling, analysis, and related research—as well as an on-going program of monitoring and research—on endocrine disrupting chemicals, pharmaceuticals and personal care products, or appropriate indicator or surrogate chemicals in its recharge water will likely be encouraged to continue its research efforts, and likely have no contaminants specified by CDPH for analysis under this section.

GRRPs will not be required to conduct an ongoing monitoring program for contaminants under this section, unless good indicator or surrogate chemicals can be identified through this monitoring, and analytical methods are available to perform that monitoring.

Depending on the results of analyses and other information discussed above, required monitoring may be of short duration (e.g., twice a year for two or three years). If good indicator or surrogate chemicals with available analytical methods can be identified, requirements for their monitoring will be considered. This notwithstanding, CDPH recommends an ongoing monitoring program to address public concerns about the presence in wastewater about these types of chemicals.

A monitoring program could include sampling and analysis for representatives of these categories of contaminants (including surrogates or specific chemicals indicators):

- Hormones. CDPH at this time does not recommend specific chemicals. However, GRRPs should investigate chemicals that could represent either female or male hormones, or surrogates that could represent both.

- "Industrial" endocrine disruptors: CDPH at this time does not recommend specific chemicals. However, GRRPs should investigate chemicals such as bisphenol A, nonylphenol and nonylphenol polyethoxylates, octylphenol and octylphenol polyethoxylates, and polybrominated diphenyl ethers, or surrogates that could represent one or more industrial endocrine disruptors.

- Pharmaceuticals: CDPH at this time does not recommend specific chemicals. However, GRRPs should investigate chemicals such as acetaminophen, amoxicillin, azithromycin, carbamazepine, ciprofloxacin, dilantin, gemfibrozil, ibuprofen, lipitor, meprobamate, sulfamethoxazole, trimethoprin, and salicylic acid, or surrogates that could represent one or more pharmaceuticals.

- Personal Care Products: CDPH at this time does not recommend specific chemicals. However, GRRPs should investigate chemicals such triclosan and DEET, or surrogates that could represent one or more personal care products.

- Other chemicals that may suggest the presence of wastewater: CDPH at this time does not recommend specific chemicals. However, GRRPs should investigate chemicals such as caffeine, iodinated contrast media, fire retardants such as TCEP, or surrogates that could represent one or more chemicals that suggest the presence of wastewater.

There are no drinking water standards for the contaminants listed above and no standards are anticipated. In addition, analytical methods may not be widely available (See Endnote 2).

ENDNOTE 6.

Alternatives to Using TOC

The current draft proposes that GRRPs interested in using an alternative wastewater constituent or constituents in lieu of TOC must demonstrate that the alternative proposed is quantifiable in the wastewater, recycled municipal wastewater, groundwater, and throughout the treatment processes. Further, the alternative must have identifiable treatment performance standards and an overall demonstration that it provides the same level of public health protection as the TOC requirement.

A GRRP that can demonstrate a history of sampling, analysis, and related research to support the use of alternatives should provide this information to CDPH when proposing an alternative.

One alternative that has been suggested to CDPH for consideration is the use of Biodegradable Dissolved Organic Carbon (BDOC) in concert with specific chemical indicators to assure proper removal of unregulated wastewater-derived organics for surface application projects. In this case, indicators are defined as individual compounds occurring at quantifiable levels that can represent certain physical, chemical and biological characteristics that are relevant to fate and transport during treatment (where treatment includes wastewater and soil aquifer treatment (SAT)). BDOC is a measure of dissolved biodegradable organic matter that is consumed or otherwise altered by indigenous bacterial populations. The use of BDOC by measuring differential (delta) TOC (i.e., the differences between recycled municipal wastewater TOC and before and after transport through the soil column) and specific chemical indicators may be able to serve as a surrogate for the absence of biodegradable organic compounds that are not derived from humic (i.e., soil) substances.

The use of BDOC/indicators would likely consist of a number of elements, including the following:

1. For each project, prior to start-up,

   A. The GRRP will select a set of indicator compounds for approval by CDPH that can be reliably measured by approved laboratory methods in recycled municipal wastewater and groundwater that also reflect good and poor removal via SAT. For purposes of this section, "good" is >90 percent, and "poor" is <25 percent removal.

   B. The GRRP will identify the laboratory or laboratories that will be used for BDOC analyses and the federal or state approved or recommended methods that will be used for those analyses. If no approved or recommended method is available for determining BDOC, the GRRP's laboratory may develop or use its own methods and should provide the analytical methods to CDPH for review. Those methods may be used until federal or state approved or recommended methods are available. Where multiple analytical methods exist, the more sensitive method should be used (i.e., that which can measure indicator compounds at a lower concentration).

   C. The GRRP will validate the presence of the proposed indicators in the recycled municipal wastewater, and would also collect baseline data from the project's monitoring wells. The selected indicators and baseline data will be presented in the GRRP's Engineering Report.

   D. The GRRP will establish baseline information on BDOC and TOC in recycled municipal wastewater and groundwater monitoring wells.

The GRRP will also characterize expected SAT performance by conducting batch soil column tests with recycled municipal wastewater and measuring BDOC and delta TOC. This information will be provided in the GRRP's Engineering Report.

2. During start-up, the GRRP, through frequent monitoring and analysis, will validate the expected BDOC performance, delta TOC, and indicator removal performance. If BDOC performs as expected, the delta TOC can serve as the routine parameter that is monitored to validate that the expected biodegradation is occurring, along with the selected indicators, provided that the GRRP also monitors TOC consistent with the regulations for a specific time period established by CDPH and designated in its permit.

3. During routine operation, the GRRP would use delta TOC and the indicators to validate performance of the project. In parallel, the GRRP will also monitor TOC consistent with the regulations for a specific time period established by CDPH, and designated in its permit. This will enable the GRRP to demonstrate the suitability of its alternative approach.

4. The RWC will initially be set at 20%, or some other value, as determined in its permit. The GRRP may be allowed to increase the RWC up to 50% in a phased manner over time (such as five years) as long as BDOC and indicator performance are the same as the performance observed at the 20% or initial RWC. At each increased step, the GRRP will also monitor TOC consistent with the regulations for a specific time period established by CDPH, and designated in its permit.

5. If the BDOC in any monitoring well associated with the GRRP or the indicators begin to perform differently than as observed during startup or previous monitoring events, then a GRRP would have to evaluate its project for the cause and adjust the RWC downward. The GRRP will also monitor TOC consistent with the regulations.

6. As part of the proposal to CDPH, the GRRP will convene an expert panel to provide feedback to CDPH on the proposed approach and, if the proposal is accepted, to meet periodically to provide feedback on its performance and adequacy of BDOC monitoring.

7. Indicator compounds selected will be re-evaluated by the expert panel and by CDPH for continued relevance by the GRRP annually.

ENDNOTE 7. Table summarizing text of Section 60320.020 (Control of Nitrogen Compounds)*

	Method 1	Method 2	Method 3
Compliance point and monitoring	• Anywhere representative of recycled municipal wastewater or recharge water (i.e. including in or above the mound) • Samples analyzed for total nitrogen • Reduced monitoring available	• Anywhere representative of recycled municipal wastewater or recharge water. (i.e. prior to surface or subsurface application or from within a mound or vadose zone prior to reaching the GW table) • Samples analyzed for total nitrogen, nitrate, nitrite, ammonia, organic nitrogen, DO, and BOD • A groundwater sample analyzed for DO • Reduced monitoring available	• Only for projects in operation for ≥ 20 years • Groundwater downgradient of the recharge area • Samples analyzed for nitrate and nitrite
Standard(s)	• 5 mg/L total N as an average	• 10 mg/L total nitrogen and • Limits established in the engineering report for other constituents	MCLs for nitrate and nitrite
Frequency of sampling	2 per week	As established by CDPH and specified in the operations plan	• Specified in the engineering report and operations plan. • Relatively frequent monitoring at locations between the recharge area and downgradient domestic wells is required.
Consequence of failure	• Investigate, correct, and notify if the average of two consecutive samples >5 mg/L • Suspend application of recycled municipal wastewater if the 4-week average of all samples >5 mg/L	• Investigate, correct, and notify if the average of two consecutive samples >10 mg/L total nitrogen standard or exceeds standard for other constituents • Suspend surface and subsurface application of recycled municipal wastewater until the average of two consecutive samples meets all limits	• Notify the Department and RWQCB if > MCLs • Suspend surface and subsurface application unless demonstrated that the groundwater no longer exceeds the MCLs.
Rationale	Method 1 relies on such a low limit for the total N in the recycled municipal wastewater that the chance that the NO_2 or NO_3 MCL could be exceeded is minute.	Method 2 relies on: 1. A low enough limit for the total N in the recycled municipal wastewater that the chance that a NO_2 or NO_3 MCL could be exceeded is low, combined with 2. A set of limits determined for a specific GRRP and explained in the Engineering Report for nitrite, organic nitrogen and /or ammonia necessary to limit oxidation to NO_2 or NO_3, and a set of minimum levels for an excess DO over BOD requirement in the recycled municipal wastewater and/or a DO requirement in the groundwater as necessary to prevent reduction of NO_3 to NO_2	Method 3 relies on: 1. A demonstration that historic recharge with water containing comparable levels of nitrogen has not caused a problem, 2. Evidence that recharge water can be tracked and monitored throughout the flow path, and 3. Monitoring to show that the MCLs for NO_2 and NO_3 are met in the groundwater.

*Note: This table provides a *summary* of the regulatory requirements and is not intended to be comprehensive.

APPENDIX B – GRRP APPROVAL STEPS

From Jim Crook

CITY OF FRESNO INCORPORATED OCT. 12, 1885

Potable Reuse Project Sequence of events for Approval

Prepare Engineering Report (details of proposed project)

Submit Engineering Report to CDPH, RWQCB, and County Health Agency for review

CDPH, RWQCB, and County Health agency review Engineering Report and request changes, additional information, etc.

CDPH accepts Engineering Report (usually after revisions by the project proponent)

Notice of Public Hearing released at least 30 days before scheduled hearing date

CDPH person is hearing officer at public hearing

Proponent prepares document for CDPH signature that includes a Summary of Public Hearing, Findings of Fact, and Conditions

> Findings of Fact includes all necessary details of proposed project
>
> Conditions include specific CDPH regulatory requirements for project that conform to draft groundwater recharge regulations

CDPH approves Summary of Public Hearing, Findings of Fact, and Conditions (usually after several revisions)

CDPH sends a letter to the RWQCB stating that the project complies with all CDPH requirements and recommends that the RWQCB incorporate all of the Findings of Fact and Conditions (which are appended to the letter) into the proponent's waste discharge requirements

RWQCB approves Findings of Fact and includes them in the proponent's permit

Total time if starting from scratch is at least 1 year (likely longer, e.g., 2 years) not counting a demonstration study of proposed treatment train, which is not required but is recommended

jc: 072909

APPENDIX C – FRESNO POTENTIAL CUSTOMERS

Potential Recycled Water Irrigation Customers

Customer Name	Water Zone	Customer Type	Customer ID	Parcel Acres	Estimated Irrigable Acres [1]	Estimated Irrigation Usage [2] (AFY)	Max Month Demand [3] (AFY)	Max Day Demand [4] (AFY)	Peak Hour Demand [5] (AFY)
Clovis Quadrant									
Clovis	Clovis	School	C-1	49.74	29.84	80.15	191	248.5	745.6
Buchanan	Clovis	School	C-2	87.14	52.29	140.42	335	435.4	1306.3
Cemetery	Clovis	Cemetery	C-3	9.10	8.64	23.21	55	72.0	216.0
Northeast Quadrant									
Carter G. Woodson Public Charter School	Northeast	School	NE-3	1.30	0.78	2.10	5	6.5	19.5
Fresno Prep Academy	Northeast	School	NE-12	4.17	2.50	6.72	16	20.8	62.5
Willow International Center	Northeast	School		66.79	40.08	107.63	257	333.7	1001.2
Copper River Country Club	Northeast	Golf Course	NE-49	720.13	684.13	1837.28	4,382	5697.2	17091.7
Fort Washington Country Club	Northeast	Golf Course	NE-48	130.36	123.85	332.60	793	1031.4	3094.1
Woodward Lakes	Northeast	Lake	NE-50	48.14	48.14	129.28	308	400.9	1202.7
Belcher	Northeast	Park	NE-56	5.49	5.21	14.00	33	43.4	130.2
Cary	Northeast	Park	NE-62	8.80	8.36	22.44	54	69.6	208.8
East Rotary	Northeast	Park	NE-53	4.19	3.98	10.68	25	33.1	99.4
Einstein	Northeast	Park	NE-59	7.88	7.49	20.10	48	62.3	187.0
El Dorado	Northeast	Park	NE-57	5.63	5.35	14.36	34	44.5	133.6
Kaiser	Northeast	Park	NE-54	4.70	0.71	1.89	5	5.9	17.6
Keith Tice	Northeast	Park	NE-52	4.06	0.61	1.64	4	5.1	15.2
Large	Northeast	Park	NE-58	6.05	5.75	15.44	37	47.9	143.7
Layne	Northeast	Park	NE-61	8.66	8.23	22.10	53	68.5	205.6
Manchester	Northeast	Park	NE-63	9.49	9.02	12.11	29	37.5	112.6
Robinson	Northeast	Park	NE-55	4.77	4.53	12.17	29	37.7	113.2
Rotary West	Northeast	Park	NE-64	14.23	13.52	36.30	87	112.6	337.7
University	Northeast	Park	NE-51	2.37	2.25	6.05	14	18.8	56.3
Vinland	Northeast	Park	NE-60	8.09	7.68	20.63	49	64.0	191.9
Woodward Regional	Northeast	Park	NE-65	285.71	271.42	728.92	1,739	2260.3	6781.0
Calvary Chapel Christian	Northeast	School	NE-9	2.66	1.60	4.29	10	13.3	39.9
Carden School of Fresno	Northeast	School	NE-40	19.60	11.76	31.58	75	97.9	293.8
Central Valley Christian Academy	Northeast	School	NE-14	6.15	3.69	9.91	24	30.7	92.2
First Church Christian Academy	Northeast	School	NE-11	3.27	1.96	5.28	13	16.4	49.1
Fresno Christian Schools	Northeast	School	NE-8	2.24	1.34	3.60	9	11.2	33.5
La Petite Academy	Northeast	School	NE-5	0.71	0.43	1.15	3	3.6	10.7
Mountain View Christian	Northeast	School	NE-13	4.59	2.75	7.39	18	22.9	68.8
Northpointe Christian Leadership Academy	Northeast	School	NE-36	18.04	10.82	29.07	69	90.1	270.4
Reaching Potentials Educational Institute	Northeast	School	NE-2	0.22	0.13	0.36	1	1.1	3.3
Sierra View Christian Academy	Northeast	School	NE-1	0.17	0.10	0.27	1	0.8	2.5
Truth Tabernacle Christian	Northeast	School	NE-10	2.88	1.73	4.65	11	14.4	43.2
Ahwahnee Middle School	Northeast	School	NE-34	16.67	10.00	26.86	64	83.3	249.8
Centennial Elementary School	Northeast	School	NE-15	7.80	4.68	12.57	30	39.0	116.9
Clovis North	Northeast	School		38.15	22.89	61.47	147	190.6	571.8
Clovis North - Middle School	Northeast	School		58.67	35.20	94.54	226	293.2	879.5
Clovis West High School	Northeast	School	NE-44	56.41	33.85	90.90	217	281.9	845.6
Copper Hills Elementary School	Northeast	School	NE-31	16.38	9.83	26.39	63	81.8	245.5
Eaton Elementary School	Northeast	School	NE-21	9.02	5.41	14.54	35	45.1	135.3
Erma Duncan Polytechnical High School	Northeast	School	NE-35	16.98	10.19	27.36	65	84.9	254.6
Fort Washington Elementary School	Northeast	School	NE-37	18.35	11.01	29.57	71	91.7	275.1
Herbert Hoover High School	Northeast	School	NE-43	46.60	27.96	75.09	179	232.9	698.6
Holland Elementary School	Northeast	School	NE-20	8.70	5.22	14.03	33	43.5	130.5
James S. Fugman Elementary School	Northeast	School	NE-33	16.50	9.90	26.58	63	82.4	247.3
Kastner Intermediate School	Northeast	School	NE-38	18.67	11.20	30.09	72	93.3	279.9
Liberty Elementary School	Northeast	School	NE-29	14.99	8.99	24.16	58	74.9	224.7
Lincoln Elementary School	Northeast	School	NE-41	34.71	20.83	55.93	133	173.4	520.3
Manchester Gate	Northeast	School	NE-16	8.03	4.82	12.95	31	40.1	120.4
Maple Creek Elementary School	Northeast	School	NE-30	15.94	9.57	25.69	61	79.7	239.0
McCardle Elementary School	Northeast	School	NE-18	8.33	5.00	13.43	32	41.6	124.9
Mountain View Elementary School	Northeast	School	NE-28	14.55	8.73	23.45	56	72.7	218.1
Pyle Elementary School	Northeast	School	NE-22	9.08	5.45	14.63	35	45.4	136.1
Riverview Elementary School	Northeast	School	NE-32	16.49	9.89	26.56	63	82.4	247.1
Robinson Elementary School	Northeast	School	NE-23	9.21	5.53	14.84	35	46.0	138.0
Thomas Elementary School	Northeast	School	NE-19	8.68	5.21	13.99	33	43.4	130.1
Tioga Middle School	Northeast	School	NE-39	19.06	11.43	30.70	73	95.2	285.6
Valley Oak Elementary School	Northeast	School	NE-27	14.01	8.41	22.57	54	70.0	210.0
Viking Elementary School	Northeast	School	NE-26	10.91	6.55	17.59	42	54.5	163.6
Vinland Elementary School	Northeast	School	NE-24	9.27	5.56	14.93	36	46.3	138.9
Wolters Elementary School	Northeast	School	NE-25	9.89	5.94	15.94	38	49.4	148.3
Ashlan Park Christian School	Northeast	School	NE-7	2.17	1.30	3.49	8	10.8	32.5
Fresno Christian School	Northeast	School	NE-4	2.12	0.32	0.86	2	2.7	8.0
Fresno Montesori School	Northeast	School	NE-17	8.19	4.92	13.20	31	40.9	122.8
Northwest Quadrant									
Crescent View Charter High School	Northwest	School	NW-39	27.61	16.56	44.48	106	137.9	413.8
KIPP Academy Fresno	Northwest	School	NW-3	0.70	0.42	1.13	3	3.5	10.5
Valley Preparatory Academy	Northwest	School	NW-6	2.22	1.33	3.58	9	11.1	33.3
Fig Garden Golf Course	Northwest	Golf Course	NW-44	133.26	126.59	339.98	811	1054.2	3162.7
Islewood Golf Course	Northwest	Golf Course	NW-42	48.91	46.47	124.79	298	387.0	1160.9
San Joaquin Country Club	Northwest	Golf Course	NW-43	127.80	121.41	326.05	778	1011.1	3033.2
Lake Van Ness	Northwest	Lake	NW-45	28.83	28.83	77.43	185	240.1	720.3
Dante-Alluvial	Northwest	Park	NW-54	6.82	6.48	17.40	42	54.0	161.9
Dog	Northwest	Park	NW-50	2.37	2.25	6.04	14	18.7	56.2
Forkner	Northwest	Park	NW-55	7.03	6.67	17.92	43	55.6	166.7
Grannys'	Northwest	Park	NW-46	1.08	1.03	2.76	7	8.5	25.6
Highway City	Northwest	Park	NW-49	2.03	1.92	5.17	12	16.0	48.1
Holman	Northwest	Park	NW-52	4.58	4.35	11.67	28	36.2	108.6
Lions	Northwest	Park	NW-57	8.56	8.13	21.84	52	67.7	203.2
Logan	Northwest	Park	NW-58	9.02	8.57	23.01	55	71.4	214.1
Oso de Oro	Northwest	Park	NW-51	3.99	3.79	10.18	24	31.6	94.7
Pinedale	Northwest	Park	NW-48	1.64	1.56	4.18	10	13.0	38.9
Quigley	Northwest	Park	NW-56	8.22	7.81	20.97	50	65.0	195.1
Riverbottom	Northwest	Park	NW-59	41.79	39.70	106.61	254	330.6	991.8
Riverpark	Northwest	Park	NW-60	123.02	116.87	313.86	749	973.3	2919.8
Spano	Northwest	Park	NW-47	1.12	1.07	2.87	7	8.9	26.7
Stallion	Northwest	Park	NW-53	5.68	5.40	14.49	35	44.9	134.8
Fairmont Preschool and Kindergarten	Northwest	School	NW-1	0.36	0.21	0.57	1	1.8	5.3
Pathfinders Institute	Northwest	School	NW-7	3.85	2.31	6.21	15	19.3	57.8
Souls Harbor Christian Academy	Northwest	School	NW-2	0.44	0.26	0.71	2	2.2	6.6
St. Anthony	Northwest	School	NW-15	8.69	5.22	25.16	58	57.8	57.8
World Harvest Christian Academy	Northwest	School	NW-29	13.50	8.10	21.75	52	67.4	202.3
Baird Middle School	Northwest	School	NW-19	9.39	5.63	15.13	36	46.9	140.8
Bullard High School	Northwest	School	NW-41	48.41	29.05	78.00	186	241.9	725.7
Bullard Talent Project	Northwest	School	NW-21	9.62	5.77	15.51	37	48.1	144.3
Central High East Campus	Northwest	School	NW-40	46.95	28.17	75.65	180	234.6	703.8

Cooper Middle School	Northwest	School	NW-32	16.54	9.92	26.65	64	82.6	247.9
Del Mar Elementary School	Northwest	School	NW-13	8.37	5.02	13.48	32	41.8	125.4
Figarden Elementary School	Northwest	School	NW-28	12.15	7.29	19.58	47	60.7	182.2
Florence E. Rata	Northwest	School	NW-10	6.66	3.99	10.73	26	33.3	99.8
Forkner Elementary School	Northwest	School	NW-25	10.60	6.36	17.08	41	52.9	158.8
Fort Miller Middle School	Northwest	School	NW-34	17.81	10.69	28.70	68	89.0	267.0
Gibson Elementary School	Northwest	School	NW-9	6.28	3.77	10.13	24	31.4	94.2
Herndon-Barstow Elementary School	Northwest	School	NW-27	11.24	6.75	18.12	43	56.2	168.5
John Steinbeck Elementary School	Northwest	School	NW-36	19.31	11.58	31.11	74	96.5	289.4
Kratt Elementary School	Northwest	School	NW-16	8.78	5.27	14.14	34	43.8	131.5
Lawless Elementary School	Northwest	School	NW-17	8.80	5.28	14.18	34	44.0	131.9
Malloch Elementary School	Northwest	School	NW-12	8.27	4.96	13.32	32	41.3	123.9
Nelson Elementary School	Northwest	School	NW-33	16.71	10.02	26.92	64	83.5	250.4
New Horizon High School	Northwest	School	NW-4	1.62	0.97	2.61	6	8.1	24.3
Norman Liddell Elementary School	Northwest	School	NW-22	9.67	5.80	15.59	37	48.3	145.0
Phoenix Elementary Academy Community D	Northwest	School	NW-5	1.81	1.08	2.91	7	9.0	27.1
Pinedale Elementary School	Northwest	School	NW-24	10.50	6.30	16.92	40	52.5	157.4
Powers-Ginsburg Elementary School	Northwest	School	NW-26	10.62	6.37	17.12	41	53.1	159.3
Rio Vista Middle School	Northwest	School	NW-38	27.13	16.28	43.72	104	135.6	406.7
River Bluff Elementary School	Northwest	School	NW-30	13.85	8.31	22.31	53	69.2	207.5
Roeding Elementary School	Northwest	School	NW-11	7.63	4.58	12.29	29	38.1	114.4
Slater Elementary School	Northwest	School	NW-23	10.24	6.15	16.50	39	51.2	153.5
Starr Elementary School	Northwest	School	NW-20	9.51	5.71	15.33	37	47.5	142.6
Teague Elementary School	Northwest	School	NW-37	24.31	14.58	39.17	93	121.5	364.4
Tenaya Middle School	Northwest	School	NW-31	15.28	9.17	24.63	59	76.4	229.1
Wawona Middle School	Northwest	School	NW-35	18.28	10.97	29.46	70	91.3	274.0
William Saroyan Elementary School	Northwest	School	NW-18	8.94	5.36	14.40	34	44.7	134.0
Wilson Elementary School	Northwest	School	NW-14	8.54	5.12	13.76	33	42.7	128.0
Northwest Elementary School	Northwest	School	NW-8	5.93	3.56	9.55	23	29.6	88.9
Southeast Quadrant									
FYI Airport	Southeast	Airport	SE-36	842.54	210.63	565.68	1,349	1754.1	5262.3
Sierra Charter School	Southeast	School	SE-4	1.73	1.04	2.79	7	8.6	25.9
Belmont Country Club	Southeast	Golf Course	SE-39	109.36	103.89	279.01	666	865.2	2595.6
Hanks Par 3 Golf Course	Southeast	Golf Course	SE-37	24.48	23.26	62.47	149	193.7	581.1
Sunnyside Country Club	Southeast	Golf Course	SE-40	136.65	129.82	348.65	832	1081.1	3243.4
Village Green Golf Course	Southeast	Golf Course	SE-38	45.99	43.69	117.33	280	363.8	1091.5
Airways	Southeast	Park	SE-52	101.29	96.23	258.43	616	801.4	2404.1
Carroza	Southeast	Park	SE-46	8.59	8.16	21.92	52	68.0	203.9
East Fresno Boys/Girls Club	Southeast	Park	SE-43	4.39	4.17	11.21	27	34.8	104.3
Elks Club	Southeast	Park	SE-50	17.01	16.16	43.41	104	134.6	403.8
Fresno Fairgrounds	Southeast	Park	SE-51	93.03	88.38	237.36	566	736.0	2208.1
Melody	Southeast	Park	SE-45	4.82	4.58	12.31	29	38.2	114.5
Mosqueda	Southeast	Park	SE-48	10.13	9.62	25.84	62	80.1	240.4
Oso de Oro II	Southeast	Park	SE-47	9.41	8.94	24.01	57	74.4	223.3
Palm Lakes	Southeast	Park	SE-53	132.30	125.68	337.53	805	1046.6	3139.9
Park	Southeast	Park	SE-41	0.43	0.41	1.11	3	3.4	10.3
Pilibos	Southeast	Park	SE-49	12.86	12.22	32.82	78	101.8	305.3
Sunnyside	Southeast	Park	SE-44	4.71	4.47	12.02	29	37.3	111.8
Willow-Balch	Southeast	Park	SE-42	1.48	1.40	3.77	9	11.7	35.1
Campus Christian Academy	Southeast	School	SE-1	0.36	0.22	0.58	1	1.8	5.4
Cornerstone Christian	Southeast	School	SE-5	2.20	1.32	3.55	8	11.0	33.0
Fresno Adventist Academy	Southeast	School	SE-34	39.54	23.73	63.72	152	197.6	592.8
Fresno Sunnyside Christian Academy, Isp	Southeast	School	SE-2	0.87	0.52	1.41	3	4.4	13.1
St. Helen	Southeast	School	SE-8	7.13	4.28	11.48	27	35.6	106.8
Fresno Pacific University	Southeast	School	SE-3	22.98	13.79	37.02	88	114.8	344.4
Ayer Elementary School	Southeast	School	SE-15	9.26	5.56	14.92	36	46.3	138.8
Aynesworth Elementary School	Southeast	School	SE-10	7.90	4.74	12.73	30	39.5	118.5
Burroughs Elementary School	Southeast	School	SE-9	7.82	4.69	12.60	30	39.1	117.2
Cambridge Continuation High School	Southeast	School	SE-6	4.10	2.46	6.60	16	20.5	61.4
David L. Greenberg Elementary School	Southeast	School	SE-28	17.35	10.41	27.95	67	86.7	260.0
Easterby Elementary School	Southeast	School	SE-12	8.28	4.97	13.35	32	41.4	124.2
Edith B. Storey Elementary School	Southeast	School	SE-29	17.66	10.60	28.45	68	88.2	264.7
Elizabeth Terronez Middle School	Southeast	School	SE-32	24.96	14.98	40.22	96	124.7	374.2
Ericson Elementary School	Southeast	School	SE-11	8.19	4.91	13.20	31	40.9	122.8
Ewing Elementary School	Southeast	School	SE-14	8.87	5.32	14.29	34	44.3	133.0
Ezekiel Balderas Elementary School	Southeast	School	SE-19	10.59	6.35	17.07	41	52.9	158.8
Fancher Creek Elementary School	Southeast	School	SE-25	15.62	9.37	25.17	60	78.0	234.1
Fresno County Court	Southeast	School	SE-16	9.28	5.57	14.95	36	46.3	139.0
Irwin O. Addicot Elementary School	Southeast	School	SE-24	14.20	8.52	22.88	55	70.9	212.8
John S. Wash Elementary School	Southeast	School	SE-23	14.20	8.52	22.88	55	70.9	212.8
Kings Canyon Middle School	Southeast	School	SE-31	18.36	11.02	29.58	71	91.7	275.2
Lane Elementary School	Southeast	School	SE-13	8.35	5.01	13.46	32	41.7	125.2
Lone Star Elementary School	Southeast	School	SE-22	13.41	8.05	21.61	52	67.0	201.0
Molly S. Bakman Elementary School	Southeast	School	SE-20	11.19	6.71	18.03	43	55.9	167.7
Roosevelt High School	Southeast	School	SE-33	34.56	20.73	55.68	133	172.7	518.0
Scandinavian Middle School	Southeast	School	SE-18	10.36	6.21	16.69	40	51.7	155.2
Sequoia Middle School	Southeast	School	SE-27	16.86	10.11	27.16	65	84.2	252.7
Sunnyside High School	Southeast	School	SE-35	49.83	29.90	80.29	192	249.0	747.0
Temperance-Kutner Elementary School	Southeast	School	SE-21	13.00	7.80	20.94	50	64.9	194.8
Turner Elementary School	Southeast	School	SE-17	10.00	6.00	16.11	38	50.0	149.9
Academy for New Americans	Southeast	School	SE-30	17.79	10.67	28.66	68	88.9	266.6
Southwest Quadrant									
Chandler Airport	Southwest	Airport	SW-68	155.24	38.81	104.23	249	323.2	969.6
Cemetery	Southwest	Cemetery	SW-71	197.92	188.03	504.96	1,204	1565.8	4697.5
Cemetery	Southwest	Cemetery	SW-69	18.27	17.35	46.61	111	144.5	433.6
Cemetery	Southwest	Cemetery	SW-70	38.65	36.71	98.60	235	305.8	917.3
Edison-Bethune Charter Academy	Southwest	School	SW-43	9.38	5.63	15.11	36	46.9	140.6
New Millenium Charter School	Southwest	School	SW-7	0.47	0.28	0.76	2	2.4	7.1
Sunset Elementary School	Southwest	School	SW-45	9.67	5.80	15.58	37	48.3	144.9
W.E.B. Dubois Public Charter School	Southwest	School	SW-23	5.31	3.19	8.55	20	26.5	79.6
Bigby-Villa	Southwest	Park	SW-83	2.41	2.29	6.14	15	19.0	57.1
Carver	Southwest	Park	SW-87	4.62	4.39	11.78	28	36.5	109.6
Chandler	Southwest	Park	SW-82	1.98	1.88	5.05	12	15.7	47.0
Courthouse Park	Southwest	Park	SW-99	13.94	13.24	35.55	85	110.2	330.7
Dickey	Southwest	Park	SW-81	1.94	1.84	4.95	12	15.4	46.1
Fink-White	Southwest	Park	SW-94	8.89	8.44	22.67	54	70.3	210.9
Frank H. Ball	Southwest	Park	SW-84	2.95	2.80	7.52	18	23.3	69.9
Fresno Metropolitan Museum	Southwest	Park	SW-76	0.16	0.15	0.42	1	1.3	3.9
Grizzlies Stadium	Southwest	Park	SW-98	10.87	10.32	27.73	66	86.0	257.9
Hinton	Southwest	Park	SW-90	6.03	5.73	15.38	37	47.7	143.1
Hobart	Southwest	Park	SW-79	0.64	0.61	1.64	4	5.1	15.2
Holmes	Southwest	Park	SW-95	9.19	8.73	23.44	56	72.7	218.0
Hyde	Southwest	Park	SW-97	10.82	10.28	27.61	66	85.6	256.8
Ivy	Southwest	Park	SW-88	4.69	4.46	11.97	29	37.1	111.3
Kearney Park	Southwest	Park	SW-102	144.44	136.02	367.74	877	1140.3	3421.0

Lafayette	Southwest	Park	SW-86	4.49	4.27	11.47	27	35.6	106.7
Meux	Southwest	Park	SW-75	0.13	0.12	0.33	1	1.0	3.1
Nelsen	Southwest	Park	SW-85	3.87	3.67	9.87	24	30.6	91.8
Park	Southwest	Park	SW-77	0.28	0.26	0.71	2	2.2	6.6
Park	Southwest	Park	SW-73	0.04	0.04	0.10	0	0.3	0.9
Park	Southwest	Park	SW-72	0.03	0.03	0.08	0	0.2	0.7
Park	Southwest	Park	SW-74	0.04	0.04	0.11	0	0.3	1.0
Pride	Southwest	Park	SW-78	0.32	0.30	0.81	2	2.5	7.6
Radio	Southwest	Park	SW-91	7.32	6.95	18.66	45	57.9	173.6
Roeding Regional	Southwest	Park	SW-101	138.83	131.89	354.20	845	1098.3	3295.0
Romain	Southwest	Park	SW-93	7.88	7.49	20.11	48	62.4	187.1
San Pablo Family	Southwest	Park	SW-80	0.96	0.91	2.46	6	7.6	22.9
Sunset	Southwest	Park	SW-96	9.82	9.33	25.05	60	77.7	233.0
Victoria-West	Southwest	Park	SW-92	7.35	6.99	18.76	45	58.2	174.6
Wills	Southwest	Park	SW-89	5.70	5.41	14.54	35	45.1	135.2
Roeding Regional	Southwest	Park - Water	SW-103	6.10	0.00	0.00	0	0.0	0.0
Armenian Community School of Fresno	Southwest	School	SW-13	1.36	0.82	2.19	5	6.8	20.4
Faith Baptist Academy	Southwest	School	SW-5	0.32	0.19	0.51	1	1.6	4.8
Koinonia Christian	Southwest	School	SW-6	0.44	0.26	0.70	2	2.2	6.6
Our Lady of Victory	Southwest	School	SW-16	4.00	2.40	6.44	15	20.0	59.9
Sacred Heart	Southwest	School	SW-30	7.22	4.33	11.64	28	36.1	108.3
San Joaquin Memorial High School	Southwest	School	SW-32	41.03	24.62	66.12	158	205.0	615.1
FRESNO CITY COLLEGE	Southwest	School	SW-1	51.21	30.73	82.52	197	255.9	767.7
Addams Elementary School	Southwest	School	SW-37	8.38	5.03	13.51	32	41.9	125.7
Akira Yokomi Elementary School	Southwest	School	SW-27	6.50	3.90	10.48	25	32.5	97.5
Ann B. Leavenworth	Southwest	School	SW-50	10.71	6.43	17.26	41	53.5	160.5
Birney Elementary School	Southwest	School	SW-38	8.43	5.06	13.59	32	42.1	126.4
Calwa Elementary School	Southwest	School	SW-40	8.45	5.07	13.61	32	42.2	126.6
Carver Academy	Southwest	School	SW-39	8.43	5.06	13.59	32	42.1	126.4
Central Unified Alternative/Opportunity	Southwest	School	SW-17	4.50	2.70	7.25	17	22.5	67.4
Columbia Elementary School	Southwest	School	SW-36	8.29	4.97	13.35	32	41.4	124.2
Dailey Elementary School	Southwest	School	SW-18	4.59	2.75	7.40	18	22.9	68.8
Dewolf West High School	Southwest	School	SW-19	4.68	2.81	7.54	18	23.4	70.1
Edison Computech	Southwest	School	SW-61	18.81	11.29	30.31	72	94.0	282.0
Edison High School	Southwest	School	SW-66	36.13	21.68	58.22	139	180.5	541.6
El Capitan Middle School	Southwest	School	SW-59	17.28	10.37	27.85	66	86.3	259.0
Fremont Elementary School	Southwest	School	SW-31	7.75	4.65	12.50	30	38.7	116.2
Fresno County Community	Southwest	School	SW-22	5.31	3.18	8.55	20	26.5	79.6
Fresno County Special Education	Southwest	School	SW-10	0.72	0.43	1.16	3	3.6	10.8
Fresno High School	Southwest	School	SW-65	33.99	20.39	54.76	131	169.8	509.5
Fulton Special Education	Southwest	School	SW-42	9.34	5.61	15.05	36	46.7	140.1
Hamilton Elementary School	Southwest	School	SW-58	16.82	10.09	27.10	65	84.0	252.1
Heaton Elementary School	Southwest	School	SW-25	6.43	3.86	10.36	25	32.1	96.4
Homan Elementary School	Southwest	School	SW-34	7.99	4.79	12.87	31	39.9	119.7
J. E. Young Academic Center	Southwest	School	SW-9	0.64	0.38	1.03	2	3.2	9.6
Jackson Elementary School	Southwest	School	SW-14	3.25	1.95	5.24	12	16.2	48.7
James K. Polk Elementary School	Southwest	School	SW-63	19.09	11.45	30.76	73	95.4	286.2
Jefferson Elementary School	Southwest	School	SW-29	6.65	3.99	10.72	26	33.2	99.7
King Elementary School	Southwest	School	SW-51	10.94	6.56	17.62	42	54.6	163.9
Kirk Elementary School	Southwest	School	SW-3	5.19	3.12	8.37	20	25.9	77.8
Lincoln Elementary School	Southwest	School		6.48	3.89	10.44	25	32.4	97.1
Lowell Elementary School	Southwest	School	SW-24	5.32	3.19	8.58	20	26.6	79.8
Madison Elementary School	Southwest	School	SW-60	18.13	10.88	29.22	70	90.6	271.8
Mayfair Elementary School	Southwest	School	SW-28	6.62	3.97	10.67	25	33.1	99.3
McKinley Elementary School	Southwest	School	SW-47	10.01	6.01	16.14	38	50.0	150.1
McLane High School	Southwest	School	SW-41	8.49	5.10	13.68	33	42.4	127.3
Miguel Hidalgo Elementary School	Southwest	School	SW-52	11.03	6.62	17.77	42	55.1	165.3
Muir Elementary School	Southwest	School	SW-35	8.14	4.89	13.12	31	40.7	122.1
Norseman Elementary School	Southwest	School	SW-54	12.40	7.44	19.99	48	62.0	185.9
Orange Center Elementary	Southwest	School	SW-48	10.04	6.02	16.17	39	50.1	150.4
Roosevelt Elementary School	Southwest	School	SW-53	11.63	6.98	18.74	45	58.1	174.3
Rowell Elementary School	Southwest	School	SW-44	9.40	5.64	15.14	36	46.9	140.8
Susan B. Anthony Elementary School	Southwest	School	SW-46	9.85	5.91	15.88	38	49.2	147.7
Tehipite Middle School	Southwest	School	SW-62	19.08	11.45	30.75	73	95.3	286.0
Webster Elementary School	Southwest	School	SW-21	5.10	3.06	8.22	20	25.5	76.4
West Fresno Elementary School	Southwest	School	SW-57	16.46	9.87	26.52	63	82.2	246.7
West Fresno Middle School	Southwest	School	SW-49	10.63	6.38	17.12	41	53.1	159.3
West Park Elementary School	Southwest	School	SW-55	14.17	8.50	22.82	54	70.8	212.3
Winchell Elementary School	Southwest	School	SW-33	7.85	4.71	12.66	30	39.2	117.7
Wishon Elementary School	Southwest	School	SW-67	37.83	22.70	60.96	145	189.0	567.1
Yosemite Middle School	Southwest	School	SW-4	15.71	9.42	25.31	60	78.5	235.5
Armenian Community School	Southwest	School	SW-12	1.29	0.77	2.08	5	6.4	19.3
Fresno Valley High School	Southwest	School	SW-20	4.87	2.92	7.85	19	24.3	73.0
St. Therese School	Southwest	School	SW-8	0.50	0.30	0.81	2	2.5	7.6
TOTAL						12,859	30,671	39,855	119,448

Irrigation Factors

Airport	25%
Cemetery	95%
Golf Course/Country Club	90%
Lake	100%
Park	95%
Park - Water	0%
School	60%

Peak Day Peaking Factor	30%

Notes:
(1) Irrigable acreage is estimated by multiplying parcel acreage by the irrigation factor. This is an adjustment for unirrigated parcel area.
(2) Estimated irrigation usage has been calculated by multiplying the irrigable area by the average irrigation requirement for the Fresno area.
(3) The maximum month irrigation has been calculated by multiplying the average irrigation requirement by the maximum month irrigation requirement (July = 20 percent of annual demand).
(4) Maximum day irrigation demand is assumed to 30 percent larger than the maximum month demand.
(5) The peak hour demand has been estimated assuming an eight hour irrigation period.

Removed Customers

Calif State Univ Fresno	Northeast	School	NE-47	264.26	158.55	425.81	1,016	1320.4	3961.2
Sports Complex	Southwest	Park		141.10	141.10	378.93	904	1175.0	3525.1

APPENDIX D – 1996 RWRF MASTER PLAN – AGRICULTURAL EXCHANGE EVALUATION

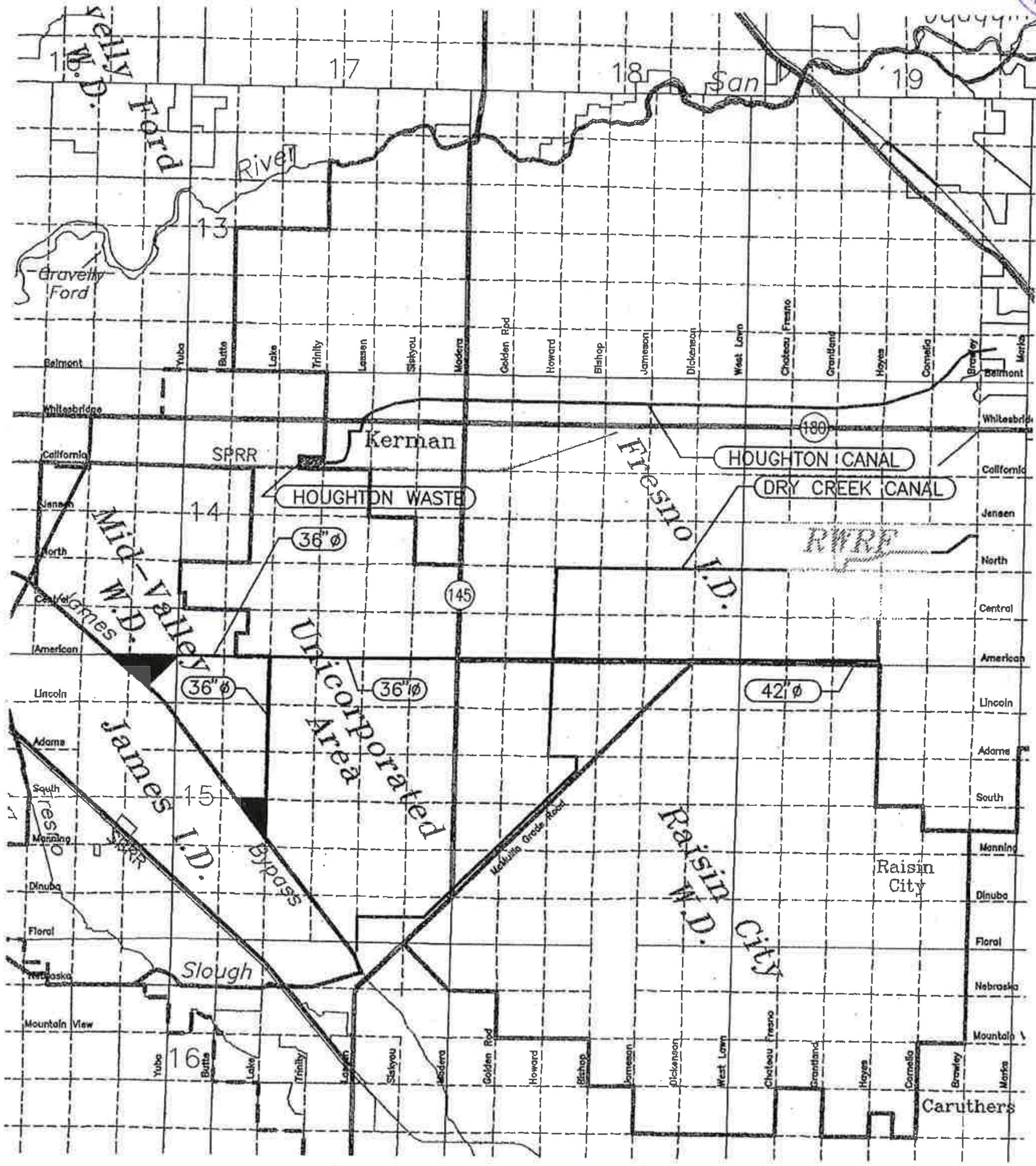
Raisin City Water District

In January 1995, Raisin City Water District (RCWD) submitted a proposal to take delivery of secondary undisinfected effluent from the RWRF. Meetings with the RCWD Board of Directors (Spring 1996) confirmed that RCWD is interested in negotiating an agreement with the City based on the original proposal. This proposal includes year round delivery of approximately 45 mgd through pipelines to disposal ponds located in RCWD. Turnouts from the pipelines would also be provided for direct irrigation.

Technical Elements. The RCWD proposal for 45 mgd of RWRF effluent includes an estimated 48,000 ft of pipeline and three 320 acre disposal ponds (total 960 acres assuming a conservative percolation rate of 2 in/day). The pipe sizes required range from 66 inches to 42 inches in diameter. The three pond sites are not located on adjacent property, therefore the pipe size requirements are reduced after each turnout to a pond. Review of the regional topography indicates that the effluent can be delivered to the ponds by gravity flow. This would be confirmed in final design.

Institutional Elements. The RCWD Board of Directors has expressed strong commitment to the proposed project, primarily because the effluent provides a reliable source of water for agricultural use. This project would increase effluent reuse and provide incidental groundwater recharge in a water-short area. Incidental percolation would help to off-set the declining groundwater parts of the District. The District currently relies solely on groundwater for agricultural use.

This project requires a transfer of agricultural land for use as disposal ponds. The proposed locations of the off-site ponds is approximately six to seven miles south of the RWRF, as shown in Figure 4. Approximately one-half of the proposed pond locations is currently planted with vineyards and orchards; the other half is planted with seasonal crops. However, the RCWD Board expects that adequate land is available through willing sellers in the event the proposed locations are not available.



LEGEND:

DISTRIBUTION TO MVWD

RWRF–PLANT BOUNDARIES

ALL SHADED AREAS–POTENTIAL POND LOCATIONS

Figure 4
PROPOSED MVWD REUSE/DISPOSAL PROJECT
Fresno Clovis Wastewater Facilities
Master Plan Report

If implemented this project may require mitigation to FID because delivery of effluent to RCWD would occur outside the FID boundary. As noted above, additional hydrogeologic studies and are necessary to determine to what extent, if any, mitigation would be required. The studies must identify the potential benefit of incidental percolation from the disposal operation in RCWD. The incidental percolation should help to offset the declining groundwater levels in the vicinity of RCWD (i.e., flatten the groundwater gradient), thereby reducing the amount of localized incidental groundwater flow out of FID toward RCWD.

The construction of additional disposal ponds is necessary to meet existing and future flow conditions at the plant, and therefore should not be viewed as a "growth inducing project". Moreover, there is a regulatory directive to expand the disposal capacity. The transfer of agricultural land to disposal lands will result in some lost agricultural production; however, the lost agricultural production may be offset by improving area-wide groundwater elevations through incidental percolation.

Cost. The estimated total project cost for the pipeline and land for the three ponds is approximately $37 million (assuming no costs for mitigation). This cost includes approximately $13.6 million for pipelines; $2.4 million for land; $9.6 million for pond construction, and; engineering costs and contingency allowance.

Based discussion the RCWD Board of Directors, it is anticipated that RCWD could share in the costs up to approximately $0.2 - 0.24 million/year. This equates to an assessment of roughly $4 to $5/acre. Total costs to the City would be approximately $3.7 million/yr, or approximately $67/acre-foot. These costs represent the expected maximum project costs. It may be possible to reduce total costs to the City to approximately $25/acre-foot. Cost savings could be realized by reduced land requirements for percolation (e.g., 4 in/day percolation rate), reduced costs for pipeline construction, or economy of scale/shared costs for a joint project with other irrigation districts (ref. J. Boren RCWD September 1996).

Mid-Valley Water District

In January 1995, Mid-Valley Water District (MVWD) submitted a proposal to take delivery of secondary undisinfected effluent from the RWRF. Meetings with the MVWD Board of Directors (Spring 1996) confirmed interest in negotiating an agreement with the City based on the original proposal, which includes year round delivery of 15 mgd through pipelines to disposal ponds. Turnouts from the pipelines would also be provided for direct irrigation.

Technical Elements. The MVWD proposal for approximately 15 mgd of RWRF effluent includes approximately 79,000 feet of pipe for delivery to a 300 acre reservoir. The pipe sizes required range from 36 to 42 inches. Review of the regional topography indicates that the effluent can be delivered to the ponds by gravity flow.

Institutional Elements. The proposed locations of the off-site ponds is approximately fifteen miles west- southwest of the RWRF, as shown in Figure 5. The proposed sites were identified by the MVWD as potentially available for pond construction.

Conversations with MVWD indicate willingness to proceed with the proposal. The farmers within the district consider this to be a beneficial project because of the potential for direct use as well as the incidental percolation. MVWD currently has no surface water rights and relies solely on groundwater pumping.

Potential institutional issues include FID mitigation and the transfer of agricultural land to disposal ponds, as described above.

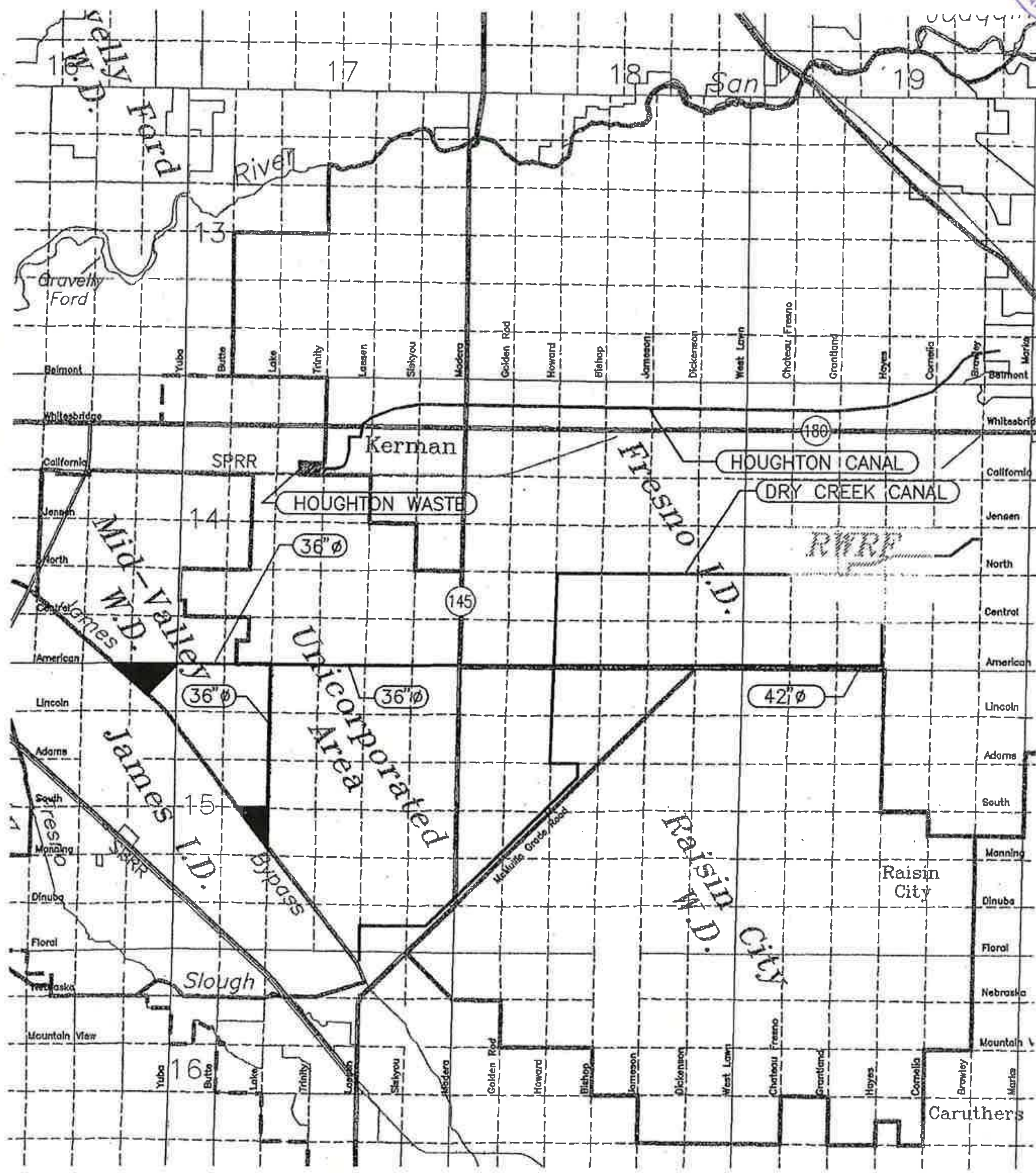
Cost. The estimated total project cost is $28.1 million (assuming no mitigation). This cost includes $15.8 million for pipeline; $0.6 million for land; $3.0 million for pond construction, and; cost allowances for engineering and contingencies.

Based discussion the MVWD Board of Directors, MVWD could share in the costs up to approximately $0.05 to 0.06 million/year. This equates to an assessment of roughly $4 to $5 per acre. Total costs to the City would be approximately $2.6 million/yr, or approximately $152/acre-foot. As noted above for RCWD, this estimate represents the expected maximum cost to the City. It may be possible to reduce total costs to the city to approximately $50/acre-foot (assuming no economy of scale or shared costs for a joint project with other irrigation districts). Like RCWD, total project costs could also be reduced if less land is required for percolation or if pipeline costs can be reduced.

James and Tranquillity Irrigation Districts

James Irrigation District (JID) and Tranquillity Irrigation District (TID) are located approximately 15 miles south-southwest of the RWRF. Both districts receive surface water through contracts with the U.S. Bureau of Reclamation. JID currently operates groundwater extraction wells along McMullen Grade Road (on the border of RCWD and an unincorporated area) and pumps water into Dry Creek Canal. The water flows from Dry Creek to the James Bypass which distributes water throughout JID. JID's canals are interconnected with TIDs distribution system. The two districts have the ability to share water resources and have expressed willingness to enter in a joint venture.

JID is currently coordinating a recharge project with the Kings River Conservation District (KRCD) to build 80 acres of basins in the southwest corner of the unincorporated area (in the northwest corner of Section 35, T15S, R17E). Seasonal flood flow from the Kings River would be diverted to these ponds, approximately one out of every four years. The original intent was that the basins would be farmed the other four years, however, JID is considering a revision of the plan to make the basins a joint project between JID and TID and the City of Fresno, so that secondary



LEGEND:

DISTRIBUTION TO MVWD

RWRF-PLANT BOUNDARIES

ALL SHADED AREAS-POTENTIAL POND LOCATIONS

Figure 5
PROPOSED MVWD REUSE/DISPOSAL PROJECT
Fresno-Clovis Wastewater Facilities Master Plan Report

undisinfected effluent could be diverted to the basins during the non-flood years. A separate project for disposal of effluent only could also be developed.

Technical Elements. JID has indicated interest in extracting 35,000 ac-ft/yr of effluent and TID indicated interest in extracting 14,000 ac-ft/yr of effluent. These annual extractions rates are roughly equivalent to 45 mgd average annual flow. The districts would be extracting at a greater rate primarily during the summer months, but flow to the basins from the RWRF would remain relatively steady year round at about 45 mgd.

Between 430 and 1,670 acres of ponds would be required for reuse/disposal of 45 mgd of effluent flow, based on percolation rates of 4 in/day and 1 in/day respectively. The soils in the area are sandy so a minimum percolation rate of 2 in/day could be obtained with proper management with regular rehabilitation. For this percolation rate a minimum of 830 acres of ponds would be required. Assuming additional land required for roads and berms is equivalent to 15 percent of the pond acreage, a total of approximately 1,000 acres is needed (approximately equal to one and a half square miles).

Delivery to the basins by gravity would require approximately 79,000 feet of pipeline ranging from 60 to 66-inch diameter. This would be confirmed in final design.

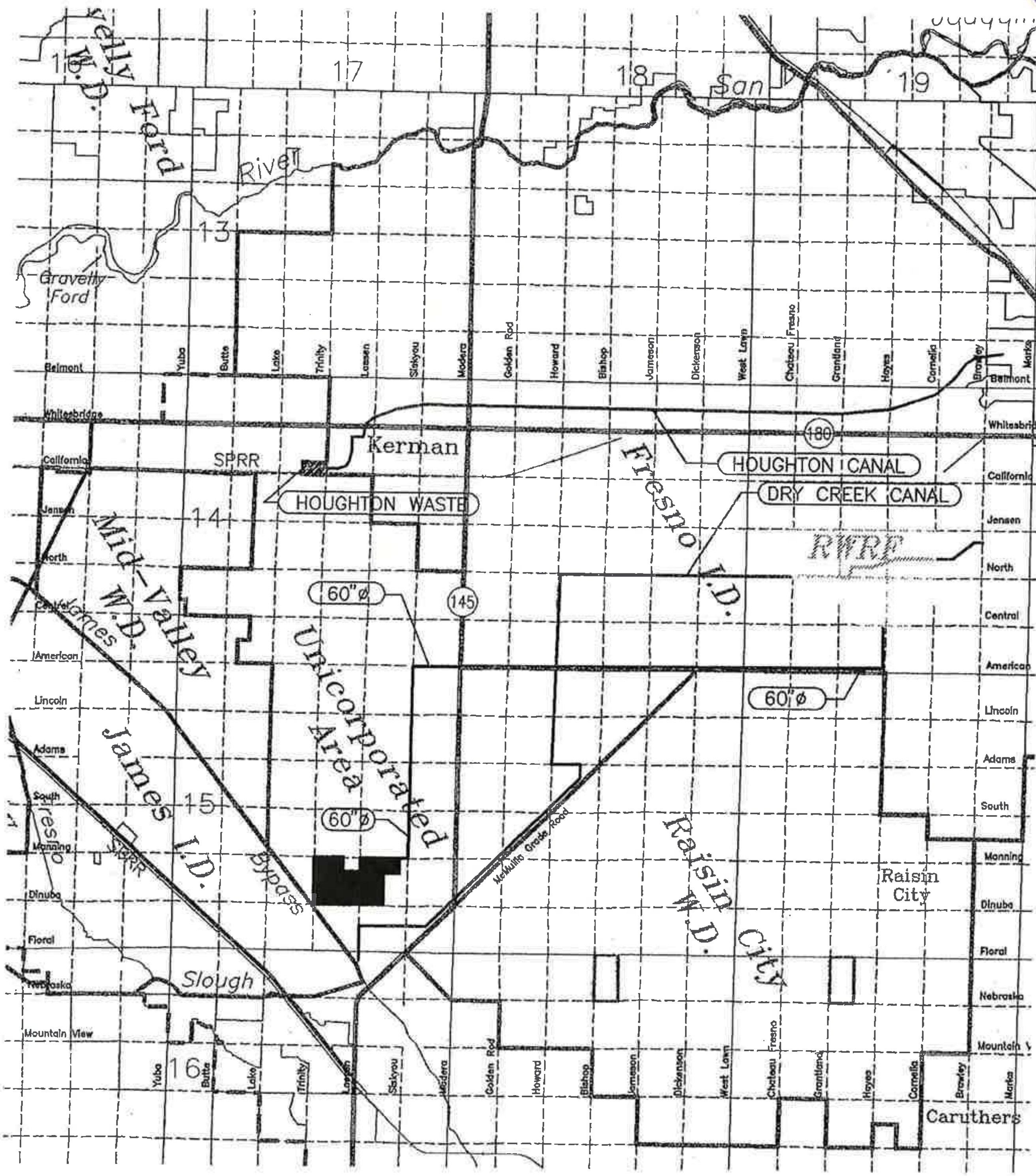
Institutional Elements. JID and TID have indicated a willingness to proceed with the proposal. The farmers within the district consider this to be a beneficial project because of the potential for improving the regional groundwater levels through incidental percolation. Groundwater in the unincorporated area has historically been overdrafted.

Acreage near and around the JID proposed recharge site are currently farmed primarily in seasonal alfalfa and grains. Proposed pond locations which are currently farmed with seasonal crops are shown in Figure 6. These locations are adjacent to the planned recharge basin, and are also in proximity to a possible pipeline route. The current owners have not yet been approached to determine their willingness to sell.

Potential institutional issues include FID mitigation and the transfer of agricultural land to disposal ponds, as described above.

Cost. The estimated total project cost is $51.8 million. This cost includes $23.7 million for pipeline; $2 million for land; $10 million for pond construction, and; cost allowances for engineering and contingencies.

JID/TID have indicated a willingness to share in costs for this project. Assuming a share in the costs up to approximately $0.15 to 0.18 million/year (assessment of roughly $4 to $5 per acre),



LEGEND:

DISTRIBUTION TO JID/TID RWRF–PLANT BOUNDARIES

ALL SHADED AREAS–POTENTIAL POND LOCATIONS

Figure 6
PROPOSED JID/TID REUSE/DISPOSAL PROJECT
Fresno-Clovis Wastewater Facilities Master Plan Report

the total costs to the City would be approximately $4.8 million/yr, or approximately $91/acre-foot. As noted for RCWD and MVWD, this represents the expected maximum project cost.

APPENDIX E – SEWER FLOW CURVES FROM MONITORING DATA

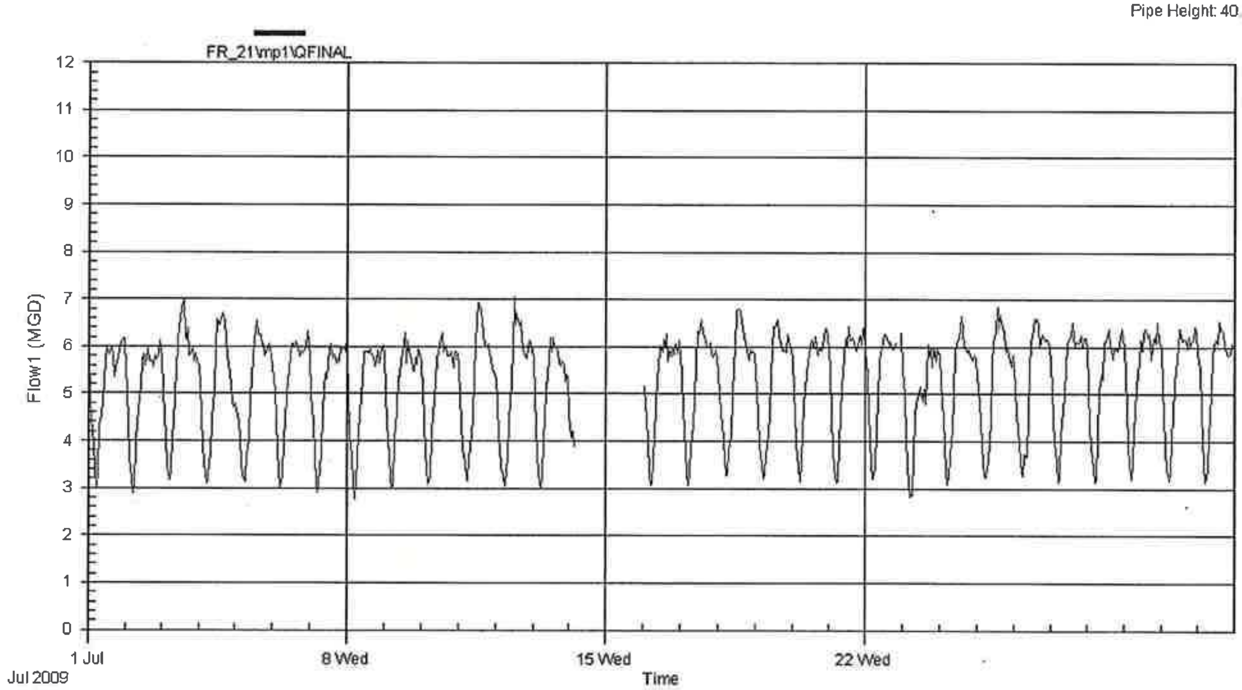
City of Fresno - SOUTHWEST QUADRANT, DOUNSTREAM OF ROEDING PARK
Sewer Monitoring Station No.21
N. Fruit Ave. 990 feet n/o W. Nielsen Ave.
Pipe Height: 40.5"
Pipe Dimensions: 40.5" x 41.5"

FR21\mp1\QFINAL (MGD - Total MG)

Date	Time	Min.	Time	Max.	Average	Total	Rain
07/01/09	6:00	2.892	23:00	6.319	5.168	5.168	0.00
07/02/09	5:45	2.756	23:00	6.366	5.050	5.050	0.00
07/03/09	6:00	3.061	14:00	7.272	5.391	5.391	0.00
07/04/09	5:30	2.880	14:45	6.984	5.137	5.137	0.00
07/05/09	6:15	3.046	14:00	6.746	5.127	5.127	0.00
07/06/09	5:45	2.843	22:45	6.793	5.209	5.209	0.00
07/07/09	5:45	2.865	23:00	6.365	5.106	5.106	0.00
07/08/09	5:45	2.653	12:30	6.290	5.110	5.110	0.00
07/09/09	6:15	2.834	13:15	6.453	5.127	5.127	0.00
07/10/09	4:45	2.747	13:45	6.520	5.196	5.196	0.00
07/11/09	5:30	2.985	13:00	7.141	5.234	5.234	0.00
07/12/09	6:45	2.890	12:00	7.456	5.235	5.235	0.00
07/13/09	5:30	2.703	11:00	6.607	5.098	5.098	0.00
07/14/09	3:15	3.797	0:15	4.707	4.225	0.616	0.00
07/15/09						–	0.00
07/16/09	6:15	2.863	23:15	6.421	5.237	4.965	0.00
07/17/09	5:15	2.889	13:45	6.749	5.312	5.312	0.00
07/18/09	6:15	3.025	12:45	7.102	5.350	5.350	0.00
07/19/09	6:15	3.009	14:30	7.007	5.268	5.268	0.00
07/20/09	5:15	2.875	23:15	6.769	5.364	5.364	0.00
07/21/09	5:30	3.053	22:45	6.647	5.378	5.378	0.00
07/22/09	5:15	3.087	23:15	6.650	5.355	4.797	0.00
07/23/09	6:00	2.723	16:45	6.168	4.867	4.867	0.00
07/24/09	5:45	2.961	14:30	6.831	5.295	5.295	0.00
07/25/09	6:15	3.041	13:45	7.090	5.293	5.293	0.00
07/26/09	6:15	3.163	13:00	7.006	5.353	5.353	0.00
07/27/09	5:00	3.007	14:15	6.628	5.368	5.368	0.00
07/28/09	6:15	3.036	14:00	6.784	5.339	5.339	0.00
07/29/09	5:15	3.057	22:00	6.700	5.428	5.428	0.00
07/30/09	6:00	3.058	22:45	6.673	5.396	5.396	0.00
07/31/09	5:15	2.860	14:45	6.689	5.378	5.378	0.00
ReportAvg		2.955		6.664	5.213		
ReportTotal						151.955	0.000

ADS Environmental Services

Pipe Height: 40.50



SCALE 1 : 9,958

1,000 2,000 3,000
FEET

N

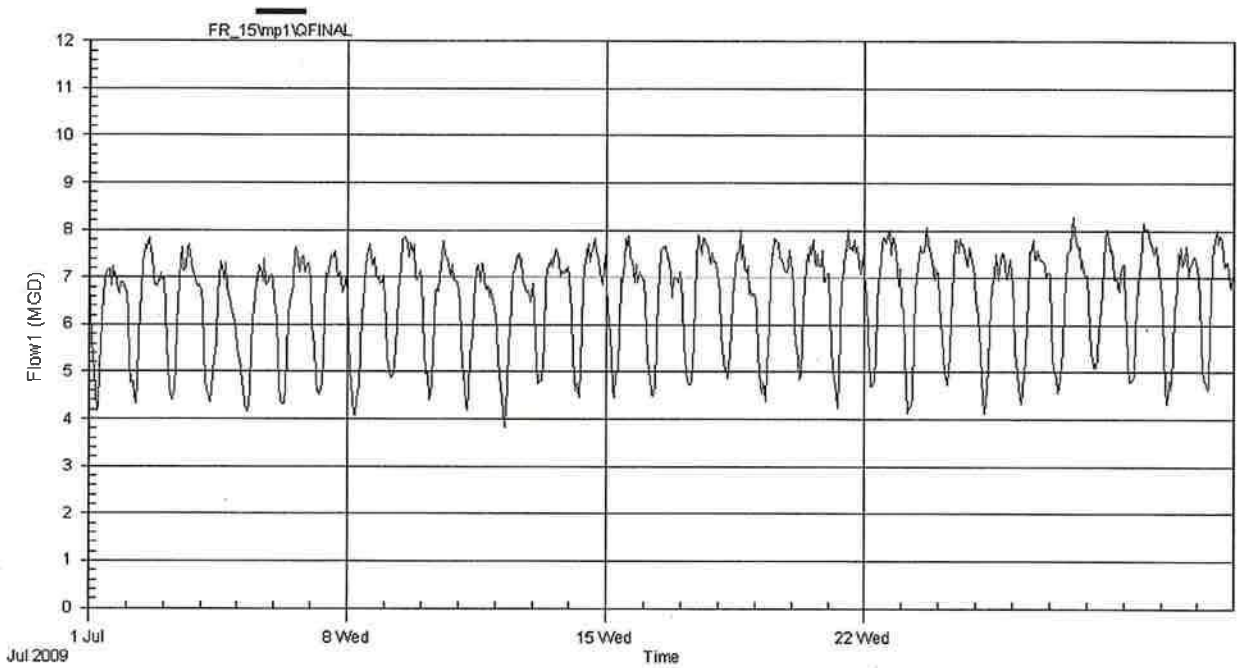
City of Fresno - SOUTHWEST QUADRANT - UPSTREAM OF FRUIT & CHURCH SITE
Sewer Monitoring Station No.15
428 W. California Ave
Pipe Height: 48.00"
Pipe Dimensions: 48.00" x 48.00"

FR_15\mp1\QFINAL (MGD - Total MG)

Date	Time	Min.	Time	Max.	Average	Total	Rain
07/01/09	5:45	3.877	13:00	7.438	6.331	6.331	0.00
07/02/09	6:00	4.066	14:45	7.998	6.468	6.468	0.00
07/03/09	5:15	4.130	12:45	7.915	6.425	6.425	0.00
07/04/09	7:45	4.081	14:15	7.610	6.010	6.010	0.00
07/05/09	7:00	4.057	17:00	7.663	6.048	6.048	0.00
07/06/09	6:15	4.039	14:30	7.965	6.372	6.372	0.00
07/07/09	6:45	4.283	16:30	8.016	6.390	6.390	0.00
07/08/09	5:30	3.750	14:00	7.842	6.284	6.284	0.00
07/09/09	6:00	4.768	14:15	8.041	6.636	6.636	0.00
07/10/09	5:15	4.241	14:30	7.817	6.446	6.446	0.00
07/11/09	6:30	4.115	16:30	7.637	6.214	6.214	0.00
07/12/09	6:30	3.540	14:30	7.759	6.132	6.132	0.00
07/13/09	4:30	4.397	14:45	7.834	6.586	6.586	0.00
07/14/09	6:15	4.219	16:00	7.991	6.619	6.619	0.00
07/15/09	5:15	4.410	14:00	8.296	6.588	6.588	0.00
07/16/09	5:30	4.325	15:15	8.084	6.483	6.483	0.00
07/17/09	5:45	4.646	15:15	8.337	6.706	6.706	0.00
07/18/09	6:00	4.442	14:00	8.113	6.569	6.569	0.00
07/19/09	7:15	4.145	15:30	8.154	6.517	6.517	0.00
07/20/09	5:30	4.424	17:45	8.048	6.787	6.787	0.00
07/21/09	6:00	4.087	13:15	8.206	6.696	6.696	0.00
07/22/09	6:00	4.272	15:30	8.410	6.829	6.829	0.00
07/23/09	4:15	3.816	16:30	8.270	6.530	6.530	0.00
07/24/09	5:30	4.469	14:00	8.012	6.761	6.761	0.00
07/25/09	6:30	3.900	13:30	7.814	6.384	6.384	0.00
07/26/09	5:45	4.142	13:15	8.114	6.491	6.491	0.00
07/27/09	5:30	4.159	16:00	8.469	6.669	6.669	0.00
07/28/09	6:45	4.687	12:00	8.094	6.671	6.671	0.00
07/29/09	7:00	4.198	13:30	8.666	6.809	6.809	0.00
07/30/09	4:45	3.923	11:45	7.929	6.500	6.500	0.00
07/31/09	6:30	4.418	16:00	8.254	6.693	6.693	0.00
ReportAvg		4.194		8.026	6.505		
ReportTotal						201.644	0.000

ADS Environmental Services

Pipe Height: 48.00



Sewer

PublicWorks

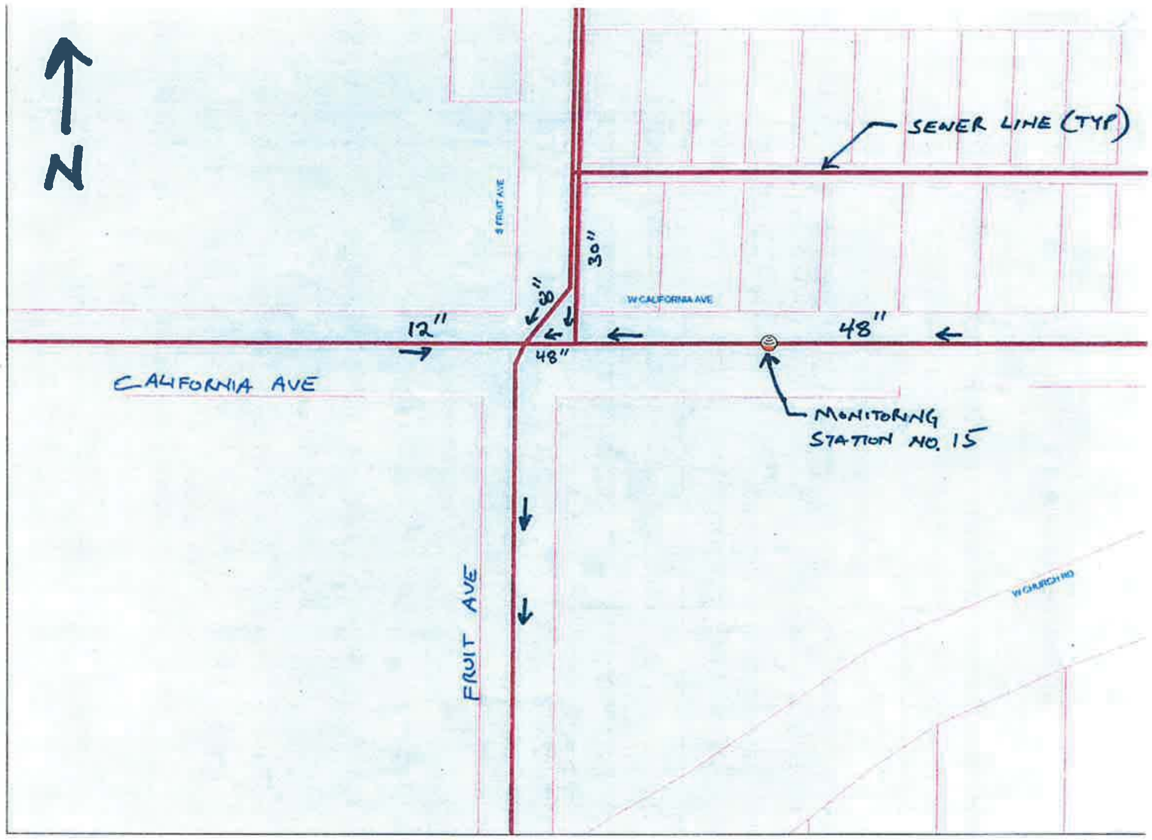
Public Utilities Easments

Parcels

Parcels

City Limits

Fresno County



City of Fresno - NORTHWEST QUADRANT
Sewer Monitoring Station No.2
Intersection of Herndon and Blythe Ave.
Pipe Height: 45.25"
Pipe Dimensions: 44.75" X 45.13"

FR_02\mp1\QFINAL (MGD - Total MG)

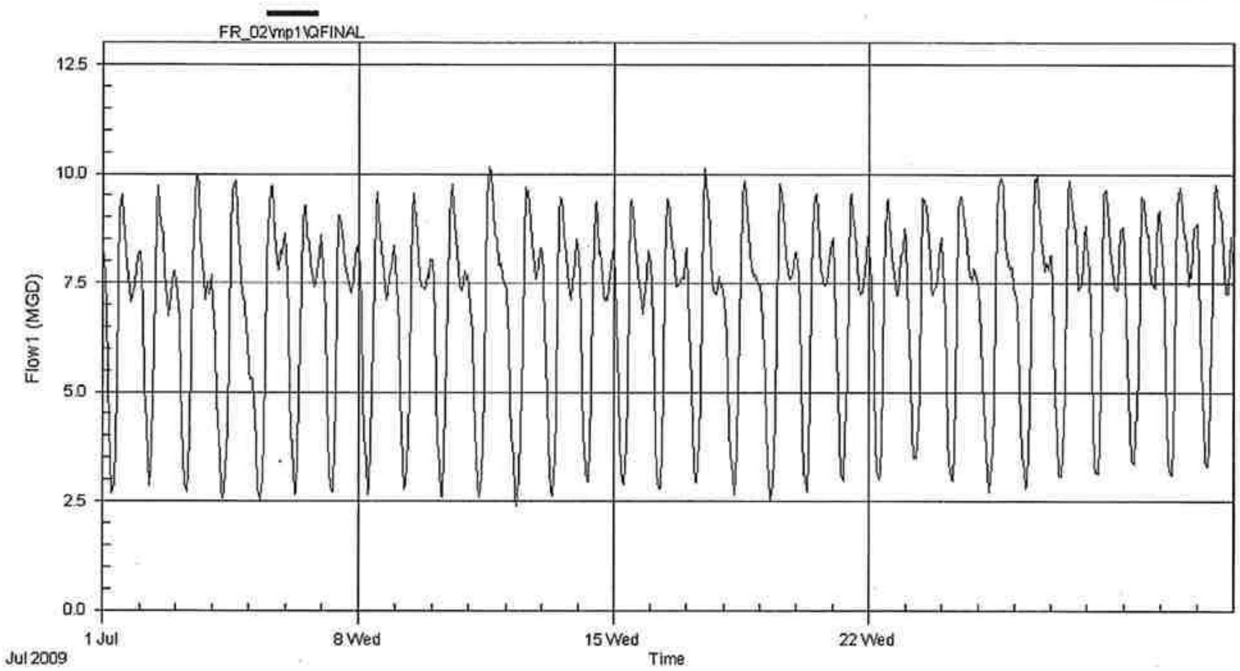
Date	Time	Min.	Time	Max.	Average	Total	Rain
07/01/09	6:45	2.525	12:15	9.821	6.824	6.824	0.00
07/02/09	6:30	2.683	12:15	9.909	6.787	6.787	0.00
07/03/09	7:15	2.537	15:00	10.130	6.727	6.727	0.00
07/04/09	7:30	2.473	14:45	10.120	6.352	6.352	0.00
07/05/09	7:15	2.473	15:45	10.080	6.391	6.391	0.00
07/06/09	6:30	2.511	13:15	9.578	6.816	6.816	0.00
07/07/09	7:00	2.427	12:00	9.557	6.726	6.726	0.00
07/08/09	7:15	2.571	12:15	9.788	6.816	6.816	0.00
07/09/09	6:45	2.596	12:30	9.740	6.734	6.734	0.00
07/10/09	6:45	2.474	13:00	10.140	6.778	6.778	0.00
07/11/09	7:15	2.435	13:30	10.330	6.791	6.791	0.00
07/12/09	7:30	2.249	13:45	9.914	6.501	6.501	0.00
07/13/09	7:15	2.332	12:45	9.878	6.757	6.757	0.00
07/14/09	7:15	2.742	11:15	9.545	6.719	6.719	0.00
07/15/09	7:15	2.796	12:15	9.727	6.685	6.685	0.00
07/16/09	6:45	2.595	11:45	9.759	6.763	6.763	0.00
07/17/09	6:45	2.815	12:45	10.220	6.829	6.829	0.00
07/18/09	7:15	2.540	14:00	10.100	6.671	6.671	0.00
07/19/09	7:45	2.361	13:45	9.992	6.575	6.575	0.00
07/20/09	7:15	2.598	11:30	9.954	6.874	6.874	0.00
07/21/09	7:15	2.820	11:30	9.716	6.868	6.868	0.00
07/22/09	6:00	2.884	11:30	9.777	6.862	6.862	0.00
07/23/09	7:00	3.230	11:45	9.599	6.938	6.938	0.00
07/24/09	7:00	2.921	12:15	9.762	6.906	6.906	0.00
07/25/09	7:30	2.600	16:15	10.140	6.780	6.780	0.00
07/26/09	7:45	2.655	14:00	10.090	6.740	6.740	0.00
07/27/09	6:15	2.873	11:45	9.915	6.993	6.993	0.00
07/28/09	7:00	2.945	12:00	9.764	7.003	7.003	0.00
07/29/09	5:30	3.221	12:00	9.689	7.122	7.122	0.00
07/30/09	7:45	3.037	12:00	9.749	7.143	7.143	0.00
07/31/09	6:00	3.114	12:45	9.949	7.085	7.085	0.00
ReportAvg		2.678		9.885	6.792		
ReportTotal						210.556	0.000

Pipe Dimensions: 44.75" X 45.13"

ADS Environmental Services

Intersection of Herndon and Blythe Ave.

Fresno, CA
Pipe Height: 44.75



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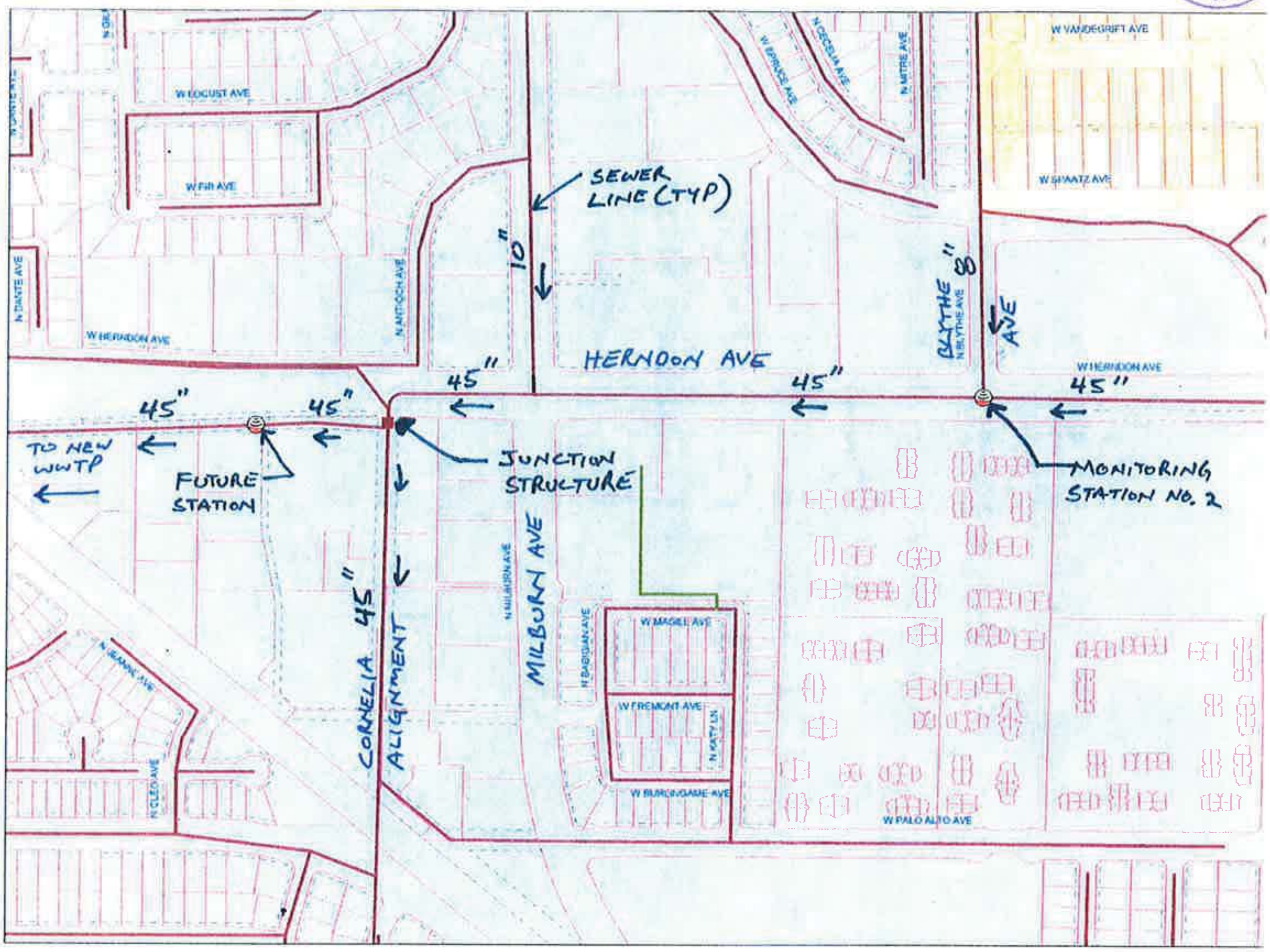


SCALE 1 : 5,532

500 1,000 1,500
FEET

N

City of Fresno - SOUTHEAST QUADRANT
Sewer Monitoring Station No.9
Intersection of Chestnut and Madison
Pipe Height: 38.88"
Pipe Dimensions: 38.88" X 38.88"

FR_09\mp1\QFINAL (MGD - Total MG)

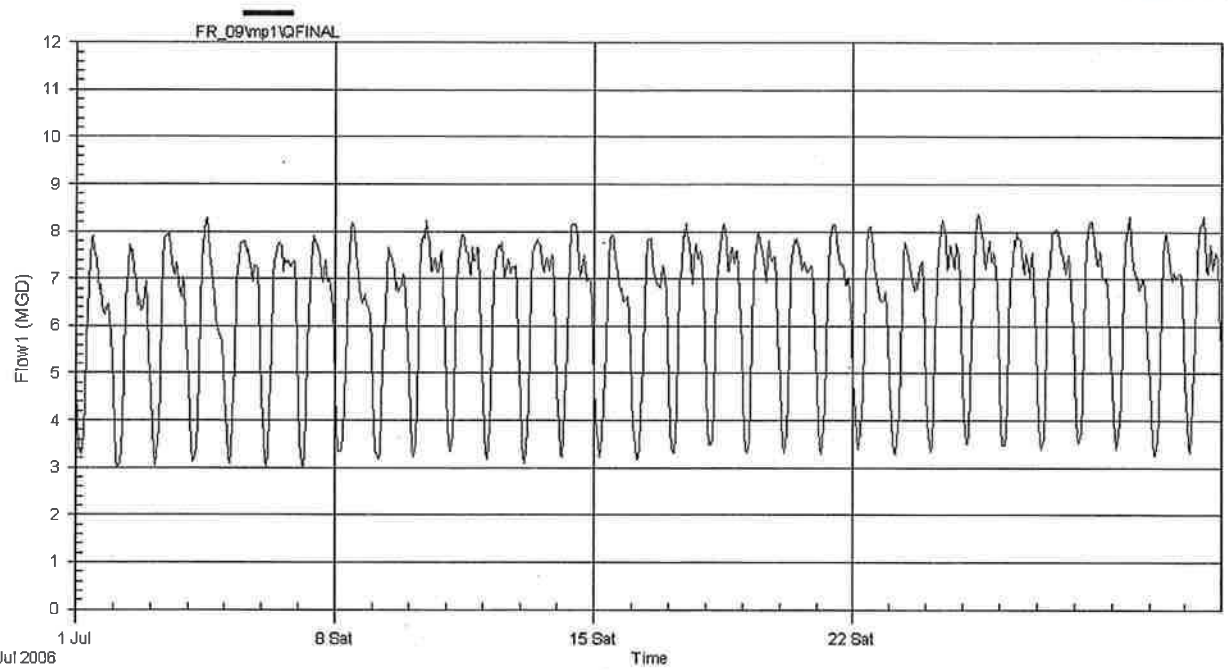
Date	Time	Min.	Time	Max.	Average	Total	Rain
07/01/06	3:30	3.096	11:30	8.063	5.911	5.911	0.00
07/02/06	2:45	2.817	10:30	7.815	5.776	5.776	0.00
07/03/06	3:00	2.969	12:00	8.150	6.177	6.177	0.00
07/04/06	3:30	2.915	12:00	8.574	5.845	5.845	0.00
07/05/06	2:45	3.002	11:15	7.969	6.252	6.252	0.00
07/06/06	3:00	2.938	13:00	8.050	6.280	6.280	0.00
07/07/06	3:00	2.851	10:00	8.009	6.197	6.197	0.00
07/08/06	2:45	3.212	11:00	8.539	6.033	6.033	0.00
07/09/06	5:00	3.043	10:00	7.781	5.923	5.923	0.00
07/10/06	3:30	3.120	11:45	8.327	6.448	6.448	0.00
07/11/06	3:45	3.287	11:00	8.030	6.439	6.439	0.00
07/12/06	3:15	3.126	12:30	7.927	6.298	6.298	0.00
07/13/06	3:15	3.028	11:15	8.000	6.335	6.335	0.00
07/14/06	3:15	3.137	10:45	8.407	6.352	6.352	0.00
07/15/06	3:15	3.193	11:45	8.125	5.981	5.981	0.00
07/16/06	3:15	3.144	10:15	8.035	6.018	6.018	0.00
07/17/06	3:15	3.272	11:00	8.312	6.452	6.452	0.00
07/18/06	3:15	3.379	12:30	8.281	6.446	6.446	0.00
07/19/06	3:15	3.160	10:00	8.186	6.419	6.419	0.00
07/20/06	3:30	3.257	9:15	8.000	6.398	6.398	0.00
07/21/06	3:00	3.142	12:00	8.406	6.336	6.336	0.00
07/22/06	4:00	3.347	11:00	8.209	6.079	6.079	0.00
07/23/06	4:15	3.194	10:15	7.998	6.039	6.039	0.00
07/24/06	4:00	3.195	11:00	8.364	6.495	6.495	0.00
07/25/06	3:00	3.363	10:15	8.459	6.593	6.593	0.00
07/26/06	3:15	3.378	11:45	8.150	6.446	6.446	0.00
07/27/06	3:15	3.241	11:00	8.330	6.498	6.498	0.00
07/28/06	3:15	3.467	10:30	8.373	6.455	6.455	0.00
07/29/06	3:30	3.313	11:00	8.449	6.143	6.143	0.00
07/30/06	3:45	3.188	11:30	8.111	6.083	6.083	0.00
07/31/06	3:30	3.119	12:30	8.619	6.477	6.477	0.00
ReportAvg		3.158		8.195	6.246		
ReportTotal						193.624	0.00

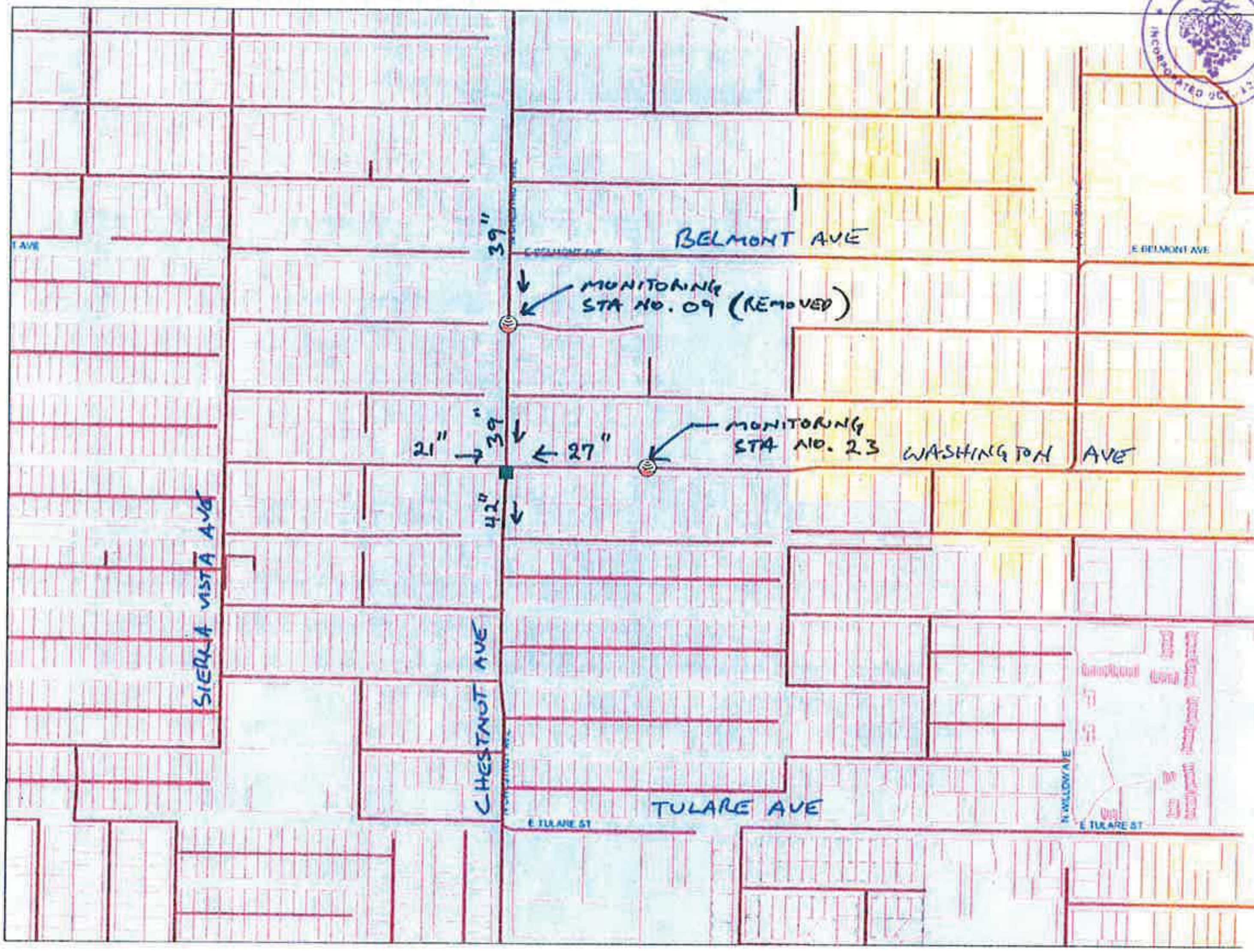
Pipe Dimensions: 38.88" X 38.88"

ADS Environmental Services

Intersection of Chestnut and Madison

Fresno, CA
Pipe Height: 38.88





SCALE 1 : 8,843

500 1,000 1,500
FEET

N

APPENDIX F – BASIS OF COST MEMORANDUM

BASIS OF COST

1.0 PURPOSE

The purpose of this memorandum is to describe the methodology and assumptions used in developing the Recycled Water Master Plan (RWMP) basis of cost estimate. Cost estimates developed for the RWMP were planning level estimates and utilized for capital planning of future recycled water projects and for estimating the potential impact of those projects on sewer rates.

2.0 PROJECT DESCRIPTION

The RWMP project alternatives consist of water recycling facilities (treatment modifications at the RWRF and/or satellite treatment facilities), and a recycled water distribution system to serve large and small users in the four quadrants of the City (SW, NW, NE, and SE). The project is located within the Sphere of Influence (SOI) of the City of Fresno, including "county islands" and other incorporated areas of Fresno County. The project is anticipated to be constructed in phases and will include modular treatment facilities or satellite treatment plants with an initial total capacity of 8 MGD, expandable to 32 MGD; approximately 500,000 lineal feet of 8-inch through 60-inch pipelines; six booster pump stations; four distribution system storage tanks of 1.0 to 1.5 million gallons each; and customer turnouts.

3.0 METHODOLOGY

The level of accuracy that can be expected for any cost estimate is directly proportional to the level of engineering effort completed. For the RWMP quantity take-offs were performed based on conceptual site plans for the treatment plant alternatives and for distribution system alignment corridors. Construction cost estimates were developed using historical costs from recent Carollo and BCF projects, proprietary cost curves, and vendor quoted information. Past construction cost estimates were adjusted to January 2010 costs for Fresno California using the ENR Construction Cost Index (CCI). The current "location factor" for the City of Fresno is 1.072.

Cost estimates included for the RWMP included:

- Capital cost (costs for construction of facilities)
- Project costs (capital costs plus contingency for engineering, administration and legal associated with implementation of the project)
- O&M costs (annual operating and maintenance costs of proposed projects)

Capital costs included a design contingency appropriate for this planning level of detail and have an accuracy of -30 percent to +50 percent (AACE International Recommended Practices and Standards, No. 18R-97). Because there was more uncertainty associated with the processes and facilities of the treatment alternatives, a 30 percent design contingency was given to the treatment facilities estimates. A 25 percent design contingency was given to the distribution system facilities because more information was available about the cost of pipeline construction in main corridors throughout the City. Costs are in January 2010 dollars (ENR 8660).

Project costs included a placeholder contingency of 20 percent of the capital costs to account for project implementation costs such as design, environmental review, and permitting, legal, administration and construction management.

The following table summarizes the direct cost multipliers used to develop the RWMP cost estimates.

Table 1 Cost Estimate Direct Cost Multipliers
Recycled Water Master Plan
City of Fresno

Multiplier	Percent
Construction costs adjusted to 2010	ENR 8660
Location factor for Fresno California	1.072
Planning level design contingency for treatment facilities	30
Planning level design contingency for distribution system facilities	25
Engineering, Legal and Administration	20

O&M costs were estimated based on historical unit O&M costs of the City's wastewater system operation including costs for power, labor, chemicals, and replacement materials. Table 2 summarizes the unit costs used to develop the recycled water system annual O&M costs.

CITY OF FRESNO INCORPORATED OCT. 12, 1885

Table 2	Estimated O&M Unit Costs Recycled Water Master Plan City of Fresno
Power	$0.20/kWh
Labor	$50/hr
Chemicals	
• Citric Acid	$0.50 lb
• Sodium Hypochlorite	$0.12/lb
• Alum	$0.10/lb
• Polymer	$1.60/lb
Replacement Materials	5%/yr

4.0 ASSUMPTIONS

4.1 Treatment Plants

Treatment plant cost estimates were developed for each of the treatment alternatives: Alternative 1, delivery of recycled water from the RWRF, and Alternative 2, delivery of recycled water from satellite treatment plants located in the vicinity of users in each quadrant of the City. In addition, costs were developed for expanding treatment at the North Fresno WRF, which is a project that is independent of the main treatment alternative selected. The following assumptions were used to develop facilities costs for construction of recycled water facilities at the RWRF.

1. Media filtration, UV disinfection, and chlorine or chloramines for distribution system disinfection.
2. Secondary processes already exist with A-side and B-side secondary treatment trains.
3. Nitrification/denitrification step was not included because it is possible that future NdN required for potential GRRPs could be achieved though operational changes at the RWRF.
4. Media filtration and disinfection costs were estimated based on recent bid tabs and vendor quotes.

The following assumptions were used to develop facilities costs for construction of satellite recycled water facilities:

1. The total capacity of satellite treatment plants is limited by sewer flows in outlying areas (fewer users can be served from SWRFs).

2. Full primary, secondary and tertiary treatment processes are required.
3. Nitrification/denitrification step was included to meet requirements of future GRRPs.
4. Solids from SWRFs would be sent to the RWRF for treatment.
5. A range of treatment alternatives were considered:
   a. Activated sludge process followed by media filtration and UV (lower cost).
   b. Membrane bioreactor (MBR) followed by ozone or UV (higher cost)
6. Satellite plants would be located on City owned property. Footprint for AS process was estimated to be between 6 to 8 acres. Footprint for MBR process was estimated to be about two acres.
7. MBR costs were estimated based on cost curves developed from bid tabs (see Figure 1 below).
8. Costs for AS process with NdN were scared from SEGA 2006 Satellite study update.

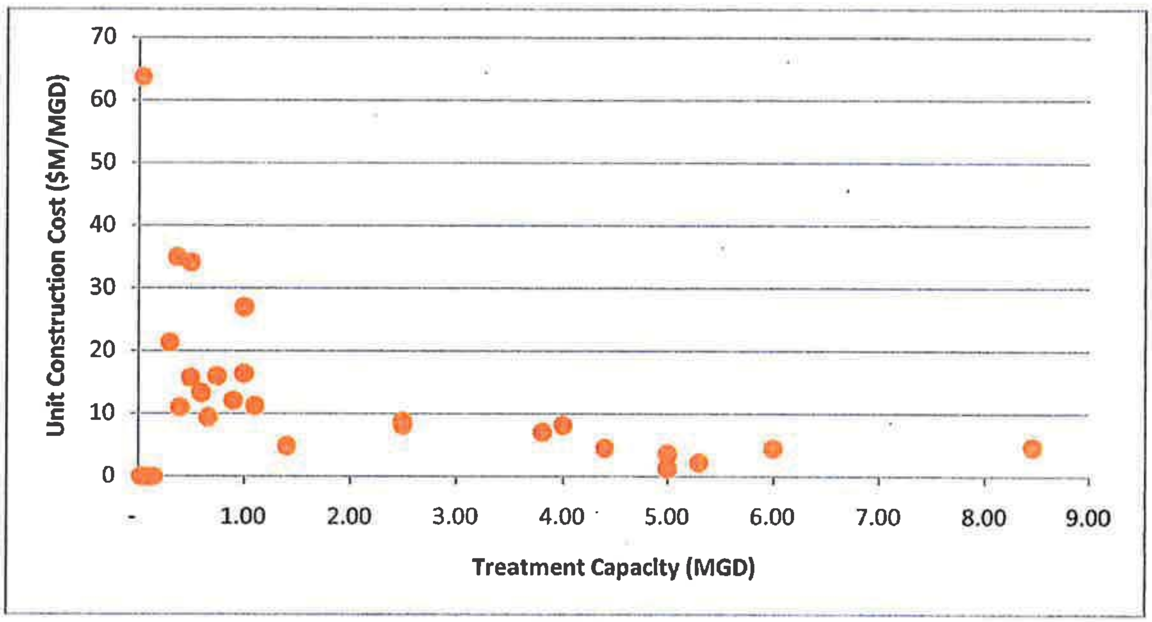


FIGURE 1
MBR SATELLITE TREATMENT PLANT COST CURVE
RECYCLED WATER MASTER PLAN
CITY OF FRESNO

The following assumptions were used to develop facilities costs for expansion of the North Fresno WRF:

1. Capacity of the NRWRD would be expanded from 0.71 MGD average dry weather flow to 1.08 MGD average dry weather flow.
2. SBR process will be maintained.
3. Existing chlorination system will be replaced with UV or ozone.

4. Media filtration and disinfection costs were estimated based on recent bid tabs and vendor quotes.

4.2 Pipelines

The following assumptions were used to develop the distribution system pipeline cost estimates:

1. Open cut installation with a trench section reflecting vertical trench sections.
2. Identification of existing utilities and consideration of alternative construction methods in some locations to avoid interface of existing utilities.
3. Native material will be used as trench backfill.

5.0 COST ESTIMATES

The cost estimates herein are based on our perception of current conditions in the project location. The estimates reflect our professional opinion of accurate planning level costs at this time and will be subject to change as the project matures in the future design phases.

Estimates of facilities were grouped into two alternatives (of which the second alternative has two options) that included:

- Alternative 1 – Treatment at RWRF
- Alternative 2 – Treatment at SWRF utilizing MBR with Ozone and UV (high costs)
- Alternative 3 – Treatment at SWRF utilizing Activated Sludge with UV (low costs)

From these alternatives, total capital costs were calculated for the distribution system (including pump stations), treatment plant, and storage. Capital costs were then "normalized" to $/MGD costs for comparison of alternatives. Shown in Table 3 is a summary of the cost estimates for alternatives identified in the Recycled Water Master Plan.

Table 3 Summary of Construction Cost Estimates for the Master Plan Project Alternatives
Recycled Water Master Plan
City of Fresno

Alternative	Length (mi)	Delivery (AFY)	Distr. Sys. Costs ($M)	Treatment capacity	Treatment Costs ($M) (1)	$/gallon - Treatment	Storage volume (MG) (2,3)	Storage Costs ($M)	$/gallon - Storage	Total Capital Costs ($M)	$/MGD
SW-1	36.28	4,125	48.7	5.5	12	2.15	0/8.1	7	0.86	68	12.3
NW-1	28.1	1,877	49.8	5.3	9	1.70	0/6.9	6	0.87	65	12.2
NE-1	16.17	2,720	39.6	4.8	11	2.29	0/6.1	5	0.82	56	11.6
SE-1	7.35	995	16.6	2.8	6	2.14	0/5.1	4	0.78	27	9.5
total	87.9	9,717	155	18.4	38			22		215	

Alternative 2 Costs (with MBR)

Alternative	Length (mi)	Delivery (AFY)	Distr. Sys. Costs ($M)	Treatment capacity	Treatment Costs ($M) (4)	$/gallon - Treatment	Storage volume (MG) (2)	Storage Costs ($M)	$/gallon - Storage	Total Capital Costs ($M)	$/MGD
SW-2 (5)	32.46	4,139	36.3	5.5	50	9.09	0.4/4.1	7	1.56	93	17.0
NW-2	21.5	1,709	24.8	4.7	51	10.85	0.7/1.2	3	1.58	79	16.8
NE-2 (6)	1.75	508	4.3	1.08	5	4.63	0/0	0	-	9	8.6
NE-3	3	4,900	6.1	4	47	11.75	2-Jan	4	2.11	57	14.3
SE-2	9.09	951	5.4	3	36	12.00	0/2.6	4	1.54	45	15.1
total	67.8	12,207	76.9	18.28	189			18		284	

Alternative 2 Costs (with activated sludge)

Alternative	Length (mi)	Delivery (AFY)	Distr. Sys. Costs ($M)	Treatment capacity	Treatment Costs ($M) (7)	$/gallon - Treatment	Storage volume (MG) (2)	Storage Costs ($M)	$/gallon - Storage	Total Capital Costs ($M)	$/MGD
SW-2 (5)	32.46	4,139	36.3	5.5	37	6.73	0.4/4.1	7	1.56	80	14.6
NW-2	21.5	1,709	24.8	4.7	35	7.45	0.7/1.2	3	1.58	63	13.4
NE-2 (8)	1.75	508	4.3	1.08	5	4.63	0/0	0	-	9	8.6
SE-2	9.09	951	5.4	3	26	8.67	0/2.6	4	1.54	35	11.8
total	64.8	7,307	70.8	14.28	103			14		188	

(1) Alternative 1 treatment costs assume media filtration + UV; include feed pump station
(2) Influent storage/effluent storage
(3) Half of effluent storage provided at RWRF in existing basins
(4) Alternative 2 treatment costs assume MBR + UV; include feed pump station
(5) Partially served from the RWRF and partially served from a new SRWF
(6) Expansion of North Fresno WRF to 1.08 mgd w/ SBR and UV
(7) Alternative 2 treatment costs assume Activated Sludge (with NdN) + UV (include feed pump station)
(8) Includes pipeline from RWRF and expansion of North Fresno WRF to 1.08 mgd w/ SBR and UV

pw:\Documents\Client\CA\Fresno\8230A00\Data\Task 08\Cost Summary.xlsx

APPENDIX G – BENEFIT – COST ANALYSIS

City of Fresno Recycled Water System Expansion Economic Analysis

Prepared by:

Stratus Consulting Inc.
PO Box 4059
Boulder, CO 80306-4059
303-381-8000

Under subcontract to:

Carollo Engineers

Contact:

James L. Henderson

July 30, 2010

City of Fresno Recycled Water System Expansion Economic Analysis

This chapter contains an economic analysis of the expansion of the City of Fresno's (the City's) recycled water system, as detailed in the City of Fresno Recycled Water Master Plan, and explores the potential types of environmental, social, and economic benefits that may accrue to the City, agricultural water users in the Fresno Irrigation District (FID), urban irrigation users in Fresno, and the general public.

The analysis starts with an introduction to economic analysis of recycled water projects, and in particular, the Triple Bottom Line (TBL) form of the benefit-cost analysis (BCA). This is followed by a short project summary, followed by a discussion of defining the baseline for the analysis and other assumptions made to set up the analysis. Project costs are then summarized, followed by a detailed discussion of project benefits. After discussion of additional social costs, a section containing sensitivity analysis is included at the end of the analysis. The effect of alternate assumptions regarding the appropriate discount rate and other key assumptions is explored in that section. This is followed by a summary of analysis conclusions.

1. Introduction

Although recycled water is often more expensive than some traditional options for providing water, recycled water provides some benefits that these other alternatives do not. Therefore, it is important to go beyond cost comparisons by also considering how the benefits of reuse compare to its cost. To do this, a clear distinction must be made between financial and economic analysis:

1. A financial analysis of water reuse is based solely on the cash flows of expenses and revenues in and out of the agency

2. An economic analysis provides a benefit/cost perspective by considering a broader view of the value of the reclaimed water.

By focusing solely on revenues, a financial analysis provides an overly narrow perspective of the "value" of the waters provided. For example, a financial analysis does not include benefits to the environment and social costs avoided when reuse enables a community to forgo developing alternative water supply options. Therefore, it is important to consider the benefits and costs of each option, rather than considering only costs.

Water and wastewater programs are typically evaluated using cost-effectiveness (C-E) analysis. Using a C-E analysis, the least expensive alternative is identified for obtaining a specific outcome. This assumes that the level of benefits from the various options is identical and the only important distinction is cost. In contrast, the BCA looks at relevant options and explores how the benefits and costs compare to each other, providing a method of evaluating the full social and environmental impacts of the project. The BCA approach helps identify if an objective is worth pursuing and/or which options provide the greatest net benefit to society. The TBL approach used below is a variant of the BCA approach.

The TBL is a planning tool that helps agencies track their progress toward promoting sustainability and is a streamlined version of a social BCA. Benefits and costs identified in the economic analysis are categorized into one of three bottom lines, which consist of:

1. A **financial** bottom line that reflects the cash flow accounting stance of the agency. In addition to any revenues from deliveries of water to new customers, this category often includes any financial benefits in terms of avoided costs and cost offsets due to avoiding other water resource management options. This might include avoiding development of an alternative water supply, or upgrading a wastewater treatment system to protect water quality.

2. The **social** impacts that reflect impacts on societal values. Social benefits take numerous forms, including adherence to a widely shared "environmental ethic" for recycling and the use of "green" approaches to local resource management challenges. This can also include increasing water supply reliability, thereby promoting societal security.

3. The **environmental** impacts that reflect effects on the natural environment. Environmental benefits can include many of the ecological services and environmental values enjoyed by the public. This can range from the value of wetland habitat and the potential wildlife values associated with it, to the avoided degradation of water quality in water bodies that receive wastewater.

2. Project Summary

The recommendation of the Recycled Water Master Plan is to expand distribution of recycled water from the Regional Wastewater Reclamation Facilities (RWRF). The City currently produces nearly 80,000 acre-feet of wastewater per year at the RWRF. The City and FID have an agreement whereby the City extracts 30,000 acre-feet per year (AFY) of percolated effluent for delivery to FID canals for use by local farmers. The majority of the remaining effluent is available for other beneficial uses.

The overall goal of expanded recycled water use in Fresno is to offset the City's potable water use, enhance the sustainability of the water supply, and lessen the burden on the wastewater treatment plant percolation ponds that are currently used for effluent discharge. Recommended reuse opportunities include urban reuse, agricultural reuse, and groundwater recharge. If all the users identified for urban reuse are served, the potential urban reuse opportunity for existing larger users is over 9,800 AFY. Serving existing and future residential and commercial users would result in additional use of over 4,300 AFY. The potential amount of agricultural reuse is approximately 24,200 AFY, including 4,200 AFY in expansion of undisinfected secondary delivery to farmers adjacent to the RWRF, and 20,000 AFY of expansion of pumping for delivery to FID over the next 30 years. However, agricultural reuse will not generate potable offsets for the City unless FID is willing to trade recycled water for surface water to augment the City's potable supply. This outcome is dependent on negotiations between FID and the City. And, groundwater recharge is recommended to the extent practical in the northwest, southwest and southeast quadrants of the City.

It was assumed for analysis purposes that the project would start in the year 2011, and span 30 years until 2040. Potential phasing of the project is divided into short term (0-3 years), medium term (4-10 years), and long term (greater than 10 years). This phasing was roughly interpreted for economic analysis purposes, and start years were assigned to specific parts of the project based on the master plan recommendations.

Table 1 summarizes the result of the BCA, including monetized and qualitative benefits, and the stakeholders that accrue those benefits. This table shows that monetized benefits for the project are estimated to outweigh the monetized costs when a 2.5% real discount rate is used. Net monetized benefits are estimated to be $9.4 million, and total net benefits are believed to be much higher than that when non-monetized benefits and costs are considered. The costs and benefits shown in this table are discussed in detail in Sections 4 and 5.

Table 1. BCA Overview – Using 2.5% Real Discount Rate (millions, 2010 USD)

Benefit or Cost Category	Present Value	Stakeholder Accruing Cost or Benefit
Costs – Total		
Capital and O&M costs	335.8	City of Fresno
Monetized Benefits		
Avoided alternative water supply costs	77.4	City of Fresno
Avoided water quality treatment costs	252.5	City of Fresno
Avoided agricultural water supply costs	1.7	Farmers
Avoided fertilizer costs for agriculture	8.9	Farmers
Avoided fertilizer costs for urban irrigation	4.7	Urban irrigators
Total monetizable benefits	345.2	
Qualitative Benefits and Costs	**Relative Magnitude***	
Long-term gain in wildlife habitat	++	Public
Demonstration of "green" water use ethic	+	City of Fresno
Improved diversification of water supply portfolio	+	City of Fresno
Public perception of recycled water	–	Public
Short-term construction impacts	–	Public
Total Net Benefits (Monetizable Benefits – Costs)	9.4	

All values in millions of dollars.
Assume 2.5% real discount rate and 30-year analysis period.
O&M = operations and maintenance.
* Magnitude of likely effect on net benefits:
++ = Likely to increase net benefits significantly.
+ = Likely to increase net benefits relative to quantified estimates.
U = Uncertain effect on net benefits relative to quantified estimates.
– = Likely to decrease net benefits.
– – = Likely to decrease benefits significantly.

3. Defining the Baseline and Setting Up the Analysis

3.1 Baseline Definition

The baseline for a project reflects the actions or the conditions that are expected in the future if the proposed project is not undertaken. The baseline not only needs to account for current conditions, but also to reflect changes that are likely to occur over time in the absence of the investment in the project. Defining the baseline is especially important because some benefits of the project will follow directly from the definition of the without-project baseline. One benefit may be the result of avoiding alternate projects to supply the amount of water that will be supplied by the project. Another benefit may come from improving the quality of groundwater supplies.

For this project, there are both water quantity and water quality aspects to the without-project baseline. The main driver from a water quality standpoint is that the City is required by the Central Valley Regional Water Quality Control Board (RWQCB) to improve the quality of the groundwater beneath the percolation ponds. Reducing the hydraulic and constituent loading burden on the percolation ponds by implementing a significant reuse program would lower the concentrations of these constituents in the groundwater. The six major pollutants identified were arsenic, manganese, total dissolved solids (TDS), electrical conductivity (EC), sodium, and total nitrogen. Without the proposed project, the City will not be able to follow one of the major recommendations in the "Best Practicable Treatment and Control (BPTC) Comprehensive Evaluation" submitted to the RWQCB in December 2009, which is to reduce the hydraulic and contaminant of concern loading into the percolation ponds by direct effluent recycling. In that case, the City would have to consider other ways to remove the contaminants of concern, including installing a reverse osmosis (RO) plant to treat a similar amount of water as would reliably be removed via the proposed reuse project.

From a water quantity standpoint, the City is planning for recycled water use to help meet growing overall demands for City-supplied water. Without the proposed project, the City would have to seek alternative supplies, mostly from projects that are in various stages of planning and some of which do not yet exist, including local groundwater banks or the proposed Temperance Flat Reservoir on the San Joaquin River. Using more groundwater to meet projected demands is not considered an option because of the City's goal to enhance the long-term sustainability of the City's water supply. This includes reducing groundwater use to be aligned with annual recharge rates in order to stop groundwater level declines that are expected to increase into the future if the current amount of groundwater use is projected into the future.

3.2 Choice of Discount Rate and Analysis Period

Several standard assumptions were made to frame this analysis. The economic analysis is performed in real dollars, meaning that benefit and cost values are shown to change over time only if they are projected to increase or decrease at a rate different from the expected rate of inflation (3%). A real discount rate of 2.5% was used in the analysis, based on a general cost of capital for water utilities of around 5.5%. The real discount rate can roughly be calculated by subtracting the expected rate of inflation (3%) from the nominal cost of capital (5.5%). The analysis period was set to 30 years in order to match the average expected life of the assets to be installed with the project, and the analysis period set in the Recycled Water Master Plan.

4. Costs

The present value costs of the proposed recycled water project were determined based on the planned timing for development and implementation of the individual alternatives, as outlined in the master plan recommendations. Costs are included for development of urban and agricultural reuse opportunities, as well as for groundwater recharge.

Table 2 presents the present value capital and O&M costs associated with each of the preferred recycled water alternatives. Cost estimates were determined based on a real discount rate of 2.5% over a 30-year project time period. As shown in Table 2, project costs are expected to total $320 million in present value. Detail on expected project costs is explained in the section on project alternatives in the Recycled Water Master Plan.

Table 2. Present Value Costs* for Proposed Reuse Alternatives (millions, 2010 USD)

	Capital Costs	O&M Costs	Total Costs
Low Cost Scenario			
Urban reuse alternatives (Alternative 1 existing larger users)	$208.6	$45.4	$254.0
Agricultural reuse alternatives (Alternatives AG1 and AG2)	$17.8	$11.9	$29.7
Groundwater recharge (assuming 50% of identified basins are constructed)	$45.7	$6.4	$52.1
Total	$272.1	$63.7	$335.8

* Present value costs are calculated by assuming timing of expenditures over the 30-year project life and discounting costs to present value using a real discount rate. Therefore, present value costs will differ slightly compared to the costs upon which they are based that are shown in the master plan.

5. Benefits

5.1 Financial Benefits

Avoided alternative water supply costs

The City is counting on adding recycled water to its portfolio of water supplies starting in 2020 in order to meet projected demand while maintaining more sustainable groundwater withdrawal amounts. Without the projected recycled water supply, the City would not meet the deficit with groundwater withdrawals. Instead, the City would need to develop other potential supply sources that are in various stages of conceptual development at present. Those sources include local water banks to store flood releases on the San Joaquin or Kings River, or the proposed Temperance Flat Reservoir on the San Joaquin River.

It is unclear how the City would participate in water banks it does not directly develop, such as FID's Waldron Pond. No information was available on detailed plans for Fresno's development of water banks, possibly with other jurisdictions. It is uncertain therefore how reliable the supply that might be available to Fresno from a water bank would be, or what the cost will be.

The U.S. Bureau of Reclamation (the Bureau) published an analysis of the proposed Temperance Flat project (U.S. Bureau of Reclamation and California Department of Water Resources, 2008). The preferred option is estimated to cost $3.35 billion, and would provide between 112,000 and 180,000 AFY. The Bureau calculated an annualized cost for this project of $169 million, based on a 100-year amortization time period and a 4.875% interest rate. Simply dividing the annual cost by the annual yield results in water costing roughly $950 to $1,500 per AF per year. The analysis does not clearly specify the share of water yield that will go to municipal and industrial (M&I) use as opposed to agricultural use, nor does it provide the details behind the Bureau's benefits calculations. Analysis by Peter Gleick of the Pacific Institute roughly calculates that the Bureau is assigning a value of $850 per acre foot (AF) to M&I benefits from the project (Gleick, 2009). Analysis by an economist reviewing the Bureau's study calculates an implied value of alternative supplies of over $600 per AF (Michael, 2009). A value of $600 per AF also has generally been mentioned as the willingness to pay for Los Angeles to acquire available supplies from the area (Subcommittee on Water and Power, 2005). We use $600 per AF as a conservative cost of fully developing a project, with a realization that a project such as Temperance Flat would result in much higher costs. However, if a project already developed by another entity would allow Fresno to store excess water, then the cost per AF could be lower.

For this study, the $600 per AF estimate is applied only to the cost to replace the recycled water scheduled for urban use, because this is the portion of recycled water supply that can be relied upon to create a potable water offset. This results in $2.5 million in avoided cost in the intermediate term of the project, jumping to $5.8 million per year as more urban uses are switched to recycled water. The total present value of water supply development costs to serve urban uses that are avoided by recycled water use is $82.5 million over the 30-year project life.

Avoided water quality treatment costs

The City is required by the RWQCB to improve the quality of the groundwater beneath the percolation ponds. Constituents of concern are salts, nitrogen, and metals (arsenic and manganese) that are mobilized from the alluvium by effluent percolation. Reducing the hydraulic and constituent loading burden on the percolation ponds by implementing a significant reuse program would reduce the concentrations of these constituents in the groundwater.

Under the recommended approach for recycled water development, urban reuse would be combined with agricultural reuse and groundwater recharge to expand the use of effluent produced. To the extent that the produced effluent would otherwise have been discharged at the RWRF evaporation ponds, then the constituent and hydrologic loading burden at the ponds will be reduced and the concentrations of these constituents in the groundwater will be reduced.

One way to understand the value of the recycled water program in reducing constituent loading at the RWRF is to consider other possible methods to reduce constituent loading. One possibility that has been explored specifically for reducing concentrations of salts (as measured either by

TDS or by sodium) discharged at the RWRF is the use of a RO plant. The alternatives that have been explored include a 10% removal of TDS, a 10% sodium removal, and a 25% sodium removal. Alternative methods for removal include a pellet reactor system and a brine concentrator.

Under the recommended approach in the Recycled Water Master Plan, urban reuse from larger users alone would remove up to 9,800 AFY from disposal at the RWRF treatment ponds. This volume matches the volume of water that would be treated via RO under the 10% TDS removal target. While serving existing and future residential and commercial users as well as agricultural users may further reduce discharge of constituents at the RWRF ponds, depending on the location of recycled water use production, this urban reuse amount is used as a conservative illustration of the cost to otherwise remove constituents of concern.

Capital costs for the 10% TDS removal alternative range from $180.0 million for the pellet reactor option to $170.2 million for the brine concentrator, after updating to January 2010 dollars (costs updated from September 2007 original estimate using the Construction Cost Index from the Engineering News Record). O&M costs range from $6.3 million per year for the pellet reactor option to $33.6 million per year for the brine concentrator option.

These costs include the brine disposal cost of $45 per ton to remove the brine from evaporation ponds. The brine concentrator option has the advantage of lesser brine production, but at the expense of higher O&M costs. In terms of present value costs of the 30-year analysis time period, the cost of the pellet reactor is significantly lower than the brine concentrator option. Assuming a real discount rate of 2.5%, the total present value cost of the pellet reactor over the 30-year project life is $278 million (vs. $738 million for the brine concentrator).

5.2 Social Benefits

Reduced agricultural irrigation costs

Farmers that switch to the use of recycled water as their primary source of irrigation water will realize substantial cost savings. Recycled water will provide farmers with a reliable supply of water throughout the irrigation season. Farmers that use recycled water will benefit from avoiding costs associated with groundwater pumping in dry years (i.e., in years where surface water supplies from FID are unavailable later in the irrigation season).

After paying a per-acre assessment fee, farmers are allowed to irrigate fully until FID water supplies become unavailable. The irrigation season in Fresno typically runs from March 1 to August 31. The point in the year at which FID water supplies are no longer available depends on the level of Kings River runoff. For example, in a year where Kings River runoff is at 40% of normal, surface water irrigation supplies may be cut off in July. Farmers pay the same per-acre fee at the beginning of each season, regardless of how long surface water is available. In 2010, this charge ranged from approximately $29 to $47 per acre per year, depending on the type of water service.

In years when runoff is below normal (i.e., years when surface supplies become unavailable prior to the end of the irrigation season), most farmers will switch to a secondary source of water (i.e., groundwater). Groundwater is much more expensive than surface water, and is estimated to cost about $25 to $35 per AF of water (including pumping). Farmers pay their own costs to pump groundwater, in addition to the assessment fee.

To estimate benefits to farmers, we determined the frequency of shortages (i.e., years when Kings River runoff is below normal) in recent years, as well as the average shortage amount during those years (percent below normal). Data back to 1980 show a shortage in 18 of the past 30 years, or a 60% probability of shortage. The average delivery amount in years with below normal deliveries compared to the long-term average normal delivery over the past 100 years was 61%. We used these two measurements to determine an annual average shortage amount of 23% (1 minus the sum of 60% of years at 61% delivery and 40% of years at 100% delivery), meaning that on average, farmers will need to supplement 23% of their irrigation supplies with groundwater. Based on the estimated average cost of $30 per AF for groundwater irrigation, the benefit from avoided supplemental groundwater pumping is estimated to be about $6.97 per acre per year.

Over the next 30 years, when taking into account the timing and implementation of the agricultural alternatives, the total present value of the annual avoided costs amounts to approximately $1.7 million, assuming a real discount rate of 2.5%.

Avoided fertilizer costs for urban reuse

This project also will allow for reduced fertilizer use for municipal irrigation users such as parks, schools, and golf courses that are expected to take recycled water. Nutrients available in recycled water will allow municipal irrigation users to reduce fertilizer treatment applied to the soil. Urban use of recycled water is expected to total up to 9,800 AFY for existing larger users such as golf courses, parks and schools that would typically use lawn fertilizers.

Although exact offset of fertilizer use from use of recycled water is difficult to estimate due to daily and seasonal nutrient variations in the recycled water, an estimate is available from the potential fertilizer value of recycled water produced from the Irvine Ranch Water District. This value is used to calculate the potential benefits from the offset of fertilizer use from this project. Using a fertilizer price index for the United States from the Food and Agriculture Organization of the United Nations (FAO), and after adjusting for existing data on the nitrogen, potassium, and phosphorus values of recycled water produced at the Fresno RWRF, the value of offset fertilizer use per AF of water applied is $36.56, when updated to 2010 dollars (updated from Asano, 1981). When multiplied by the amount of recycled water to be delivered from this project for urban irrigation for larger users (9,800 AFY), the total avoided fertilizer cost is approximately $358,000 per year. Assuming a 2.5% real discount rate, the present value of this benefit over the assumed 30-year life of the project is approximately $4.7 million.

Avoided fertilizer costs for agricultural reuse

This project will allow for reduced fertilizer use for agricultural users expected to take recycled water. Recycled water contains substantial amounts of nitrogen, phosphorus, and potassium (Kopec et al., 1993). Nutrients available in recycled water will allow agricultural users to reduce fertilizer treatment applied to the soil. Agricultural use of recycled water is expected to total up to 24,200 acre-feet by the end of the project.

Although the exact offset of fertilizer use from the use of recycled water is difficult to estimate due to daily and seasonal nutrient variations in the recycled water, an estimate is available from the potential fertilizer value of recycled water produced from the Irvine Ranch Water District. This value is used to calculate the potential benefit from the offset of fertilizer use from this project. Using a fertilizer price index for the United States from the FAO, and after adjusting for existing data on the nitrogen, potassium, and phosphorus values of recycled water produced at the Fresno RWRF, the value of offset fertilizer use per AF of water applied is $36.56, when updated to 2010 dollars (updated from Asano, 1981). When multiplied by the amount of recycled water to be delivered from this project for agricultural irrigation (up to 24,200 AFY when the project is fully developed), the total avoided fertilizer cost is approximately $884,000 per year. Assuming a 2.5% real discount rate, the present value of this benefit over the assumed 30-year life of the project is approximately $8.9 million.

Demonstration of commitment to "green" water use ethic

In many parts of the United States, there is a growing trend among individuals, local governments, and businesses to promote environmental stewardship and sustainability. The City is committed to being a leader in promoting sustainable water management. Using reclaimed water instead of potable water for irrigation is one way to help demonstrate environmental leadership. By posting the reclaimed water sign ("We're using water wisely by irrigating with reclaimed water"), the City's "green" image would be portrayed to all public park and golf course visitors and other individuals passing these sites.

This benefit cannot be monetized with the information available. However, this benefit was determined to potentially have a positive effect on the net benefits of the project if it could be monetized (a qualitative benefit rating of +).

Improved diversification of water supply portfolio

Adding a significant expansion of reclaimed water to the City's supplies will help diversify the City's supply portfolio. A major advantage of using reclaimed water is its relative insensitivity to droughts. Adding a drought-independent and locally controlled source of water can add important value, especially when other supplies in the portfolio have yields that are highly correlated with drought cycles.

This benefit cannot be monetized with the information available. However, this benefit was determined to potentially have a positive effect on the net benefits of the project if it could be monetized (a qualitative benefit rating of +).

5.3 Environmental Benefits

Long-term gain in wildlife habitat

RWRF is currently one of the most popular birding sites in the region. According to the eBird web site run by Cornell University, 75 different bird species were counted at the RWRF in 2009. The most frequently seen species include the northern shoveler (with a high count of 2,435 individual species at one time), the least sandpiper (high count of 1,500 individuals), and the American coot (high count of 1,100 individuals). Other species that visit the site in large numbers are the ruddy duck, bufflehead, eared grebe, American pipit, cliff swallow, tree swallow, and the long-billed dowitcher. According to the Fresno Audubon Society web site, RWRF is also one of the best places in Fresno County to spot burrowing owls, a California Species of Special Concern (eBird, 2010).

The northwest, southwest and southeast urban reuse alternatives include the development of Groundwater Recharge Reuse Projects (GRRPs). Due to the lengthy permitting processes involved with implementation, GRRPs will likely be phased in over time. These GRRPs are expected to provide wildlife habitat similar to the disposal ponds at the RWRF. As the project is implemented, the total number of acres at the RWRF is expected to decrease as less wastewater is disposed there, but this loss in acreage is expected to be more than made up for by the gain in acreage from the GRRPs.

Groundwater recharge is planned for implementation in the southwest and northwest quadrants. In the southwest quadrant, 839 acres of land have been identified for potential recharge. This does not include areas identified for superrecharge basins. The superrecharge basins could potentially add an additional 405 acres, for 1,244 acres total. In the northwest quadrant, 303 acres of land have been identified for potential recharge, not including superrecharge basins. Including the superrecharge basins, the total potential recharge area amounts to 883 acres for the northwest quadrant. In the southeast a superrecharge basin has been identified with 320 acres. In total for the three quadrants, this amounts to about 1,142 acres of pond/recharge area, or 2,447 total acres with the superrecharge basins. However, it is likely that many of these sites will be found to be unsuitable or not easily acquired. Therefore, the total recharge pond area is likely to be significantly less. The costs assumed for groundwater recharge in this analysis are based on developing half of the additional acres identified for recharge. This implies the addition of 571 acres over the 30-year time period (839 acres + 303 acres, divided by 2). This does not count any acres developed in superrecharge basins, which would be developed by the Water Division.

Although overall acres of pond habitat will increase, pond acreage at the RWRF will decrease due to lower levels of discharge from the treatment facility. Table 3 shows the expected decrease in pond acreage at RWRF as a result of the proposed project at full implementation. It is not clear how the timing of these reductions will be phased. The acreage shown here assumes a future scenario of full development of urban irrigation and agricultural recycled water use as recommended in the master plan over the 30-year planning period, and half of potential total recharge acres identified in the plan.

Thus, the additional pond acreage provided under the GRRPs is expected to offset the reduction in acreage at the RWRF by at least 200 acres. Assuming the GRRP ponds provide similar habitat to those at RWRF, the overall project will result in net benefits. However, there may be temporary negative impacts if the loss of acreage at RWRF starts occurring before the GRRPs are implemented.

Table 3. Projected Change in Wastewater Disposal Pond Area at the RWRF By Month* (values in acres, unless otherwise noted)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Current ponding area	1,107	1,233	1,160	794	934	973	942	1,063	974	1,076	1,211	1,260
Estimated pond area with project	915	980	897	603	682	635	561	704	732	961	962	1,021
Change in Acres	192	253	263	191	252	338	381	359	242	115	249	239
Percent Change	-17%	-21%	-23%	-24%	-27%	-35%	-40%	-34%	-25%	-11%	-21%	-19%

* Based on assumed future scenario of full development of urban irrigation and agricultural recycled water use as recommended in the master plan over the 30-year planning period, and half of potential total recharge acres.

This benefit cannot be monetized with the information available. However, this benefit was determined to potentially have a significantly positive effect due to increased habitat potential on the net benefits of the project if it could be monetized (a qualitative benefit rating of ++).

6. Additional Social Costs

Public perception of recycled water

Public perception of recycled water use by municipal users may be negative, in some settings and with some members of the public. A key concern for use of reclaimed water in irrigation of public areas is the potential presence of pathogenic microorganisms in the influent wastewater. However, ensuring that the wastewater and recycled water treatment systems are effective and reliable, and controlling the extent of human exposure to reclaimed water, can minimize health risks (Asano, 2001). The treated wastewater standard for unrestricted irrigation of public spaces includes a bacterial concentration of less than 2.2 Most Probable Number (MPN) total coliform per 100 milliliters. This critical parameter for the effluent is currently and will continue to be monitored daily at the RWRF.

This cost of potential negative public perceptions cannot be monetized with the information available. However, it was determined to potentially have a negative effect on the net benefits of the project if monetized (a qualitative benefit rating of –).

Short-term construction impacts

Short-term construction impacts are expected with the proposed project. Any adverse effects have been determined to be temporary or mitigated.

This cost was not monetized, however, it was determined to potentially have a negative effect on the net benefits of the project if it could be monetized (a qualitative benefit rating of –).

7. Sensitivity Analysis

7.1 Discount Rate

The net benefits for the project are not very sensitive to the choice of discount rate. The effect of using a 6% real discount rate instead of a 2.5% real discount rate on the analysis for the proposed project can be seen in Table 4. Rules for recent analyses for Integrated Regional Water Management implementation grants from the State of California have stipulated the use of a 6% real discount rate. This choice of discount rate means that costs and benefits incurred in the early project years are relatively much more highly valued than when the cost of capital for water and wastewater utilities and the prevailing rate of inflation are used to calculate a real discount rate. However, due to the relatively even spread of both project benefits and costs over the 30-year analysis period, use of the 6% discount rate only reduces the present value of net benefits to $4.0 million, down from the $9.4 million value derived with a 2.5% discount rate.

Table 4. BCA Overview – Sensitivity Analysis When Using 6.0% Real Discount Rate (rather than 2.5%) (millions, 2010 USD)

Benefit or Cost Category	Present Value	Stakeholder Accruing Cost or Benefit
Costs – Total		
Capital and O&M costs	247.7	City of Fresno
Monetized Benefits		
Avoided water supply costs	42.2	City of Fresno
Avoided water quality treatment costs	201.2	City of Fresno
Avoided agricultural water supply costs	0.9	Farmers
Avoided fertilizer costs for agriculture	4.9	Farmers
Avoided fertilizer costs for urban irrigation	2.6	Urban irrigators
Total monetizable benefits	251.7	
Qualitative Benefits and Costs	**Relative Magnitude***	
Long-term gain in wildlife habitat	++	Public
Demonstration of "green" water use ethic	+	City of Fresno
Improved diversification of water supply portfolio	+	City of Fresno
Public perception of recycled water	–	Public
Short-term construction impacts	–	Public
Total Net Benefits (Monetizable Benefits – Costs)	4.0	

All values in millions of dollars.
Assume 6.0% real discount rate and 30-year analysis period.
* Magnitude of likely effect on net benefits:
++ = Likely to increase net benefits significantly.
+ = Likely to increase net benefits relative to quantified estimates.
U = Uncertain effect on net benefits relative to quantified estimates.
– = Likely to decrease net benefits.
– – = Likely to decrease benefits significantly.
Sum of benefit values do not exactly equal the total shown for monetizable benefits due to rounding.

7.2 Cost of Alternative Water Supplies

A key assumption is the cost of alternative water supplies that would be needed if not for the recycled water supply that will provide potable water offsets. A value of $600 per AF was used in this analysis as a best estimate of the cost of alternative water supplies. Exploration of the sensitivity of the net benefits from the project to the assumption of cost of alternative water supplies shows that the project continues to have positive net benefits until the cost of alternative water supplies is lowered to $527 per AF, assuming a 2.5% discount rate.

On the other end of the spectrum of alternate water supply costs, the high end of the cost per AF cost range for the proposed Temperance Flat Reservoir is approximately $1,500 per AF. If the value of alternate supplies is set to $1,500 per AF for this analysis, the net benefits from the project rise to $125.4 million, assuming a 2.5% discount rate.

8. Conclusions

The expansion of the City recycled water system will provide recycled water to offset some of the City's potable water use, enhance the sustainability of the water supply, and lessen the burden on the wastewater treatment plant percolation ponds that are currently used for effluent discharge.

The net benefits (benefits minus the costs) from the project are $9.4 million, when analyzed using a 2.5% discount rate, and the benefits for the project are approximately 103% of the costs. The largest benefit category is the avoided cost of reducing the hydraulic and constituent loading burden on the percolation ponds at the RWRF by another means besides implementing a significant reuse program to reduce the concentrations of these constituents in the groundwater. The alternate method investigated here for removing those pollutants is construction of a RO plant. The analysis concentrated only on the relief of constituent loading burden that would be provided by urban reuse for larger users, or approximately 9,800 AFY. Avoiding construction and operation of this RO plant would provide a present value of approximately $252 million in benefit from avoided capital and O&M costs during the 30-year analysis period.

The recycled water used for irrigation also is a significant source of water supply for Fresno. Without that water supply, the City would need to find an alternate water source. Using more groundwater is not an option, and Fresno will be making full use of its surface water supplies by 2020. So, the alternative is water banking facilities that are not yet developed or for which Fresno does not have agreements to store water, or other water supply projects that are very uncertain in their cost and potential yield for Fresno. A value of approximately $600 per AF is assumed based on recent analyses of alternative supplies. If the value of offset urban irrigation for larger users alone is counted, the value of avoided alternative water supply totals $77.4 million over the 30-year analysis period in present value. If the costs of alternative supplies is greater than $600 per AF, then the sensitivity analyses reveal that the net benefits of the reuse program would increase significantly.

Additional monetized benefits from recycled water use include avoided agricultural water supply costs, and avoided fertilizer costs for both agricultural and urban irrigation users, due to nutrients contained in the recycled water. These benefits, over the 30-year analysis period, total approximately $15.3 million in present value.

There are important benefit values that could not be monetized as well. Development of groundwater recharge basins over time is expected to result in a large net gain of ponding area that is a benefit to a wide variety of birds and other wildlife. In addition, use of recycled water allows the City to demonstrate a commitment to environmental stewardship and sustainability. And, the addition of recycled water to the water supply portfolio adds a supply that is not sensitive to droughts, and can better allow the City to cope with drought periods affecting its other supplies. These non-monetized benefits are expected to outweigh the non-monetized costs of short-term construction impacts, and the public perception of recycled water as having a public health risk. This accounting in favor of non-monetized benefits could add significant additional value to the monetized net benefits from the project, if they could be valued monetarily.

Sensitivity analysis showed that the result for the economic assessment was not sensitive to the choice of discount rate. When a 6% real discount rate is used, which is consistent with recent practice for analyzing grant applications for Integrated Regional Water Management implementation grants from the State of California, the net benefits for the project become only somewhat less positive – benefits are greater than costs for the project by $4.0 million with the 6% real discount rate, instead of $9.4 million with the 2.5% real discount rate.

Another key assumption explored with sensitivity analysis was the cost of alternative water supplies, which was assumed to be $600 per AF. Sensitivity analysis shows that the value of the monetized benefits for the project still cover the project costs until the cost of alternative water supplies is lowered to $527 per AF.

References

Asano, T. 1981. Evaluation of Agricultural Irrigation Projects Using Reclaimed Water. Agreement 8-179-215-2. Office of Water Recycling. California State Water Resources Control Board. Sacramento, CA.

Asano, T. 2001. Water from (Waste) Water – the Dependable Water Resource. Stockholm Water Symposium. August 12-18.

eBird. 2010. Welcome to eBird. Cornell Lab of Ornithology and National Audubon Society. Available: http://ebird.org/content/ebird/. Accessed May 2010.

Gleick, P. 2009. Peter Gleick: Temperance Flat Reservoir Falls Flat. Circle of Blue WaterNews. September 5. Available: http://www.circleofblue.org/waternews/2009/world/peter-gleick-temperance-flat-reservoir-falls-flat/. Accessed May 2010.

Kopec, D., C. Mancino, and D. Nelson. 1993. Using Effluent Water on Your Golf Course. USDA Green Section Record. July/August.

Michael, J. 2009. Temperance Flat Dam Cost-Benefit Analysis. Valley Economy. August 16. Available: http://valleyecon.blogspot.com/2009/08/temperance-flat-dam-cost-benefit.html. Accessed May 2010.

Subcommittee on Water and Power. 2005. The Economic and Environmental Benefits of New Water Storage in the San Joaquin Valley. Oversight Field Hearing before the Subcommittee on Water and Power of the Committee on Resources, U.S. House of Representatives, One Hundred Ninth Congress, First Session. Saturday, June 11, 2005 in Fresno, California. Serial No. 109-19. Available: http://ftp.resource.org/gpo.gov/hearings/109h/21760.txt. Accessed May 2010.

U.S. Bureau of Reclamation and California Department of Water Resources. 2008. Upper San Joaquin River Basin Storage Investigation. Plan Formulation Report. October.

APPENDIX H – TAG MEETING MINUTES

Engineers...Working Wonders With Water™

CONFERENCE MEMORANDUM

Project:	Fresno Recycled Water Master Plan	**Conf. Date:**	August 5, 2009
Client:	City of Fresno	**Issue Date:**	August 7, 2009
Location:	Fresno RWRF		
Attendees:	City: Steve Hogg, Reace Fisher, Rick Staggs, Kevin Norgaard, Brock Buche TAC members: Ron Young, Dave Requa, Jim Crook, Robin Saunders, Bob Jaques	Carollo: Lou Carella, Lydia Holmes, Penny Carlo, Tracy Clinton, Lorien Fono BCF: Karl Kienow, Luis Gonzalez Jeffery/Scott: David Bogdanov	
Purpose:	Visioning Workshop		
Distribution:	Attendees, Steve Swanback, Jamel Demir	**File:**	8230A.00

Discussion:
The following is our understanding of the subject matter covered in this conference. If this differs with your understanding, please notify us.

Introduction
Purpose of the meeting is to identify implementation issues associated with developing a 25,000 acre-feet per year (AFY) potable offset with recycled water.

Steve - have opportunity to add new supply - not just offset, but need at least 25k AFY for offset
Priorities:

- Make sure we can make offset goal
- Make sure that we're making best use of water resources, best and highest uses
- Loking to relieve burden on perc ponds and other effluent management issues
- Doing the "green" thing,

Steve - Dept of Public Utilities is responsible for solid waste, water, wastewater and others. Easier because city is both producer and purveyor. City council is extremely supportive of recycled water. Formed water subcommittee made up of 3/7 council people to look at water issues. Good timing for getting projects done. Citizen advisory committees not yet used for recycled water. Found citizen committees to be effective tools on other issues. Anticipate for recycled water. Awareness of water resources is really heightened right now. Makes for prime environment to implement projects.

Brock - 13% surface water only includes treated water, not recharge water. Contract with USBR for 60k AFY and FID 105k AFY for recharge water.

Steve - currently recycling 30-35k AFY total of which 20-30k AFY is from extracted water from below the percolation ponds and 8-10 AFY is direct reuse of undisinfected secondary effluent, piped directly to users. Each off-site use has own WDR. Existing reuse doesn't count toward offset goal. Tulare Lake Basin Plan has goal of 100% reclamation, and goal is reflected in WDR.

Wetlands development has been discussed in Southwest. Audobon Society is active doing bird counts and regularly out at ponds. Recently added island in pond for bird habitat. Stream flow enhancement is not considered reuse but wetlands might be.

Dave asks Jim: are they at risk for more permitting for incidental recharge. Jim: as time goes on, perc ponds will need to meet more restrictive regulations. Steve:CDPH has required City to do SAT study do demonstrate 5-log removal.

Steve: There has been discharge here since 1891. In 1912 ,talked about doing extraction and putting in SJ river. In mid-40s, built 1st primary treatment w/ 600 acres of ponds. In 60s added secondary and 600 more acres of ponds. In 70s, capacity was 54 MGD. In 80s went to current capacity and 1700 acres of ponds.

FID agreements mean that district needs to approve removing percolate from their boundaries. FID may argue that even direct delivery is their purview. Only one user has agreement outside of FID, and FID made City pay them a portion of the proceeds. Technically the agreement has expired and runs on a year-to -year basis, and City can get out. Assimilative capacity beneath perc ponds is approx 45 mgd. FID argues they have more jurisdiction than the City thinks. City thinks they could go directly to landowner. FID complains they don't have enough water, but the city doesn't think so. FID delivers cheap water- $35/af (Federal water is $110/AF). There's no additional use within FID - area is saturated with active crops. Have higher priority on water from the Kings River than downstream irrigation districts.

Ron: There's a concern that if City hasn't exercised water rights from FID, they may lose them.

City of Clovis argues that because they have capacity ownership of facility, they argue that they own portion of effluent. Clovis' water supply is not as reliable as Fresno's . They wanted 10% of 0.46 afy exchange water ratio and FID gave it to them last year. Steve agrees with Ron that Clovis has a reasonable claim.

Steve discussed importance of harmonizing EIRs for different plans (Regional Water Master Plan, Metro Plan and SEGA development plan). SEGA final plan and EIR due in fall 2010.

City delivers all water in the City. FID only delivers irrigation water. FID believes that they are the ones with the water right to water they convey to the City.

Brock: There's a regional groundwater master plan that the City partnered on with FID and others.

Recycling Opportunities

Irrigation Reuse

Dave: Did "back-to-school nights" to help sell projects to the public - for school reuse. Ron: went to school board meetings - showed then how to save money with reuse.

Ron: EID got ordinance to dual plumb front and backyards. Its doable but it's a stretch. Its probably better to do commercially or by HOA managed areas. City would probably work with HOAs. Robin: Implement in parks and public areas first, then go to HOAs.

Bob: Pebble Beach Golf Course ran into problems because of site-specific conditions made them more sensitive to TDS. Need to check with users as to their specific water quality needs.

Steve: having a hard time selling community that they don't need water softeners.

Dave: why can't scalping plant be turned on and off? (Because there are issues with biological processes)

Use of General permit for landscaping reuse - may not to be able to use permit because of multiple uses. Robin said they had different permits for different uses and each industrial user, but that may be specific to RB2.

Costing strategies - Ron: maybe charge the same amount as what is being charged now for potable water, especially if connection fees are paying for new infrastructure. Need to look at whole picture of city finances (40 year lifecycle cost), not just little picture of the project. In Elsnore, they have recycled water line item in budget. Dave says they charge the same for all kinds of water.

Rick: EC at Copper River is much lower than RWRF (300 micromhos/cm). This could indicate that effluent from north scalping plants is better for turf irrigation.

Haven't yet started outreach to sell recycled water to the community. Need to start now. Different pressures on different groups will help them accept recycled water. Jim wrote a WaterReuse Foundation report on using recycled water in schoolyard playgrounds. For Redwood City, it was a public relations failure - because they didn't get public input from the beginning.

Dave got developer to pay for project - both for dual plumbing and connection fees. Dave: had big new area where they required dual plumbing - but also got federal money to do retrofits. Tracy: Many schools already have separate systems for irrigation and internal use. Robin: once had to replumb a cemetery because there were hose bibs all over the place.

Industrial Use

Group agreed we should screen out washdown water for food processors.

No one thinks that industrial laundries use is a problem, but no one can identify an existing industrial laundries that uses recycled water.

Ron: industrial users are going to decided on a owner-by-owner basis, depending on benefit. Many laundries and car washes treat water internally. In Irvine had carpet dyer who really wanted recycled water and loved it because it was half the price.

Robin: Cement comes out stronger with recycled water.

Bob: algae would be a problem with open storage.

Cooling towers are major use.
Need to start talking to users to see their willingness and water quality needs.

Groundwater Recharge

Existing stormwater basins are managed by different agency (flood control district). Brock: need 800 AF of additional recharge facilities for surface water recharge. FID canals are used in the winter to remove flood water from the City. Would need separate distribution system to convey wastewater to recharge basins in the winter. City is not fully using their entitlements because they don't have the infrastructure to do so.

Would need to prove buffer distances. Jim: the type of tracer study will lead to different buffer zones. New regulations are not expected anytime soon, especially not an adopted regulations.

Brock: 300 feet from nearest well seems way too low, even has problem with 900 feet. Wants to caution that this could be a larger problem. In the summer, the zone of influence of wells is 1800 feet. Penny: could shut down a well if necessary for a really good reuse site.

Brock: need to have 80% of wells operation at any given time to meet peak day demands. In future as move to more surface supply will still use groundwater system as a backup plan in extreme drought situation.

Penny: also need to consider plumes - don't want to make contamination move due to recharge

Jim: Probably want to do tracer studies before you start projects. Base design on theory, then come back and prove it. This was successful at Inland Empire, Orange County and West Basin. There are also issues with showing TOC reduction. Need to show that you meet all standards (including drinking water standards) at the bottom of the vadose zone. Inland Empire did this by putting in lysimeters. .

Jim provided sequence of necessary steps to get a recharge project approved (separate handout). Will probably take a couple years to get a permit. One year at best.

At Inland Empire and Orange County, there was no public opposition to recharge projects, and probably West Basin. However, there have been problems in San Diego, the San Fernando Valley and also DSRSD. Probably going to put in a project in LA.

Dave: Get RWQCB to participate in all DPH meetings.

Agricultural Exchange

City of Fresno is 25% of FID land area.

There's a TMDL for EC in the SJ River.

To use canals as distribution system, need to look at conveyance capacity as well as where the canals go.

Steve: There's opportunity to negotiate for delivering water outside of FID. Only reason to go to unincorporated area is if current disposal operation becomes infeasible, since there is no opportunity for potable exchange.

There are some interconnects between FID and Consolidated Irrigation District.

It's possible that future regulations will be on what's at end of the pipe before percolation, so there would be no benefit to percolation.

There is significantly more capacity to extract percolate.

Can do undisinfected secondary on wine grapes, but not table grapes or raisins.

May expand delivery to Souza (farmer). Is there opportunity to get more water from FID for this? Ron: Could make a deal to get their water rights (eg. Pay for their assessment). Brock: This could be a good long-term new supply.

Corn and alfalfa are great crops because they uptake nitrogen. Need to confirm water use with Mohammad.

Bob: No real public perception issues since most local crops can't be bought in grocery. Most growers wanted to know what the technical issues are for irrigation operations and agronomic rates. Most engineers underestimate clogging problems in spray and drip irrigation due to algae. County health officials can add more requirements on top of Title 22. Signage was a requirement. Concern about farm workers. Needed to do farmworker health study, and there was no difference between before and after recycled water project. Steve: so far county public health hasn't been problem. Had to make sure farmers educate workers on the fact that it's not potable.

Jim: Are there any root crops in the area? Steve: Not immediately adjacent. Penny: Sensitive edible crops are about 1% of land around here.

Bob: why are they growing low value crops? Kevin: to support dairy farmers, because of soil conditions.

Steve: generally rotate between corn and alfalfa

Exchange contractors on the west side of the valley may be interested in getting effluent for opportunities for exchange.

Fisheries/Environmental Enhancement

There's water in Friant Dam that is required to be released. They could release less water from the dam, if City could supply some recycled water.

Robin: Water temperature could be an issue, like in San Jose/Coyote Creek.

Steve: Depends on where flow needs to enter the river. NE plant is overcommitted. Could use canal system to divert water to river.

There's also possibility for new wetlands in the north along the river. This wouldn't be an offset, but an additional disposal opportunity. Would also require an NPDES permit.

Discharge location is important. Could convey water through Houghton or Herndon canal.

Opportunities by Region

Southwest

Concept of locating additional treatment facilities at existing regional plant and running pipeline along Cornelia Corridor to parks/cemeteries, use old winery waste line (replace with pipe bursting) to take water to industrial users. Provide water to Ag users in vicinity. Could use either extracted percolate or provide tertiary treatment to secondary effluent.

Location of treatment facilities shown on ppt designated for a pole barn - need to move west (A side)

Jim - Use of extracted percolate - DPH would likely want disinfection for multiple barriers
Robin - tried to do no residual - had regrowth
Jim - Santa Ana River - need to disinfect after extraction
Steve H - don't have enough data to make DPH happy, but getting 5 log removal
Jim - talked to Rich Haberman at DPH - agrees not enough info to not add disinfection

Fresno sports complex - old landfill and superfund site - using groundwater remediation for irrigation. Don't assume any reuse potential

Cornelia Corridor - may be able to pick up the irrigation of large yards in area
Crossing of 99 a problem
Some subdivisions already conditioned for reuse - Steve H to get info on which areas

Jensen line - old brick sewer has been abandoned. Goes into middle of SW area

Dave - issues of regrowth in the system. Large pipes an issue if low flow. More than 5 days retention becomes a problem. DSRSD did a gradual rate increase - started out 20 % below water costs and then increased rates over time.

Potential for new AG in this area? Canals are already getting extracted water in this area. Clovis is actually paying FID to discharge to their canals.

Planned recharge area for Metro Plan - actually a depression in the GW in SW area (northeast of plant) due to overpumping.

Tracy - issue that industries can go away.

Ron - Has the City thought about buying more Ag land to do own reuse/growing?
Bob - plant surrounded by Ag - why go all over town with pipelines when could do an Ag program?
Steve H - need to continue to look at Ag - not sure can get the offset needed.
Bob - need to find out now. Most viable program.
Dave - need to have a backup program to compare.

Ron - what happens when water goes out of Ag and into Urban growth?
Brock - if density is low then demands increase because landscape irrigation is water intensive. Until get water meters - can't really determine.

Northwest
Sewer in area of proposed scalping plant (Grantline and Herndon) about 42 inch or greater.
City owned land, adjacent to Herndon Canal for siting facility and maybe recharge - 17 acres.
Outfalls from Herndon Canal to SJ River if wanted
Could irrigate golf courses, schools...
Proposed recharge facility for water proposed west of 99 (from Metro Plan). Potential to combine with wastewater.

Commercial project proposed in Herndon and 99 area - conditioned with purple pipe. Not constructed yet.
Van Ness lakes - man made lakes - water feature - not really used for contact.
Ron: At Lake Elsnore - put all effluent in lake - 5k out of 40k. RWQCB doesn't have any bacterial issues - TMDL issues for nitrogen and P. Terminal lake used for full body contact. In summertime is green - but people fish, swim and waterski.

Northeast
Potential to redirect some wastewater from forcemains to North Fresno WRF
WRF expandable to 2.5 mgd. Maybe more if use different technology (MBR)
Could irrigate golf courses, Woodward Park, potential Ag north of Woodward Lake, wetlands restoration
Potential additional scalping plant at Woodward Park?
Good location for GW recharge
Flood control basin at Chestnut and Sheppard

Southeast
Dave - make developer put in the scalping plant.
Steve - Yes, we will make them pay for it but we want to have control over the treatment plant after our experience with the Copper River plant.

Brock - SEGA proposing multiple scalping plants - not in areas shown here from previous study
Luis - Plant locations next to FID canals for Ag water reuse. Clovis also discharges into one of the canals - need to check capacity.

Satellite locations don't have to be situated where identified in 2006 study.

Brock - planned recharge area for water - some difficulty in even developing GW drinking wells in the SE area. Will know more soon.

SEGA - planned development for 105,000 people - big opportunity for residential reuse, dual plumbing in commercial buildings, recharge. Calthorpe and EDAW planned water features.

Jim - in Florida takes about 5 houses to develop enough wastewater for irrigating one yard.

Wrap-up - key issues to consider from each TAC member

Bob - put together task force of regulators and users (chairman was in charge of health so that after he was satisfied, everything went smoothly). Agricultural reuse seems most promising. Need to work out with FID agreement about what kind of offset they can get. Doesn't see why City has to deal with FID if we deliver water directly to them and they'll stop pumping groundwater. (Kevin - most growers are far away from where we need the groundwater. Brock: can't put drinking water wells in Ag land). Need to evaluate impacts if city puts all eggs in Ag basket. Doesn't see any stumbling blocks. Ag reuse seems to be immediately located (next to plant) and lowest level of treatment.

Ron - Needs to have an overarching blue ribbon panel. Representatives from all major stakeholders (citizens, regulators, elected, FID) to be included in panel. Get prior overarching buy-in and policy / goal statement. This needs to come before engineering. Also need to develop water balance. Need to let gravity do the work. Economics are most important. If the land costs are cheap enough, then can impose fees on top of that for development. Can't raise the fees so high you can't sell houses. Treatment issue is real - makes best sales pitch.

Dave - Agree about task force, but keep regulators as separate group. Get newspapers on board. Figure out what you're trying to sell. Make a paradigm choice. Cheaper to go to Ag than to add in a billion dollars of irrigation pipeline. Should not shortchange self of treatment quality now, since it's a major part of the public perception issue. In terms of concerns about overuse - using recycled water is the same as using potable water wisely.

Jim - Agree with advisory panel concept because of credibility. Need to narrow alternatives. Agree that Ag may be easiest solutions. None of industrial users have been contacted, so first need to ask them what their needs and willingness are. Keep regulatory agencies in the loop. Some in CDPH think that Title 22 isn't stringent enough for irrigation. Recognize that short-term decisions have long-term consequences. Need to seriously consider undisinfected effluent in perc ponds. Also examine whether other uses are better than recharge due to the regulatory burdens. Remember that when building satellite plants there needs to be enough remaining flow to take solids away to main plant. Recommends applying disinfection before putting in the ground. Need credible experts - not paid consultants - to deal with public outrage.

Robin - Did project w/o task forces, but thinks its necessary for recharge. If you're just doing irrigation, Redwood City is an example of outreach going wrong. Robin started smaller with parks and medians. Later, as projects are developed, people felt that they had a choice about whether to take recycled water. Get horticultural experts onboard. Need to get control over water waste in Fresno. Really need to put meters in this town. Should also have separate irrigation meters to track water use and eventually retrofit. Pricing - for commercial/industrial, maybe have fixed price for irrigation water rather than price per quantity for potable. Must make it cheaper for recycled than potable. Doesn't require cultural change in irrigation practices. Put the sign up early even though recycled water isn't yet there, so if people complain initially, you can tell them it's not there yet.

Dave Requa will send notes on mandatory requirements.

Prepared By:

Lorien Fono

LF:LF