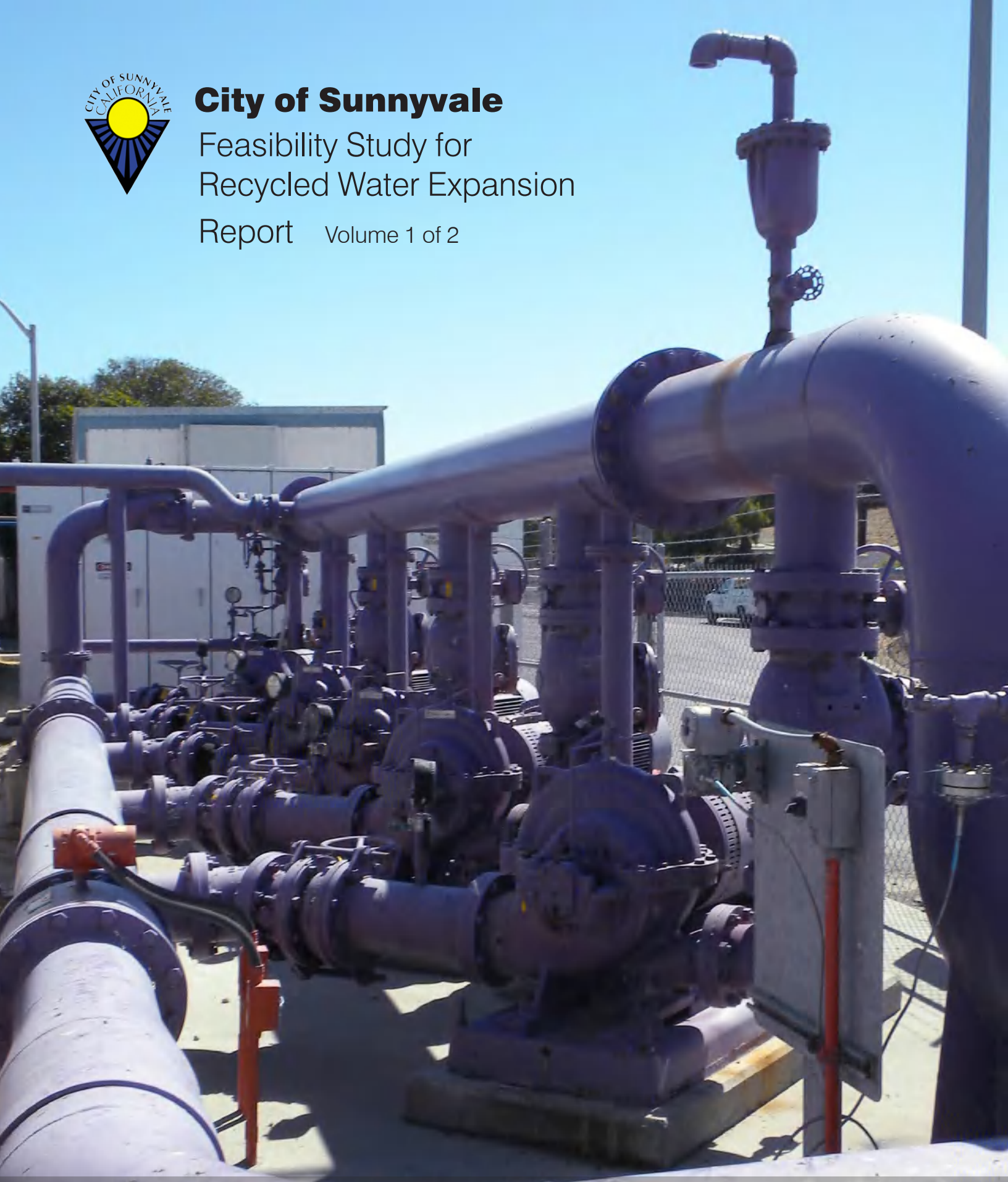
City of Sunnyvale

Feasibility Study for Recycled Water Expansion Report

Volume 1 of 2



June 2013

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City of Sunnyvale

Feasibility Study for Recycled Water Expansion Report Volume 1 of 2

June 2013

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List of Acronyms and Abbreviations

ADD	Average Day Demand
AFY	acre-feet per year
AMD	Advanced Micro Devices
APN	Assessor Parcel Number
BARDP	Bay Area Regional Desalination Project
Bay	San Francisco Bay Estuary
ºC	Degree Celsius
Cal Water	California Water Service Company
Caltrans	California Department of Transportation
CCF	hundred cubic feet
CCR	California Code of Regulations
CCT	chlorine contact tanks
CDPH	California Department of Public Health
CEC	Constituent of emerging concern
CIMIS	California Irrigation Management Information System
CIP	Capital Improvement Plan
City	City of Sunnyvale
CPUC	California Public Utilities Commission
CVP	Central Valley Project
CWSRF	California Clean Water State Revolving Fund
DAF	Dissolved Air Flotation
District	Santa Clara Valley Water District
DMF	Dual Media Filtration
DU	Dwelling Unit
DWR	Department of Water Resources
ET	evapotranspiration
Feasibility Study	Feasibility Study for Recycled Water Expansion
FL	fire services
GIS	Geographic Information System
gpm	gallon per minute
HOA	Home Owner's Association
hp	horsepower
HydroScience	HydroScience Engineers, Inc.
I & I	infiltration and inflow
ISG	Individual Supply Guarantee
LF	lineal feet
LID	Location Identification
LS	landscape services
MG	million gallon
MGD	million gallons per day
mg/L	milligram per liter

List of Acronyms and Abbreviations

MPN/100 ml	Most probable number per 100 milliliters
NPDES	National Pollutant Discharge Elimination System
NPV	Net present value
NTU	Nephelometric Turbidity Units
O&M	Operations and maintenance
PDD	Peak Day Demand
PG&E	Pacific Gas and Electric
PHD	Peak Hour Demand
POC	point-of-connection
PRV	Pressure-reducing valve
RO	Reverse Osmosis
ROW	right-of-way
RW	Recycled water or recycled water service
RWQCB	San Francisco Bay Regional Water Quality Control Board
RWMP	2000 Recycled Water Master Plan
RWS	City and County of San Francisco's Regional Water System
SAR	Sodium Adsorption Ratio
SBWR	South Bay Water Recycling
SCVWD	Santa Clara Valley Water District
SF	Square foot or square feet
SFPUC	San Francisco Public Utilities Commission
SIP	Strategic Infrastructure Plan
SJWC	San Jose Water Company
SWP	State Water Project
SWRCB	California State Water Resources Control Board
TDH	total dynamic head
TDS	total dissolved solids
TM	Technical Memorandum
USBR	United States Bureau of Reclamation
UWMP	City of Sunnyvale 2010 Urban Water Management Plan
VFD	Variable frequency drive
WPCP	Water Pollution Control Plant
WS	potable water services
WSA	Water Supply Agreement between the City and County of San Francisco and Wholesale Customers in Alameda County, San Mateo County and Santa Clara County
WRCC	Western Regional Climate Center
WWTP	Wastewater Treatment Plant

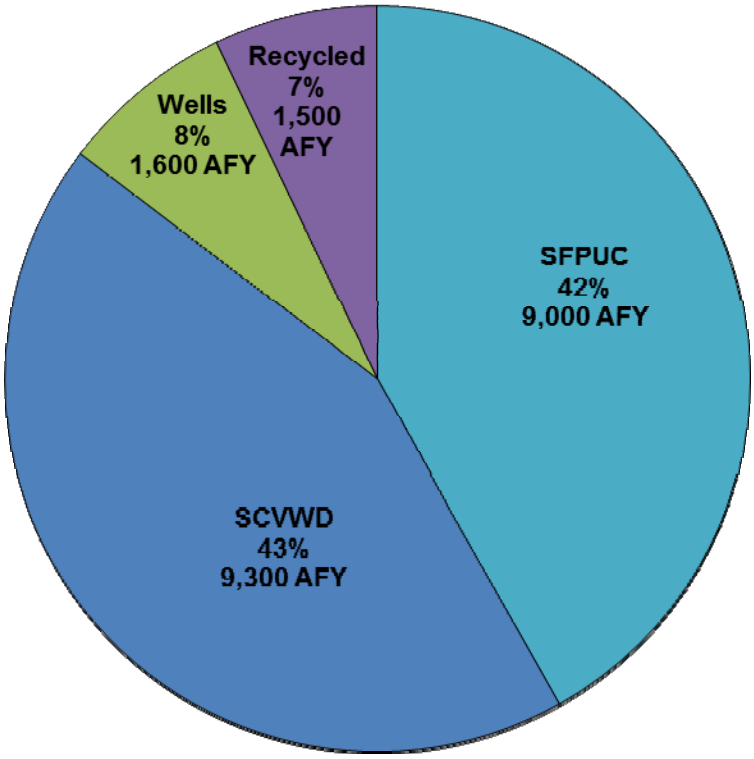
EXECUTIVE SUMMARY

The City of Sunnyvale (City) retained HydroScience Engineers to prepare a *Feasibility Study for Recycled Water Expansion* (Feasibility Study). This Feasibility Study provides the basis for future recycled water infrastructure design and construction. The purpose of this Feasibility Study is to present the next phase of near-term recycled water demand forecasts for the City as well as the water quality requirements and needs associated with specified uses and demands, and the treatment and system expansion requirements to meet those needs. The focus is on landscape irrigation uses that have minimal environmental impacts and can be implemented with very little adjustment to the existing recycled water quality.

ES.1 Water Supply Sources

The City has three sources of potable water supply: purchased surface water from the SFPUC, purchased treated surface water from the SCVWD, and groundwater from seven, City-owned and operated wells. There is one additional well that remains on stand-by for emergencies. The City also has potable distribution system inter-ties to the cities of Cupertino, Mountain View, and Santa Clara as well as to the California Water Service Company through service connections located within city boundaries that are reserved for use in case of an emergency. The City also supplies recycled water to approximately 120 customers. **Figure ES1-1** provides a breakdown of water supply sources as of 2010 according to the City's 2010 Urban Water Management Plan.

Figure ES1-1: City of Sunnyvale Sources of Water Supply



ES.2 Existing Recycled Water Supply and System

The City has developed a recycled water program, which today serves parks, golf courses, and the landscaping needs of diverse industries. A wastewater reclamation program was developed in 1991 when the City first identified short-term goals of recycling 20% to 30% of effluent from the Sunnyvale WPCP. The long-term goal of the City is to reuse 100% of all wastewater (15 MGD) generated from the WPCP to reduce or eliminate discharges to the South San Francisco Bay, as stated in the 2000 RWMP. This goal, if attained, would involve the export of recycled water outside the City limits in addition to serving recycled water customers within the City limits.

The recycled water system consists of the WPCP pump station, the San Lucar tank and pump station, the Sunnyvale Golf Course pump station, and approximately 18 miles of recycled water pipelines ranging in diameter from 6- to 36-inches. The recycled water infrastructure is a network of pipelines running along the primary roadway arteries within the northern section of Sunnyvale as well as Moffett Park Specific Plan area providing irrigation water to 120 services including industrial customers Lockheed-Martin and Yahoo. Other major customers include the Sunnyvale Golf Course, Baylands Park, and the Twin Creeks Sports Complex. Together, typical annual recycled water demands for these existing customers total approximately 1,062 AFY. Each pump station is described below:

WPCP Pump Station: The WPCP pump station is located adjacent to the WPCP's chlorine contact tanks (CCTs) and consists of six pumps with a rated firm capacity of 3,750 gpm with the largest pump out-of-service. Theses pumps currently feed the San Lucar Tank.

- **San Lucar Tank and Pump Station:** The San Lucar site is home to a 2.0 MG storage tank. This storage is comprised of a 1.5 MG recycled water storage tank and a 0.5 MG surge tank. The storage tank was built in 2000 to increase the reliability and capacity of the City to deliver recycled water. Recycled water stored in this tank is pumped into the recycled water distribution system. The pump station consists of five pumps capable of delivering 5,500 gpm with the largest pump out-of-service.
- **Sunnyvale Golf Course Pump Station:** This pump station consists of two variable speed pumps with a rated firm capacity of 1,800 gpm with the largest pump out-of-service. This pump station serves the Sunnyvale Golf Course.

Figure ES1-2 presents the location of the Sunnyvale WPCP, the existing recycled water distribution system, and the existing recycled water use area. The recycled water supply has some water quality concerns regarding total dissolved solids and color. These concerns are discussed in the follow.

ES.3 Existing Wastewater Treatment and Recycled Water Production

The City treats its wastewater and produces recycled water at the Sunnyvale Water Pollution Control Plant (WPCP) located at 1444 Borregas Avenue. The WPCP is permitted for an average dry weather flow capacity of 29.5 MGD with a 40 MGD peak wet weather flow capacity; though current influent flows to the plant average approximately 15 MGD. The WPCP receives wastewater from the sanitary sewer collection system, which must be treated before it can be discharged to the Bay. The amount of influent wastewater handled by the WPCP varies with the time of day and with the seasonal changes in demand.

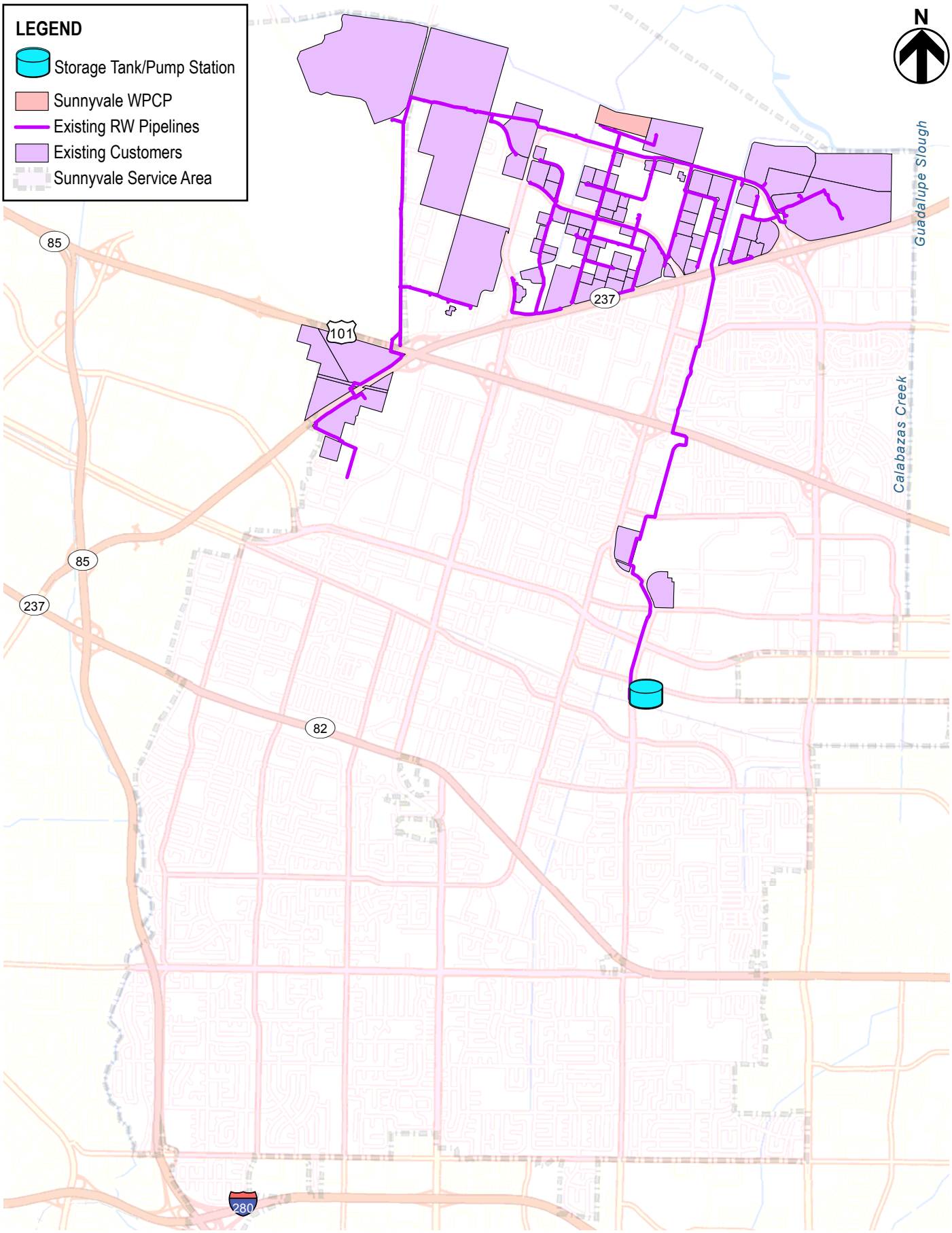


FIGURE ES1-2
CITY OF SUNNYVALE
FEASIBILITY STUDY FOR RECYCLED WATER EXPANSION
EXISTING RECYCLED WATER SYSTEM

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The WPCP is a tertiary treatment plant that produces effluent meeting the City's NPDES discharge requirements. Most of the treated water is discharged to the Bay via the Guadalupe Slough. Approximately 10% of the plant flow is treated to a higher level to meet the necessary recycled water quality, and is delivered to customers for non-potable uses, which is primarily irrigation. The process includes influent grinders, pre-aeration/grit removal, primary sedimentation, oxidation ponds, fixed growth reactor nitrification, dissolved air flotation with coagulation aided by polymer dosage, dual media filtration, chlorination, and dechlorination. The recycled water and secondary effluent production modes use the same treatment process but have different operational parameters, such as chemical dosage and disinfection level. Due to operational issues, the WPCP runs in two alternating modes, as described below.

- **Mode 1 – Secondary Effluent Discharge:** The entire advanced secondary treated municipal effluent is discharged to the San Francisco Bay and no recycled water is produced. Due to less stringent regulatory limits for turbidity compared to recycled water use, less polymer and chlorine are required during the treatment process when effluent is discharged to the Bay. As a result, the WPCP realizes lower operating costs. However, the recycled water system is reliant upon stored recycled water, and the system frequently is supplemented with potable water when recycled water is not available.
- **Mode 2 – Recycled Water Batch Production:** The entire WPCP flow is treated to meet Title 22 of the California Code of Regulations for disinfected tertiary recycled water, which is a higher level than under Mode 1. The recycled water that is produced is stored for subsequent distribution to the City customers primarily for irrigation use. The City has several operational concerns associated with this batch mode recycled water production, including:
    - Operational complexity and labor required to switch between Mode 1 and Mode 2;
    - Limited recycled water storage capacity, which requires frequent batch production during the summer irrigation season to meet recycled water demands; and
    - Excessive chlorination during the transition from Mode 2 to Mode 1 raises concerns of potential negative effluent bioassay impacts.

ES.4 Proposed Treatment System for Recycled Water Production

The proposed system consists of a sidestream MBR treatment system installation with effluent disinfection which will provide secondary and tertiary treatment to produce recycled water for reuse. A portion of the WPCP primary effluent flow would be diverted to the sidestream treatment process, treated to tertiary quality, and then sent to the chlorine contact tanks for disinfection. The remainder of the WPCP flow would continue through the WPCP, be treated to secondary standard, and then disinfected and discharged to the Bay.

A MBR system would eliminate the need for batch production of recycled water and instead allow for continuous production of recycled water for reuse. Only the portion of the WPCP flow necessary to meet recycled water customer demand would be diverted to the sidestream treatment process, allowing for continuous operation of the recycled water treatment system.

ES.5 Proposed Recycled Water Alignments

Sixteen alignments were identified and evaluated as part of this Feasibility Study. The alignments are developed to meet near-term demands. City GIS and meter data, a review of potential high demand recycled water users, and the ability to pick up potential users along particular alignments were applied as criteria to develop alignments, as described previously in this document. Four types of alignments/connections were developed, which include:

- **Wolfe Road Main:** This pipeline is intended to extend the recycled water system to the south to capture potential users along the Sunnyvale-Cupertino boundary, specifically the Apple® Campus 2.
- **Main Loop:** This alignment is intended to loop the existing recycled water system to provide reliability, connect to future storage tank site(s), and provide opportunity for further expansion and recycled water use along the alignment.
- **Potential Recycled Water Alignments:** These alignments are intended to capture outlying potential high demand users that are not located along the mainline or Wolfe Road alignments. These alignments generally extend to a specific high demand user or cluster of users and attempts to pick up as many viable users along the way.
- **Infill Connections:** Customers that have been identified along the existing recycled water pipelines and do not require pipeline extensions, but rather only retrofits of the sites to receive recycled water.

Each of the alignments was evaluated using the hydraulic model. The pipeline lengths and sizes were determined based on recommended design criteria. The recommended design criteria are presented in **Table ES1-1**.

Table ES1-1: Recommended Recycled Water Distribution System Design Criteria [1,2]

Criteria	Target Design Criteria	Criteria Limit
Maximum Pressure	105 psi	150 psi
Minimum Pressure	60 psi	40 psi
Pipe Headloss	10 ft/1000 ft	15 ft/1000 ft
Maximum Pipeline Velocity	7 fps	7 fps
Hazen Williams Coefficient (C)	120	
Irrigation Period	9:00 PM to 6:00 AM (9 hours)	
Operational Reservoir Storage	Peak Day Demand (PDD)	
Pump Station – Design Capacity	Peak Hour Demand (PHD)	
Pump Station – Minimum Number of Pumps	3	

References:
1. City of Sunnyvale's Water Utility Master Plan (IEC, 2010)
2. City of Sunnyvale's Technical Memorandum – Reclaimed Water System Hydraulic Modeling (IEC, 2010)

Table ES1-2 identifies the alignment name, the point-of-connection (POC), the estimated demand, and the estimated capital costs for the pipeline and retrofits. Each of the alignments is then ranked by the cost per acre feet per year ($/AFY). **Figure ES1-3** presents the potential alignments.

Table ES1-2: Summary of Alignments and Cost Estimates

Alignment	Pipeline Length (ft)	Number of Retrofits	Demand (AFY)	Construction + Soft Costs	Total Retrofit Cost	Total Project Cost	Annualized Cost/AFY	Rank by $1K/AFY
Infill Sites	0	50	335	$0	$2,675,000	$2,675,000	$656	2
Extensions Proposed from Existing Pipeline System								
Lakehaven Drive	4,100	11	86	$876,000	$530,000	$1,406,000	$1,356	7
Maude Avenue	6,800	2	36	$1,217,000	$145,000	$1,362,000	$3,070	15
Duane Avenue	16,500	23	429	$3,956,000	$1,665,000	$5,621,000	$1,077	4
Kifer Road East	5,000	5	51	$1,022,000	$310,000	$1,332,000	$2,176	13
Kifer Road West	1,900	5	54	$411,000	$370,000	$781,000	$1,182	5
Base Alignments								
Wolfe Road Main	13,300	13	345	$6,399,000	$840,000	$7,239,000	$1,727	10
Main Loop	24,800	43	335	$13,504,000	$2,410,000	$15,914,000	$3,902	17
Alignments Requiring Wolfe Road Main								
Iris Avenue	2,300	2	55	$479,000	$155,000	$634,000	$943	3
Marion Way	2,600	3	30	$458,000	$190,000	$648,000	$1,772	11
Dartshire Way	5,500	3	65	$1,199,000	$170,000	$1,369,000	$1,733	9
Alignments Requiring Main Loop								
Gail Avenue	1,700	4	39	$328,000	$250,000	$578,000	$1,231	6
Old San Francisco Road	1,500	3	26	$265,000	$185,000	$450,000	$1,451	8
Manet Drive	1,100	3	86	$255,000	$190,000	$445,000	$432	1
Sunnyvale-Saratoga Road	1,900	5	14	$335,000	$260,000	$595,000	$3,551	16
Remington Drive	7,100	4	59	$1,476,000	$275,000	$1,751,000	$2,443	14
Carson Drive	1,500	2	16	$265,000	$105,000	$370,000	$1,852	12
Total	**97,600**	**181**	**2,061**	**$32,445,000**	**$10,725,000**	**$43,170,000**		

Notes:
1. Existing and potential recycled water customers and demands for Moffett Field sites were not included in this analysis

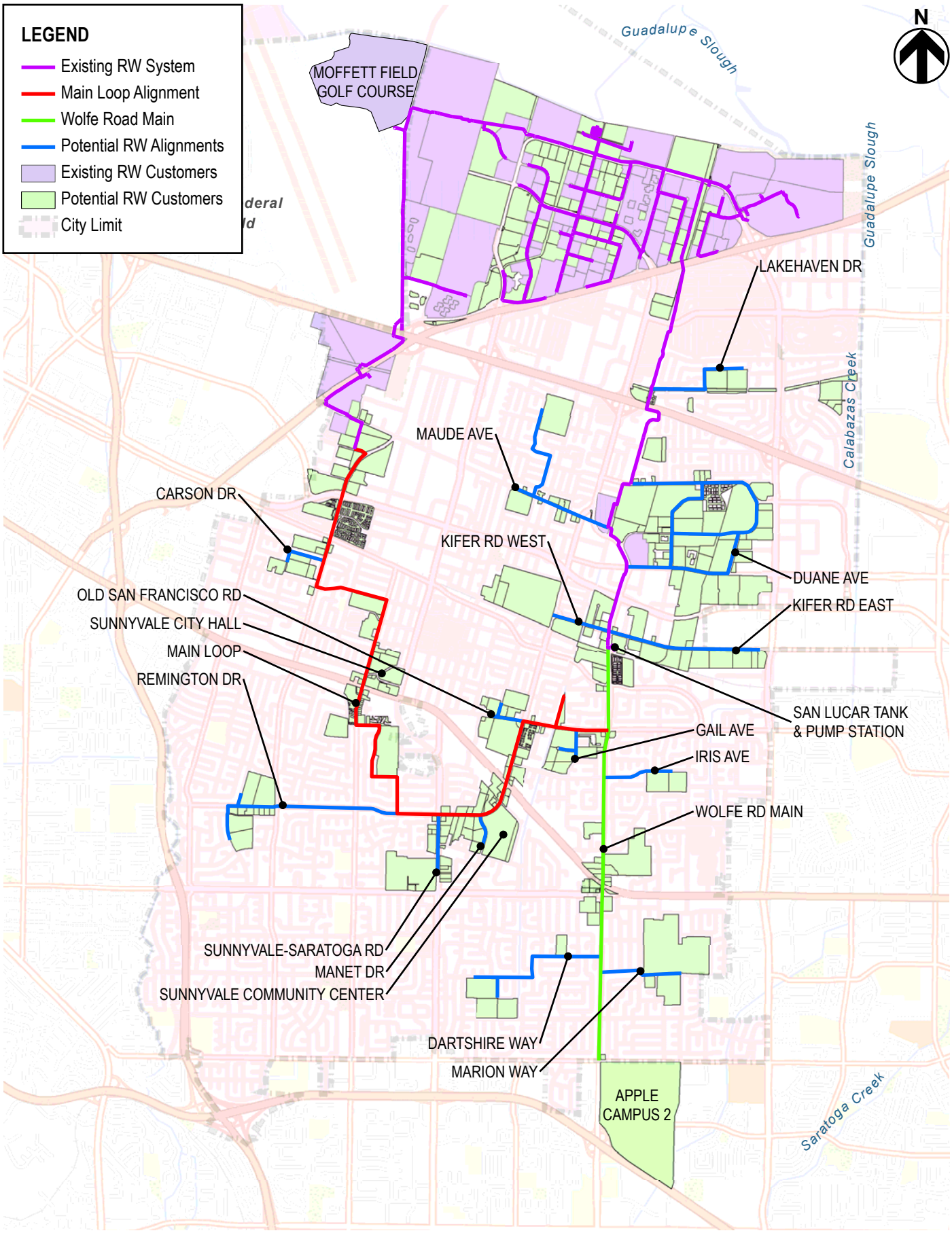

FIGURE ES1-3
CITY OF SUNNYVALE
FEASIBILITY STUDY FOR RECYCLED WATER EXPANSION
PROPOSED RECYCLED WATER ALIGNMENTS

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ES.6 Recycled Water Storage Tank Requirements and Options

The expansion of the recycled water system requires additional storage facilities and pumping capacity. Based on the estimated recycled water buildout demand of 3,123 AFY, the average day demand is 2.8 MGD and the peak day demand for the recycled water system is approximately 6.5 MGD. Both the Wolfe-Evelyn and Central tank sites have space available to build a 5.0 MG tank. This additional 5.0 MG of storage combined with the existing San Lucar Tank's operational storage volume of 1.5 MG would provide the equivalent of one peak day of recycled water storage. This would also provide the operational flexibility to seasonally shut-down one tank and pump station site for maintenance and repair, as well as reduce the need for emergency potable water back-up to the storage tanks.

- **Wolfe-Evelyn Plant Site:** The Wolfe-Evelyn site is a 3.4 acre site located on Ajax Drive, east of Wolfe Road and south of Evelyn Avenue. The site has an operational 5.0 MG potable water tank and booster pump station. The site has sufficient space to construct a new 5.0 MG recycled water storage tank and a new recycled water booster pump station. The pump station at Wolfe-Evelyn would be sized to pump recycled water to the higher elevation areas to the south as well as supplement the San Lucar storage and pumping facilities. To provide storage at the Wolfe-Evelyn site, a 2,000 LF, 24-inch extension between Wolfe Road and the tank site would be required.
- **Central Avenue Water Plant Site:** The Central Avenue site is a 1.2-acre parcel located at the corner of Central Avenue and McKinley Avenue. This site currently has two 0.5 MG potable water storage tanks that are not currently in use, as well as an inactive groundwater well that serves the potable water system. The existing groundwater well and potable water distribution system could be connected to the new recycled water storage tank via an air-gap connection to provide a supplemental emergency water supply to the recycled water system. To construct the 5.0 MG storage tank, the existing potable water storage tanks would need to be demolished. The disadvantage associated with the conversion of the Central Avenue site is the added cost of demolishing the existing 0.5 MG potable water storage tanks and constructing a total of 6,000 LF of 24-inch mainline between the Main Loop/Wolfe Road Main and the Central Avenue Plant site. The storage tank and pump station at the Central Avenue site would operate similarly to the one proposed at the Wolfe-Evelyn site.

ES.7 Capital Improvement Plan

The completion of the proposed expansion of the recycled water system would add approximately 18.5 miles of 6-inch to 24-inch pipe to meet the additional demand of 2,061 AFY and total nearly $43.2M in capital investment for recycled water distribution system improvements. Additional capital investment is needed for treatment, pumping, and storage facility improvements to support the expansion of the recycled water system. The pumping and storage improvements will be based on the selected site for the facilities. Therefore, the capital costs associated with treatment, pumping, and storage range from $99.5M to $114.1M. The overall recycled water system expansion project has been divided into multiple phases to create a Capital Improvement Plan (CIP) that is more fiscally manageable by implementing improvements over time and as they are necessary to further develop the recycled water system. A summary of the phases including other associated improvements (treatment, pumping, and storage) is provided in **Table ES1-3** below.

Table ES1-3: Proposed Capital Improvements Project Phases

Projects	Demand (AFY)	Pipeline Cost	Retrofit Cost	Total Capital Cost
Phase 1				
Wolfe Road	345	$6,399,000	$840,000	$7,239,000
Apple Contribution [1]		-$4,800,000		-$4,800,000
Wolfe Road Extensions	150	$2,136,000	$515,000	$2,651,000
Cal Water Contribution [2]		-$1,500,000		-$1,500,000
Treatment Improvements				$20,000,000
Pumping/Storage Improvements – San Lucar Site				$1,064,000
Phase 1 Total (without external contributions)	495	$8,535,000 ($2,235,000)	$1,355,000 ($1,355,000)	$24.7M ($31.0M)
Phase 2				
Infill Retrofits	335	$0	$2,675,000	$2,675,000
Duane Avenue	429	$3,956,000	$1,665,000	$5,621,000
Treatment Improvements				$11,000,000
Phase 2 Total	764	$3,956,000	$4,340,000	$19.3M
Phase 3				
Extensions	140	$1,287,000	$900,000	$2,187,000
Optional Extensions	87	$2,239,000	$455,000	$2,694,000
Treatment Improvements				$25,000,000
Pumping/Storage Improvements – Wolfe-Evelyn Water Plant Site				$10,901,000
Phase 3 Total (including optional extensions)	140 (227)	$1,287,000 ($3,526,000)	$900,000 ($1,355,000)	$38.1M ($40.8M)
Phase 4				
Main Loop	335	$13,504,000	$2,410,000	$15,914,000
Main Branch Extensions	151	$848,000	$625,000	$1,473,000
Optional Extensions	89	$2,076,000	$640,000	$2,716,000
Pumping/Storage Improvements [3] – Central Avenue Water Plant Site				$2,848,000
Phase 4 Total (including optional extensions and Central site)	486 (575)	$14,352,000 ($16,428,003)	$3,035,000 ($3,675,003)	$17.4M ($23.0M)
CIP Total [4] (including all optional extensions) [5]	**1,885 (2,061)**			**$99.5M ($114.1M)**

Notes:
1. CIP assumes Apple® will provide $4.8M in funding.
2. CIP assumes Cal Water will provide $1.5M in funding for this phase.
3. This cost would only be incurred if the Central Tank site was selected and is considered an addition to the $10.9M for pumping/storage improvements under Phase 3.
4. This cost includes all Critical Path and Supplemental Projects as well as contributions from Apple® and Cal Water.
5. This cost includes all Projects and excludes potential contributions.

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SECTION 1 – INTRODUCTION

The City of Sunnyvale (City) retained HydroScience Engineers (HydroScience) to prepare a *Feasibility Study for Recycled Water Expansion* (Feasibility Study). This Feasibility Study provides the basis for future recycled water infrastructure design and construction. The Feasibility Study builds on the 2000 Recycled Water Program Master Plan (2000 RWMP) identifies and prioritizes potential customers and recycled water system expansion alignments to achieve the City's goals for future recycled water use while maximizing efficiency in cost and implementation, and reducing treated effluent discharge to the South San Francisco Bay Estuary (Bay). The 2000 RWMP is included as **Appendix A**.

1.1 Purpose

The purpose of this Feasibility Study is to present the next phase of near-term recycled water demand forecasts for the City as well as the water quality requirements and needs associated with each of the specified uses and demands, and the treatment and system expansion requirements to meet those needs. The focus is on landscape irrigation uses that have minimal environmental impacts and can be implemented with very little adjustment to the existing recycled water quality.

The intent of this effort is to develop a Feasibility Study that includes:

- A report on the existing system, its condition, and capabilities;
- Planned expansion of service areas and sales projection scenarios, including connections to other regional recycled water systems and neighboring cities;
- Dynamic hydraulic systems models and flow projections;
- Feasibility of moving to zero discharge to the Bay at the Sunnyvale Water Pollution Control Plant (WPCP) during the dry season;
- Report on operations and maintenance practices and existing recycled water program, including fee assessment and fee schedules; and
- Up-to-date recycled water system maps in GIS format and drawings in AutoCAD format

1.2 Background

The City is located in Santa Clara County at the south end of the San Francisco Bay (see **Figure 1-1**). It is an urban, industrial, and residential community serving a population of approximately 142,000. The City and California Water Service Company (Cal Water) provide water service to the community (see **Figure 1-2**). The City's water supply sources consist of purchased treated water from SFPUC and SCVWD, groundwater, and City produced recycled water. Neighboring water retailers and wholesalers include the City of Santa Clara, the City of Mountain View, the City of San Jose, San Jose Water Company (SJWC), San Francisco Public Utilities Commission (SFPUC), and Santa Clara Valley Water District (SCVWD). Neighboring recycled water producers include South Bay Water Recycling (SBWR) and the City of Palo Alto.

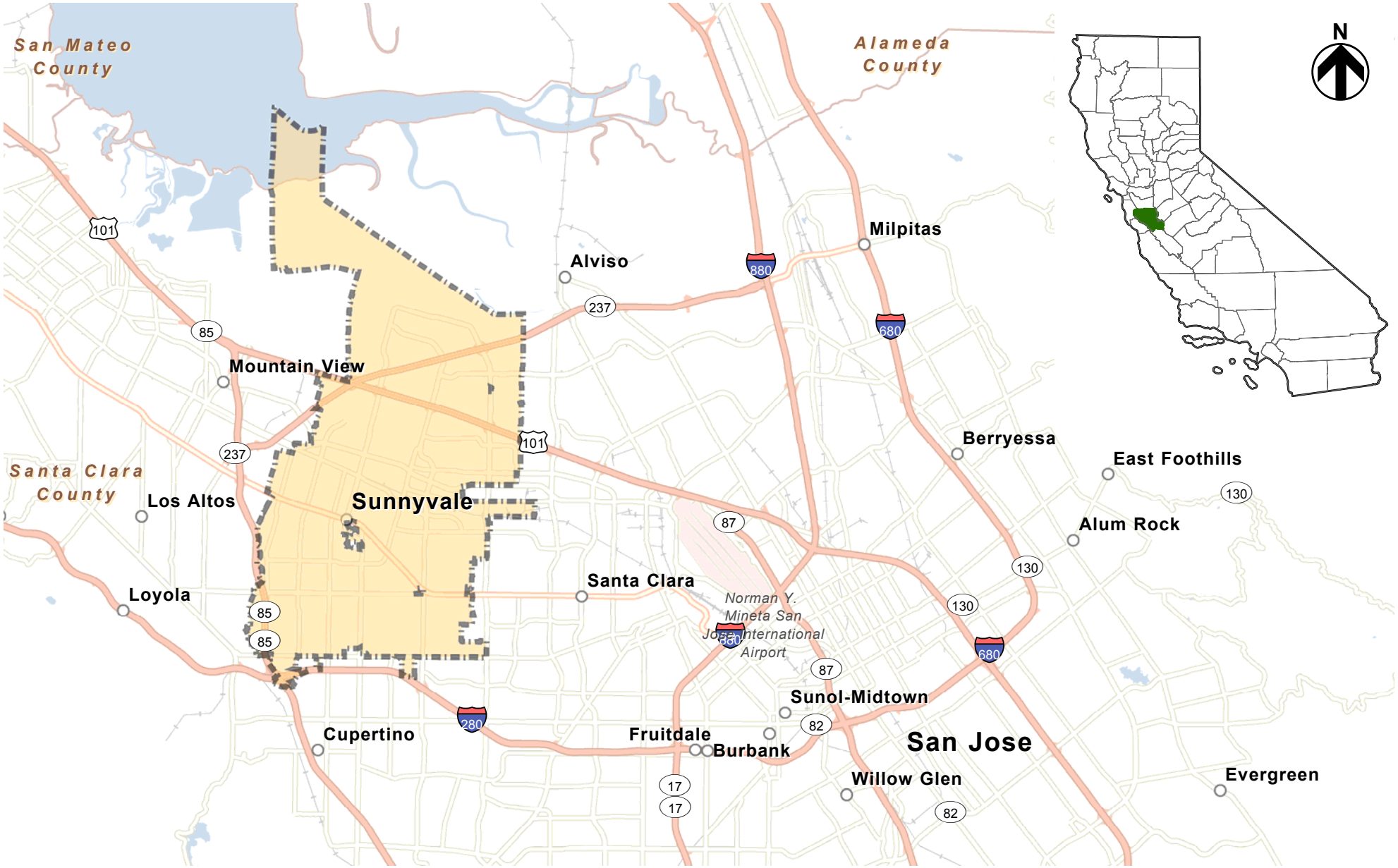


FIGURE 1-1
CITY OF SUNNYVALE
FEASIBILITY STUDY FOR RECYCLED WATER EXPANSION
PROJECT LOCATION MAP

HydroScience

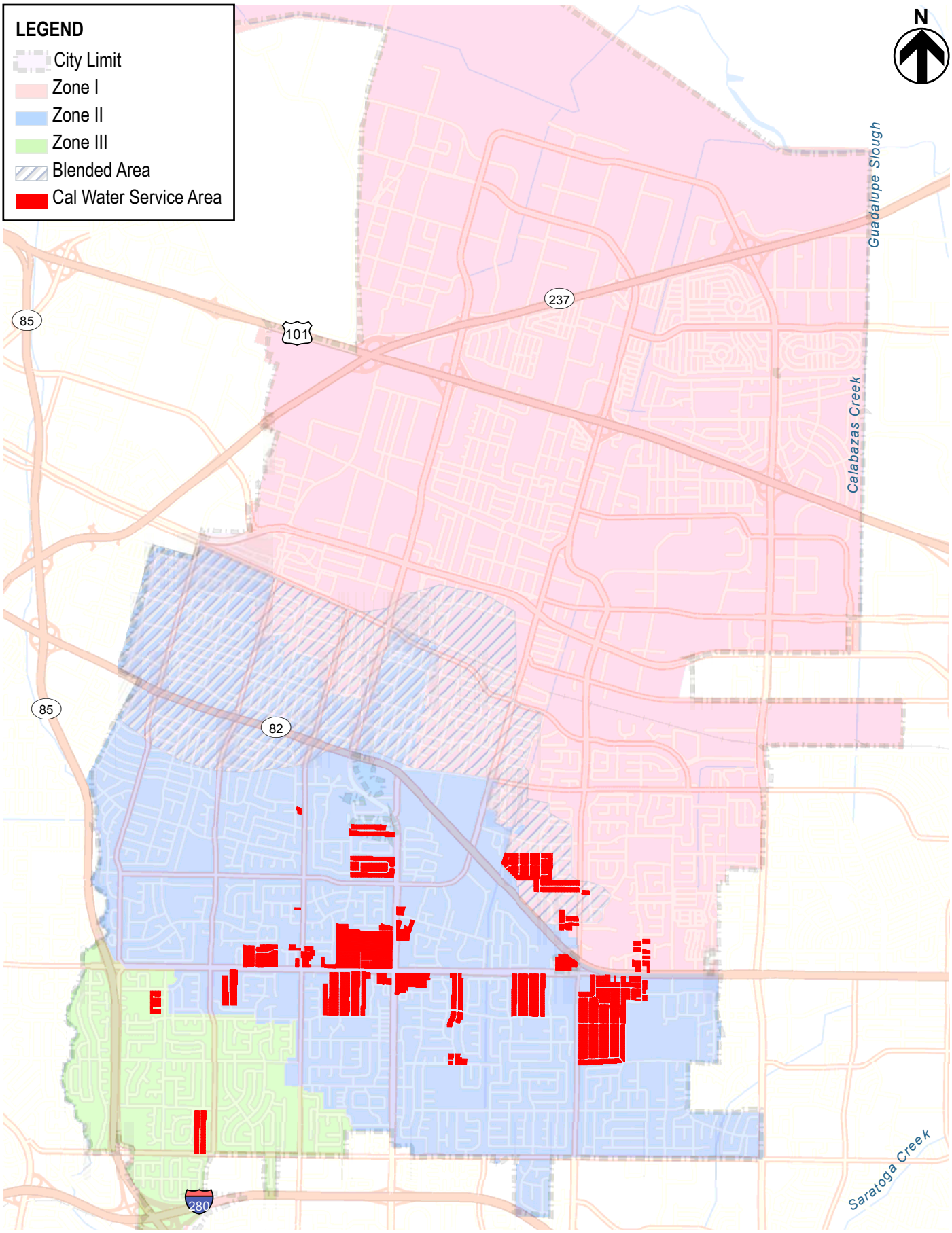


FIGURE 1-2
CITY OF SUNNYVALE
FEASIBILITY STUDY FOR RECYCLED WATER EXPANSION
WATER SERVICE AREA

HydroScience

1.3 Treatment and Disposal of Wastewater

The City treats its wastewater and produces recycled water at the Sunnyvale Water Pollution Control Plant (WPCP) located at 1444 Borregas Avenue. The WPCP is permitted for an average dry weather flow capacity of 29.5 MGD with a 40 MGD peak wet weather flow capacity; though current influent flows average approximately 15 MGD. The WPCP receives wastewater from the sanitary sewer collection system, which must be treated before it can be discharged to the Bay. The amount of influent wastewater handled by the WPCP varies with the time of day and with the seasonal changes in demand.

The WPCP is an advanced tertiary treatment plant that produces effluent meeting the City's NPDES discharge requirements. Most of the treated water is discharged to the Bay via the Guadalupe Slough. Approximately 10% of the plant flow is treated to a higher level to meet the necessary recycled water quality, and is delivered to customers for non-potable uses, which is primarily irrigation.

Historically, the City has been limited in expanding their recycled water distribution system due to the batch mode process of producing recycled water employed at the WPCP. The City is not under San Francisco Bay Regional Water Quality Control Board (RWQCB) mandate to cap the amount of treated wastewater discharged to the Bay. However, the City's National Pollutant Discharge Elimination System (NPDES) permit since 1998 (included as **Appendix B**) requires the City to take "measures to maximize reclamation and minimize the effluent discharge." As such, the City invested over $20M on their existing recycled system that includes the following elements:

- Polymer feed expansion and upgrades at WPCP
- WPCP improvements to switch from normal discharge mode to recycled water production
- WPCP pump station (5,400 gpm)
- San Lucar pump station (5,500 gpm)
- San Lucar storage (2.0 MG)
- 8" to 36" mains (74,460 ft)
- 120 customers primarily for landscape irrigation

The City's annual average recycled water demand in 2010 for recycled water was 0.76 MGD with a peak day demand of 2.5 MGD. Recycled water rates are set at 90% of the potable water rate. There is currently no connection fee, and in the past, the City provided a $3,000 subsidy for customers to convert from potable to recycled water. The existing 2000 RWMP identified near-term infill demands accessible to the existing mains; mid-term demands via a lateral; and long-term demands within and outside of the City through transmission mains and laterals. Dual-plumbing policies have been deferred until the completion of this Feasibility Study and will take into account recommendations from this effort.

Details about the current production of recycled water and proposed treatment modification options are discussed in **Sections 10.1** and **10.3**.

1.4 Previous Studies/Existing Documents

The following list provides a brief description of the previous studies and documents that have been prepared in relation to the City's recycled water system. Select documents are included in the appendices for reference.

- **Recycled Water Program Master Plan (December 2000):** This document describes the City's resources in the year 2000 for the production and distribution of recycled water. It presented opportunities for growth of recycled water use within the City limits and beyond, and presented a phased plan to construct facilities to reach those users. It describes specific use sites in the near-, mid-, and long-term timeframes and touches on the potential for streamflow augmentation and indirect potable reuse (See **Appendix A**).
- **NPDES Permit No. CA0037621, Order No. R2-2009-0061 for City of Sunnyvale Water Pollution Control Plant and sewage collection system, Santa Clara County:** This permit authorizes the City to discharge treated effluent to Moffett Channel, which is tributary to the South San Francisco Bay via the Guadalupe Slough. It details the water quality requirements, administrative requirements, effluent limitations, and discharge prohibitions that the City must implement and adhere to (See **Appendix B**).
- **Water Reclamation Requirements Order No. 94-069 for City of Sunnyvale Water Pollution Control Plant, Santa Clara County:** This permit authorizes the City as a recycled water producer to use and distribute recycled water to potential users within the City's Water Pollution Control Plant service area. It details the water quality requirements as well as the administrative requirements that the City must implement to monitor and manage the use of recycled water (See **Appendix C**).
- **Annual Recycled Water Reports (2009, 2010, and 2011):** The City prepares an annual self-monitoring report in accordance with the Master Reclamation Permit. As detailed in the permit, the producer is required to prepare and submit annual reports intended to document compliance with water quality requirements and prohibitions and to facilitate self-policing (See **Appendix D**).
- **Reclaimed Water System Hydraulic Modeling TM (September 2010):** A reclaimed water system hydraulic model was developed to analyze the operational conditions of the existing recycled water distribution system and identify recommended infrastructure developments and improvements to serve existing and potential recycled water customers. The plan targets existing users, golf courses, and public facilities, specifically parks and schools.
- **Water Reclamation Program – Administrative Procedures for Program Staff (May 1998):** This document describes the administrative procedures used by Sunnyvale's Water Reclamation Program for implementing the City's Rules and Regulations for Reclaimed Water Users and permitting reclaimed water users. This document details how the City will issue, review, and enforce permits to use reclaimed water in accordance with the Water Reclamation Permit.

1.5 Feasibility Study Organization

This Feasibility Study provides a description of the proposed recycled water program for the City of Sunnyvale. The sections contained in this document include the following:

- Section 1 – Introduction
- Section 2 – Water Supply Sources
- Section 3 – Recycled Water Quality Objectives
- Section 4 – Distribution System Planning Criteria
- Section 5 – System Design Criteria and Assumptions
- Section 6 – Recycled Water Customers
- Section 7 – Recycled Water Alignments
- Section 8 – Recycled Water Storage and Pumping
- Section 9 – Cost Development
- Section 10 – Wastewater Treatment Alternatives
- Section 11 – Capital Improvement Plan
- Section 12 – References

SECTION 2 – WATER SUPPLY SOURCES

This section describes the various water supply sources that are utilized by and potentially available to the City. Existing water supply includes potable water from water wholesalers, recycled water from the City's WPCP, and potable water via emergency interties with neighboring water utilities.

2.1 Potable Water Supply

The City has three sources of potable water supply: purchased surface water from the SFPUC, purchased treated surface water from the SCVWD, and groundwater from seven, City-owned and operated wells. There is one additional well that remains on stand-by for emergencies. The City also has potable distribution system inter-ties to the cities of Cupertino, Mountain View, and Santa Clara as well as to Cal Water through service connections located within city boundaries that are reserved for use in case of an emergency.

2.1.1 SFPUC – Wholesaler (Surface Water)

The City receives water from the City and County of San Francisco's Regional Water System (RWS), which is operated by the SFPUC. This supply is predominantly from the Sierra Nevada, delivered through the Hetch Hetchy aqueducts, but also includes treated water produced by the SFPUC from its local watersheds and facilities in Alameda and San Mateo Counties. The SFPUC supply is primarily unfiltered Hetch Hetchy water with a blend of filtered Sunol Valley water. There are six turnout connections from SFPUC's Bay Division Pipelines No. 3 and No. 4 to the City, which are listed in **Table 2-1**.

Table 2-1: SFPUC Turnout Connections

SFPUC Connection	Pressure Zone	Pipe Diameter of City Main Connection
Fair Oaks	I	30"
Lockheed	I	12" to 8" PRV and 24" to 16" PRV
Borregas	I	8"
Lawrence	I	16" and 12"
Mary	I	16"
Palomar	I	16"

The business relationship between the SFPUC and its wholesale customers is largely defined by the "Water Supply Agreement between the City and County of San Francisco and Wholesale Customers in Alameda County, San Mateo County and Santa Clara County" (WSA) entered into in July 2009. This new 25-year WSA replaced the Settlement Agreement and Master Water Sales Contract that expired in June 2009. The WSA addresses the rate-making methodology used by the SFPUC in setting wholesale water rates for its customers in addition to addressing water supply and water shortages for the RWS.

The WSA is supplemented by an individual Water Supply Contract between SFPUC and each individual retailer, also entered into in July 2009. These contracts also expire in 25 years. The City has an Individual Supply Guarantee (ISG) of 12.58 MGD (or approximately 14,100 acre-feet per year [AFY]). Although the WSA and accompanying Water Supply Contract expire in 2034, the ISG (which quantifies the SFPUC's obligation to supply water to its individual wholesale customers) survives their expiration and continues indefinitely. The Sunnyvale contract also includes a minimum purchase amount of 8.93 MGD (10,003 AFY), which the City agrees to buy, regardless of whether water sales drop below this level.

The Water Shortage Allocation Plan between the SFPUC and its wholesale customers, adopted as part of the WSA in July 2009, addresses shortages of up to 20% of system-wide use. The Tier 1 Shortage Plan allocates water from the RWS between San Francisco Retail and the wholesale customers during system-wide shortages of 20% or less. The WSA also anticipated a Tier 2 Shortage Plan adopted by the wholesale customers, which would allocate the available water from the RWS among the wholesale customers. The Tier 2 agreement was completed and approved by all the wholesale customers in March 2011.

2.1.2 SCVWD – Wholesaler (Surface Water)

The City purchases treated surface water from the SCVWD through an entitlement of imported Central Valley Project (CVP) water and the State Water Project (SWP) water, as well as surface water from local reservoirs. SCVWD's imported water is conveyed through the Sacramento-San Joaquin Delta then pumped and delivered to Santa Clara County through three main pipelines: the South Bay Aqueduct, which carries water from the SWP, and the Santa Clara Conduit and Pacheco Conduit, which bring water from the federal CVP. The water is treated at SCVWD's Rinconada Water Treatment Plant. The current contractual agreement between the City and SCVWD sunsets in 2051; it was effective in 1976 with a 75-year term.

There are two turnout connections from the SCVWD's west pipeline to the City's distribution system located in the southwestern end of the distribution system. **Table 2-2** describes the SCVWD turnout connections.

Table 2-2: SCVWD Turnout Connections

SCVWD Connection	Pressure Zone	Pipe Diameter of City Main Connection
Barranca	III	12"
Wright Avenue	III	30"

2.1.3 Local Groundwater

The City owns and operates seven active groundwater wells and one standby well for emergencies. The City uses the seven wells as a supplemental source to the imported SFPUC and SCVWD water supplies. The City exercises the active wells routinely, except for Losse 1 well, which is only used for emergencies. Water supplied by these wells is not treated. **Table 2-3** identifies each groundwater well, its capacity, and the pressure zone it serves.

Table 2-3: City of Sunnyvale Groundwater Wells

Groundwater Well	Pressure Zone	Pumping Capacity (gpm)
Central 2 [1]	I	700
Hamilton 2	II	600
Hamilton 3	II	800
Ortega	II	1,400
Raynor [1]	II	1,900
Serra	II	650
Westmoor	III	500
Losse 1 (Standby)	II	400

Notes:
1. At the time this document was developed, Central 2 and Raynor Wells were non-operational.

Within Santa Clara County, the SCVWD manages two groundwater subbasins that transmit, filter, and store water: the Santa Clara Subbasin (Department of Water Resources [DWR] Subbasin 2-9.02) and the Llagas Subbasin (DWR Subbasin 3.301). In its water supply planning, SCVWD frequently splits the Santa Clara Subbasin into two subareas, the Santa Clara Plain and the Coyote Valley. The City's groundwater comes from the Santa Clara Plain subarea of the Santa Clara Subbasin.

This subbasin contains young alluvial fill formation and the older Santa Clara Formation. Both formations are similar in character and consist of gravel, sandy gravel, gravel and clay, sand, and silt and clay. The coarser materials are usually deposited along the elevated lateral edges of the subbasins, while the flat subbasin interiors are predominantly thick silt and clay sections inter-bedded with smaller beds of clean sand and gravel.

2.1.4 Alternate Potable Water Supply Sources

The City has potential sources of additional potable water through emergency transfer connections and desalination. The City is currently connected to the cities of Cupertino, Mountain View and Santa Clara and to Cal Water through service connections located within Sunnyvale for use during emergency situations. The majority of the transfer/exchange opportunities are managed by the wholesalers, SFPUC and SCVWD. These connections are considered short term water transfers.

Desalination is a possibility for water provided by SFPUC and SCVWD. Both SFPUC and SCVWD are working together with the East Bay Municipal Utilities District, Contra Costa Water District, and the Zone 7 Water Agency as the Bay Area Regional Desalination Project (BARDP). BARDP may consist of one or more desalination facilities that would remove salt from seawater or other brackish water sources, with an ultimate total combined capacity of up to 80 MGD. Desalination would provide a potential potable water supply for municipal and industrial use. Pre-feasibility studies and pilot testing have been completed. The current estimated schedule anticipates that a site-specific analysis will be completed in 2013. The pre-design may begin in 2013, followed by full design and permitting in 2015. Construction may completed by 2020. Additional details regarding desalinated water opportunities can be found at the website: http://www.regionaldesal.com/schedule.html.

2.1.5 Water Quality Concerns

The surface water sources from the SFPUC and SCVWD meet or exceed existing water quality standards. Overall groundwater quality in Santa Clara County is good. The most notable exceptions are nitrate and perchlorate, which have impacted groundwater quality in the Llagas Subbasin. Sunnyvale has observed nitrate in excess of 50% of the MCL and conducts monitoring for nitrate more often than is required by regulation.

As the groundwater management agency in Santa Clara County, the SCVWD has ongoing groundwater protection programs to ensure high water quality and more reliable water supplies. These programs include well permitting, well destruction, wellhead protection, land use and development review, nitrate management (targeted to areas of elevated nitrate in the Coyote Subarea and the Llagas Subbasin), saltwater intrusion programs, and providing technical assistance to regulatory agencies to ensure local groundwater resources are protected.

Nitrate in the environment comes from both natural and anthropogenic sources. Small amounts of nitrate in groundwater (less than 10 mg/L) are normal, but higher concentrations suggest an anthropogenic origin. Common anthropogenic sources of nitrate in groundwater are fertilizers, septic systems, and animal waste. The drinking water maximum contaminant level (MCL) for nitrate is 45 mg/L as nitrate. Since the Santa Clara Valley has a long history of agricultural production and septic systems are still in use in the unincorporated areas of the county, monitoring for nitrate contamination is an essential groundwater management function in this valley.

2.2 Current and Projected Water Demands

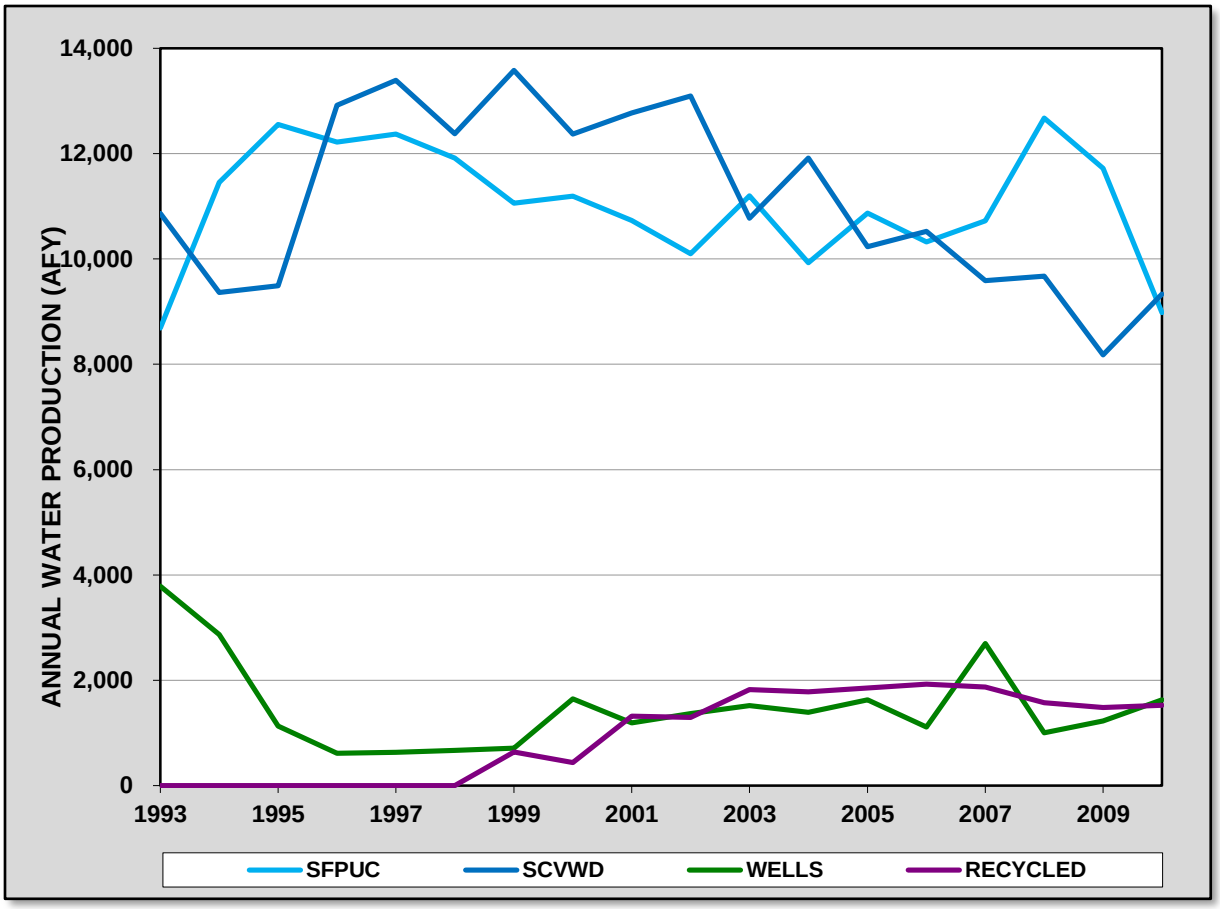
Water use varies throughout the years depending on several natural factors including the weather and the extension of seasons, but is also dependent on other factors such as business climate and the economy. Recognizing long-term general trends in water requirements is valuable in projecting future supply needs.

Water use in Sunnyvale generally increased during the period of 1993 to 2001 and steadily decreased since 2002 in response to drought-related conservation measures, economic factors and based on contractual limitations previously negotiated. The City converted its traditional sewer treatment plant in the mid 1990's to allow for the production of recycled water and began using recycled water in 1999, supplementing the overall water supply. **Figure 2-1** is a graphical depiction of the annual water use from the City's four water supply sources during the period of 1993 to 2010 as presented in the 2010 Urban Water Management Plan (UWMP).

The City categorizes its water accounts into five broad customer categories: single-family, multi-family, commercial (industrial and institutional), irrigation, and fire services. The commercial sector includes all non-residential accounts that are not classified as irrigation.

Past, current, and projected water use in the City are summarized by classification of the water delivered to all customers in **Table 2-4**, and by source in **Table 2-5**. Population is a primary factor affecting urban water demand. Since 2005, the number of service connections has increased by more than 1,500 for residential and commercial accounts. Single-family residential connections increased by 446, nearly a 20% increase; multi-family

Figure 2-1: Annual Water Production 1993-2010 (AFY)



residential connections increased by 278, over a 17% increase; and commercial/institutional connections increased by 941, nearly a 50% increase. Landscape irrigation connections have decreased from 786 to 588 connections while recycled water landscape irrigation connections increased by 31 to 112. "Other" connections, historically fire-lines, have decreased from 862 to 108 connections. The present and projected water demands for the City are shown in **Table 2-4**. The decrease in demand from 2005 to 2010 can be attributed to economic downturn.

Table 2-4: Past, Current, and Projected Water Use by Customer Type (AFY)

Customer Type	2005	2010	2015	2020	2025	2030	2035
Single family residential	8,264	7,023	6,555	6,393	6,341	6,378	6,378
Multi-family residential	6,047	8,309	7,755	7,563	7,502	7,545	7,545
Commercial	9,035	4,261	4,507	5,334	6,485	8,100	8,100
Irrigation	642	970	905	883	876	881	881
Other (Firelines)	946	911	850	829	823	827	827
Total Potable	**24,934**	**21,474**	**20,573**	**21,002**	**22,026**	**23,731**	**23,731**

Source: City of Sunnyvale 2010 Urban Water Management Plan

While the number of irrigation connections decreased since 2005, the water usage in that category increased during the same period. This is due to several factors, including the combining of water meters for greater efficiency and the increased use by large customers such as golf courses and athletic fields.

Table 2-5: Projected Demand by Source (AFY)

Service Area	2005	2010	2015	2020	2025	2030	2035
SFPUC	10,868	8,982	10,003	10,003	10,003	10,003	10,003
SCVWD	10,232	9,331	9,570	9,999	11,023	12,728	12,728
Wells	1,631	1,629	1,000	1,000	1,000	1,000	1,000
Total Demand	**24,582**	**21,464**	**20,573**	**21,002**	**22,026**	**23,731**	**23,731**

Source: City of Sunnyvale 2010 Urban Water Management Plan

Water loss within the City's distribution system can occur from various causes such as leaks, breaks, malfunctioning valves and the difference between the actual and measured quantities from water meter inaccuracies. Other losses come from legitimate uses such as water/sewer main and hydrant flushing, tests of fire suppression systems and street cleaning.

The system losses experienced by Sunnyvale's water distribution system have historically been between 4% and 8% and are thus substantially lower than the 10% losses normally experienced by systems in urban areas (AWWA, Water Resource Planning; Manual of Water Supply Practices M50, 2001, p33), as shown on **Table 2-6**. **Table 2-6** provides all other water uses and losses that are not accounted for in the past, current, and projected demands associated with user demand. Saline water intrusion barriers, groundwater recharge, and conjunctive use are not shown below since these uses are managed by SCVWD and are reflected in SCVWD's UWMP for the entire County.

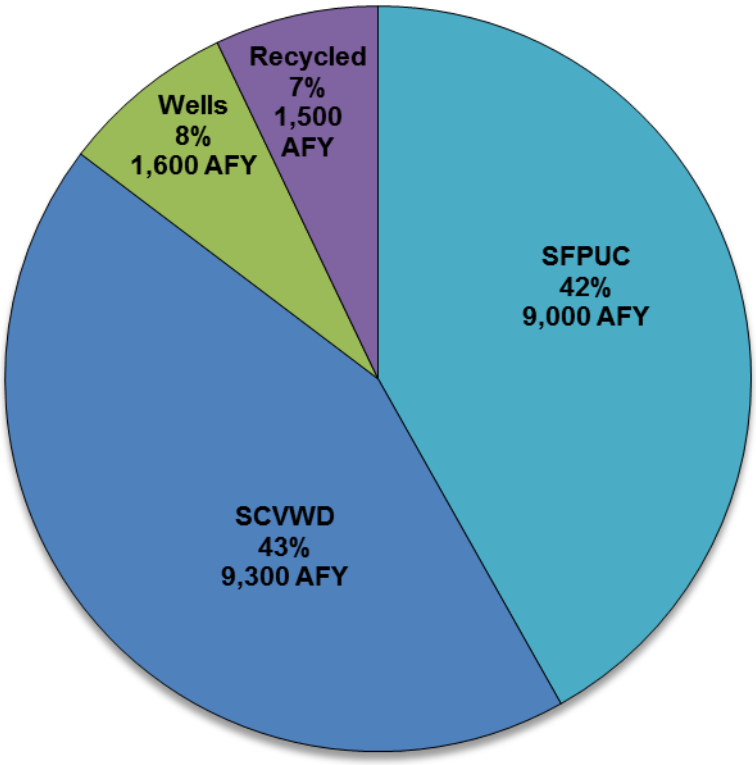
Table 2-6: Additional Water Uses and Losses (AFY)

Water Use	2005	2010	2015	2020	2025	2030	2035
Recycled Water	1,851	1,523	1,400	1,525	1,650	1,775	1,775
System Losses	1,496	1,288	1,234	1,260	1,321	1,423	1,423
Total	**3,374**	**2,811**	**2,634**	**2,785**	**2,971**	**3,198**	**3,198**

Source: City of Sunnyvale 2010 Urban Water Management Plan

Figure 2-2 represents the percentage of water supply from each source for Calendar Year 2010 as described in the City's 2010 UWMP.

Figure 2-2: City of Sunnyvale Sources of Water Supply



2.3 Recycled Water Supply

The City has developed a recycled water program, which today serves parks, golf courses, and the landscaping needs of diverse industries. A wastewater reclamation program was developed in 1991 when the City first identified short-term goals of recycling 20% to 30% of effluent from the Sunnyvale WPCP. The long-term goal of the City is to reuse 100% of all wastewater (15 MGD) generated from the WPCP to reduce or eliminate discharges to the South San Francisco Bay, as stated in the 2000 RWMP. This goal, if attained, would involve the export of recycled water outside the City limits in addition to serving recycled water customers within the City limits.

The City has designed and constructed multiple projects between 1992 and 2000 as part of Phases I and II of the 2000 RWMP. The Baylands Pipeline and Phase I Reclaimed Water Distribution System projects (constructed in 1993 and 1994, respectively) form the backbone of the City's recycled water distribution system. The Phase IIa Reclaimed Water Distribution System project (constructed in 1996) provided a network of pipelines to distribute recycled water to over 50 sites throughout the Moffett Park Area. The Maude/Macara project (constructed in 1999) extended the 'west main' to Encinal Park. The Phase IIb Reclaimed Water Distribution System project (constructed in 2000) extended the recycled water distribution system south to the San Lucar tank and pump station. **Table 2-7** provides a summary of constructed recycled water distribution projects.

Table 2-7: Existing Recycled Water Distribution Projects [1]

Project Name	Year Completed	Pipeline Diameter (inches)	Pipeline Length (feet)	Description
Baylands Pipeline	1993	12 to 36	6,300	Service to Baylands Parks, Caltrans Future service to Twin Creeks
Phase I Reclaimed Water Distribution System	1994	16 to 24	16,000	Service to Sunnyvale Golf Course & Caltrans interchanges Future service to Lockheed Martin, NASA
Phase IIa Reclaimed Water Distribution System	1996	8 to 16	37,000	Service to Moffett Park Area First segment of 'east main'
Maude/Macara Extension	1999	16	1,160	Extension of 'west main' to Encinal Park
Phase IIb Reclaimed Water Distribution System	2000	24	14,000	Extension of 'east main' to storage and pumping facilities near Wolfe & Kifer Roads (San Lucar Site)

Source: City of Sunnyvale Recycled Water Program Master Plan, December 2000.

The City's current recycled water system consists of the WPCP pump station, the San Lucar tank and pump station, the Sunnyvale Golf Course pump station, and approximately 18 miles of recycled water pipelines ranging in diameter from 6- to 36-inches. Each pump station is described below:

WPCP Pump Station: The WPCP pump station is located adjacent to the WPCP's chlorine contact tanks (CCTs) and consists of six pumps with a rated firm capacity of 3,750 gpm with the largest pump out-of-service. Theses pumps currently feed the San Lucar Tank.

- **San Lucar Tank and Pump Station:** The San Lucar site is home to a 2.0 MG storage tank. This storage is comprised of a 1.5 MG recycled water storage tank and a 0.5 MG surge tank. The storage tank was built in 2000 to increase the reliability and capacity of the City to deliver recycled water. Recycled water stored in this tank is pumped into the recycled water distribution system. The pump station consists of five pumps capable of delivering 5,500 gpm with the largest pump out-of-service.
- **Sunnyvale Golf Course Pump Station:** This pump station consists of two variable speed pumps with a rated firm capacity of 1,800 gpm with the largest pump out-of-service. This pump station serves the Sunnyvale Golf Course.

Figure 2-3 presents the location of the Sunnyvale WPCP, the existing recycled water distribution system, and the existing recycled water use area. The recycled water supply has some water quality concerns regarding total dissolved solids and color. These concerns are discussed in **Section 3.2**.

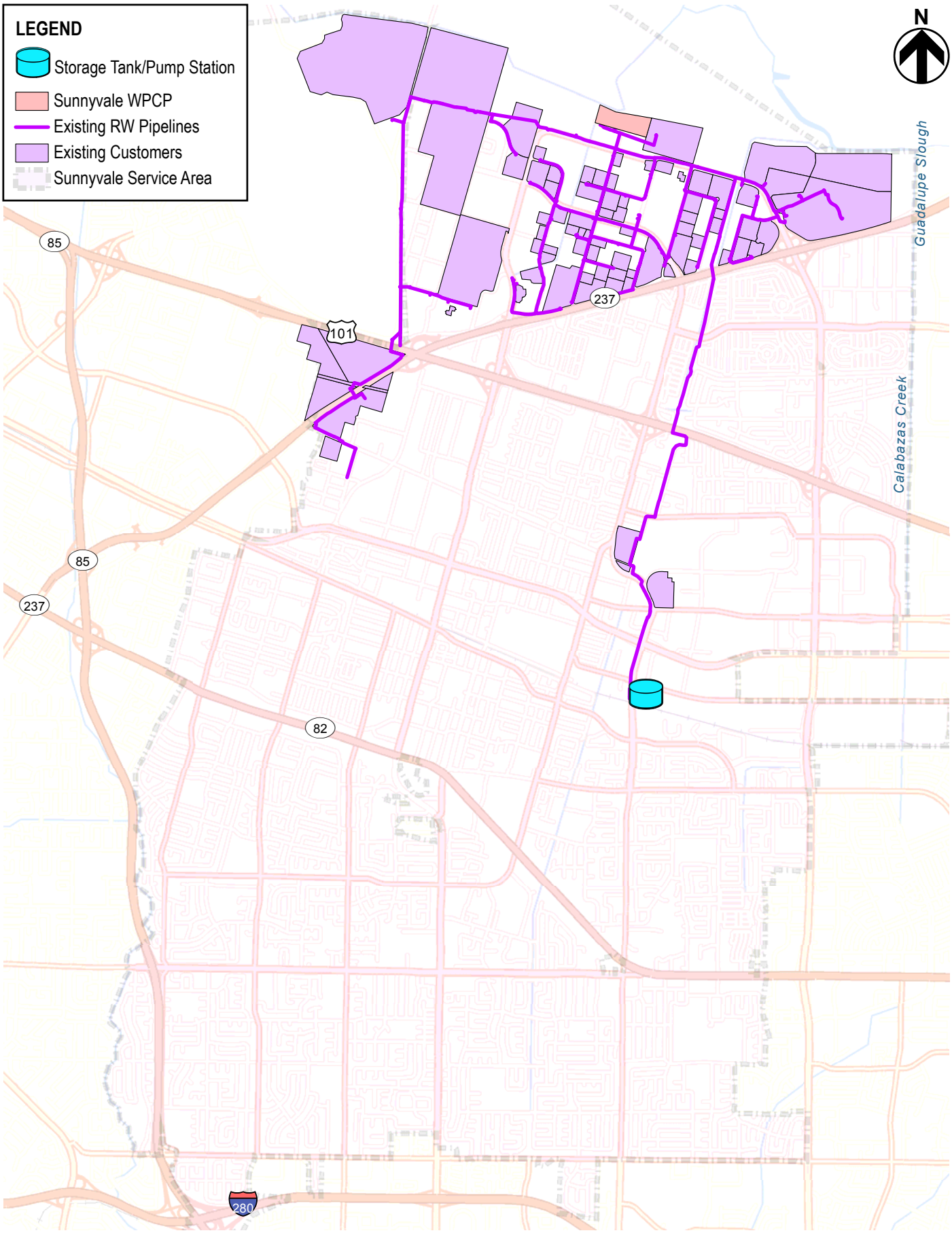


FIGURE 2-3
CITY OF SUNNYVALE
FEASIBILITY STUDY FOR RECYCLED WATER EXPANSION
EXISTING RECYCLED WATER SYSTEM

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2.4 Economic Analysis or Water Supply Alternatives

The City's water demands are projected to increase by approximately 10% between 2010 and 2035. Without the proposed recycled water projects, water demands are expected to be met by increasing the amount of water purchased from the SFPUC and SCVWD. Additional infrastructure projects are not considered necessary. Therefore, the recycled water projects primary purpose is not only to provide a water supply but to provide water supply reliability and to reduce the effluent discharge to the Bay.

The City's two imported water supply sources from the SFPUC and SCVWD have reliability issues that are not within the City's control, as discussed in the 2010 UWMP. The SFPUC's infrastructure system is vulnerable to major seismic activity that could knock out the water supply from Hetch Hetchy from 2 to 4 months. SCVWD's system is 40-50 years old and has aging issues and the levees that protect the Delta water supply are also very vulnerable to failure and contamination from flooding and sea water intrusion. It is also subject to judicial water restrictions from the US District Court in order to protect the Delta smelt.

The City currently has two ways to improve the water supply reliability which are within the City's control: groundwater and recycled water. The City received proposals in October 2012 to evaluate the feasibility of drilling two or more high production wells to improve the City's water supply reliability. It is expected that the study will be completed in 2013. SCVWD has jurisdiction over the amount of water that can be withdrawn from local wells in its aquifer, which includes the City's wells. SCVWD also charges a fee per acre-foot of groundwater extracted from the wells. The City has not maximized its utilization of groundwater, and groundwater supplies could increase, if required.

Recycled water provides a non-potable water supply option that is within the City's control and not subject to drought restrictions, Delta smelt restrictions, or groundwater restrictions. Producing more recycled water would also decrease the City's effluent discharge to the Bay. The only other way to reduce the City's effluent discharge is to increase water conservation measures in the City. This report evaluates various options to expand the recycled distribution system and wastewater treatment options to improve production, quality, and reliability of the recycled water supply. The treatment system improvements would also meet the projected recycled water capacity and water quality requirements.

The current environmental political climate makes it unlikely that the City can obtain other effluent discharge options (such as surface water discharge or land disposal). However, increased recycled water is encouraged in State legislation (Clean Water Act), and it was also encouraged in the 1998 NPDES permit as an appropriate way to use effluent discharge.

The 2007 San Francisco Bay Basin Water Quality Control Plan also has strict requirements for effluent discharges to San Francisco Bay south of the Dumbarton Bridge; however, reclaimed water is exempt from these requirements. Therefore, the recycled water project could provide an alternative to installing potentially expensive treatment processes at the WCPC.

To summarize, the qualitative benefits of the recycled project water are described below:

- Reduced potable water demands due to increased recycled water use;
- Securing a long-term adequate water supply to sustain economic growth and ensure public health;
- Drought-proof water supplies to irrigation customers;
- Less costly water supply because recycled water is retailed at 90% the cost of potable water;
- Increased reliability of the water supply;
- Reduced TDS and color in potable water supply;
- Easier to implement because not subject to quantity discharge limits;
- Reduced effluent discharge to the Bay which reduces pollutants discharged to the Bay and also benefits the saline wetlands by preventing fresh water from diluting the saline waters.

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SECTION 3 – RECYCLED WATER QUALITY OBJECTIVES

The City recycled water system is regulated by Order No. 94-069 as promulgated by the RWQCB, which dictates the water quality requirements in order to meet the standard for unrestricted reuse of recycled water. Order No. 94-069 is included as **Appendix C**. This criterion is also governed by the California Code of Regulations (CCR) Title 22 definition of disinfected tertiary recycled water.

This section describes the regulatory requirements for water quality; the existing recycled water quality produced at the WPCP, specific issues associated with the existing water quality, and proposed water quality to meet user specific needs.

3.1 Regulatory Requirements

Recycled water produced at the WPCP must meet California Department of Public Health (CDPH) criteria for disinfected tertiary recycled water, as specified in the CCR Title 22 as well as Order No. 94-069. The applicable water quality requirements are listed in **Table 3-1**.

Table 3-1: Recycled Water Quality Criteria to meet Disinfected Tertiary Standard [1]

Parameter	Criteria
CBOD (5-day, 20ºC)	20 mg/L daily maximum 10 mg/L monthly average
Dissolved Oxygen	1.0 mg/L minimum
Dissolved Sulfide	0.1 mg/L maximum
Turbidity	<2 NTU daily average <5 NTU 95% of the time within a 24-hour period <10 NTU at all times
Total Coliform	< 2.2 MPN/100 ml (7-day median) <23 MPN/100 ml (one sample maximum in 30 day period) <240 MPN/100 ml (single sample maximum)
C*T	>450 mg/L with T > 90 minutes (modal basis)

Notes:
1. Water quality requirements as identified in Order No. 94-069 (See **Appendix C**).

3.2 Existing Recycled Water Quality

Currently, recycled water that produced at the WPCP meets the regulatory requirements for disinfected tertiary as described above. In addition to meeting the requirements described above, the recycled water also has the water quality characteristics listed in **Table 3-2**, which is the data presented in the City's 2011 Annual Water Quality Report (see **Appendix D**).

Total dissolved solids (TDS) and color are two water quality issues that are of concern to the City and its recycled water customers. The current concentration of TDS in the recycled water is higher than desired, and there is a green tint to the water that is aesthetically undesirable. These two water quality issues are not caused by the batch production mode specifically but are a result of the influent quality and treatment process currently in place at the WPCP. The existing treatment process is discussed further in **Section 10.1**.

Table 3-2: Recycled Water Quality Characterization (2011 Annual RW Report)

Parameter	1/20/11	2/28/11	3/14/11	5/21/11	6/26/11	7/26/11	8/1/11	9/7/11
Anions (mg/L)								
Chloride	220	214	220	239	281	292	307	305
Bicarbonate	96	116	126	172	140	139	141	128
Sulfate	86	84	93	94	92	84	81	74
Nitrate	25	20	15	8	8	14	11	11
Phosphate	3.2	4	4.3	2.4	3	5.5	5.4	5.2
Cations (mg/L)								
Calcium	55	53	56	58	50	48	55	50
Magnesium	34	23	32	40	39	42	44	39
Sodium	142	137	141	161	160	190	194	192
Water Quality Parameters								
TDS (mg/L)	834	774	760	822	838	858	968	905
Conductivity (dS/m)	1.27	1.16	1.21	1.36	1.43	1.52	1.59	1.44
Hardness (mg/L as $CaCO_3$)	276	228	272	308	284	292	316	284
Alkalinity (mg/L as $CaCO_3$)	96	116	126	172	140	139	141	128
Salinity (g/L)	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.7
Boron (mg/L)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Ammonia (mg/L)	2	4.5	0.1	0.9	0.6	1	0.6	0.3
pH, standard units	7.03	7.09	7.67	7.21	7.56	7.47	7.23	7.2
HCO_3/Ca, ratio	0.58	0.72	0.74	0.98	0.92	0.95	0.85	0.84
SAR_{Na} [1]	3.78	4	3.81	4.1	4.11	4.78	4.81	4.93
SAR [1]	3.7	3.93	3.7	3.97	4.11	4.81	4.73	4.93

Notes:
1. SAR = Sodium Adsorption Ratio

3.2.1 Total Dissolved Solids (TDS)

Between 2007 and 2011, the average recycled water TDS concentration was approximately 930 mg/L, with a maximum of close to 1,000 mg/L (EOA, 2012). The average recycled water TDS is significantly higher than the WPCP influent, which averaged 760 mg/L in 2010 and 2011. The City has indicated that the oxidation ponds experience a high evaporation rate, particularly during the summer irrigation months, which causes this increase in the TDS concentration through the WPCP. The City's TDS water quality goal is to reduce the recycled water concentration to be consistently closer to the WPCP influent TDS of 760 mg/L to meet the water quality objectives for City customers.

3.2.2 Color

The City has seen increased levels of greenish color in the effluent that likely results from a small amount of algae remaining in the oxidation pond effluent. The dissolved air flotation (DAF) and filtration treatment processes are able to remove most of the algae from the pond effluent, but a small amount of algae remains. Although increasing the polymer dosage to a level above what is required to meet regulatory requirements may aid in the additional removal of algae, the additional chemical usage would increase operational costs.

3.2.3 Ammonia

The City currently is experiencing higher than normal concentrations of ammonia in their secondary effluent. Although the presence of ammonia should not be a concern for recycled water, the ability of technologies such as Reverse Osmosis (RO) to treat secondary effluent would be a benefit, since this could help to address other WPCP issues. However, RO concentrate would have high ammonia concentrations, which could affect the ammonia concentration in the outfall to the bay.

3.3 Recycled Water Quality Goals

The existing recycled water quality and future objectives are summarized in **Table 3-3**. The proposed alternatives were developed with the intention to meet these water quality objectives.

Table 3-3: Existing and Target Recycled Water Quality

Constituent	Units	Existing Recycled Water Quality [1]		Water Quality Objectives (Average)
		Average (2011)	Max (2011)	
TDS	mg/L	930 mg/L	1,100	760
Color	--	Green		No visible color

Notes:
1. Source: EOA, 2012. Average salinity from April through October, 2009 and 2010.

The City may pursue infiltration and inflow (I & I) projects that could reduce the TDS of the WPCP influent, but the alternatives evaluation does not consider this in the overall evaluation. Instead, this would be a realized benefit when the projects are implemented, and the TDS of recycled water would be further reduced. Wastewater treatment alternatives are further discussed in **Section 10.3**.

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SECTION 4 – DISTRIBUTION SYSTEM PLANNING CRITERIA

This section provides the planning criteria and assumptions used to develop the recycled water demands for the Feasibility Study.

4.1 Areas Considered

There are three primary areas considered as part of this Feasibility Study effort. The areas include the City of Sunnyvale, Moffett Field Business Group, and portions of the City of Cupertino. Each of the potential recycled water use areas is described below:

- **Sunnyvale:** The entire City, bounded by the City limits, is included in this analysis of potential recycled water use.
- **Moffett Field Business Group:** The City has reached out to the Moffett Field Business Group and identified potential interest in recycled water use for landscape irrigation. Initial estimates have been developed based on existing metering data.
- **Portions of Cupertino:** The City is considering an opportunity to provide recycled water to Cal Water who will serve the planned Apple® Campus 2 at the southern boundary of the City limits at Wolfe Road. The developers of the Apple® Campus 2 estimate that they have the potential to use up to 220 AFY for industrial and dual-plumbed uses, as well as between 15 and 163 AFY for irrigation uses, depending on the recycled water quality.

4.2 Basis for Demands

Water meter data and the City's existing GIS data was the primary basis for developing near-term recycled water demands for potential customers. Meter data was analyzed to identify and quantify any trends in the use of potable (and recycled) water for landscape irrigation and cooling tower use. Where water meter usage data was unavailable, local climatological data and estimated percentage of use area was applied to individual parcel sites to estimate near-term demands. Separately metered data for water usage for industrial purposes, such as cooling towers, was not available since these water demands are not usually separately metered; however, potential users have been identified based on the presence of cooling tower facilities and water usage data. The section describes the various data sources and information used to develop near-term demand estimates.

4.2.1 Land Use Zoning

Potential customers were first sorted and categorized by respective zoning districts, which have been previously identified by the City. Those zoning districts and descriptions are provided in **Table 4-1**. Non-residential parcels such as industrial, commercial, parks, and schools; and high-density residential (R3, R4, and R5) parcels with landscape irrigation meters were prioritized as potential users. Low-density residential customers (i.e. R0, R1, R1.5, R1.7, and R2) with separate irrigation meters were secondary and assumed to include common irrigation areas only. Low-density residential parcels with no irrigation meters were not considered for retrofit.

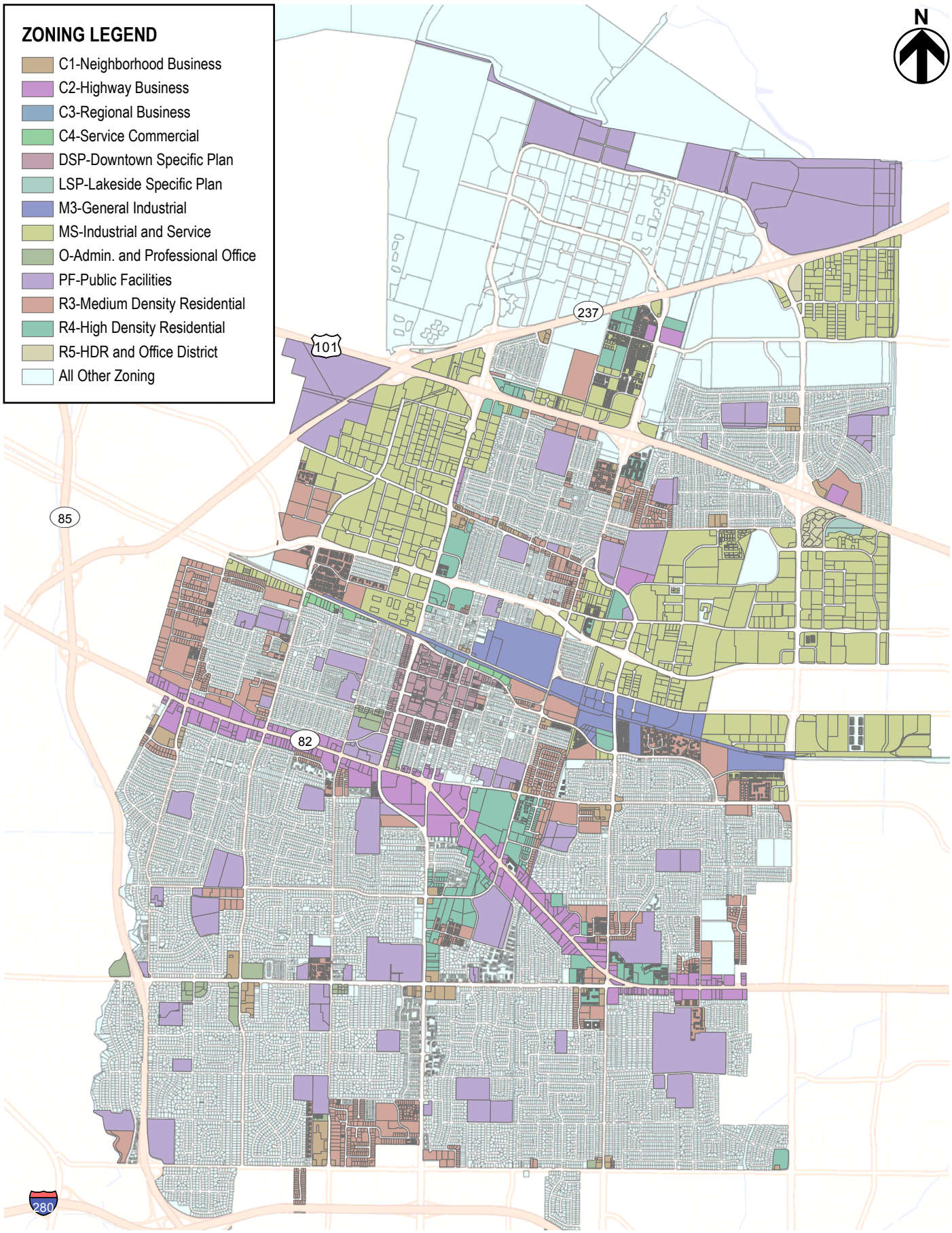

FIGURE 4-1
CITY OF SUNNYVALE
FEASIBILITY STUDY FOR RECYCLED WATER EXPANSION
LAND USE ZONE MAP

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Table 4-1: City of Sunnyvale Zoning Districts

Zone	Land Use Type	Description
R0	Low Density Residential	Single-Family Housing
R1	Low Density Residential	Single-Family Housing
R1.5	Low Medium Density Residential	Single-Family Housing
R1.7	Low Medium Density Residential	Single-Family Housing
R2	Low Medium Density Residential	Single- & Two-Family Housing
R3	Medium Density Residential	Two-Family / Duplex / Triplex Housing
R4	High Density Residential	Residential High Density (27-45 DU[1]/acre)
R5	High Density Residential/Office District	High Density Residential/Office 101/Lawrence Site Specific Plan (45-65 DU/acre)
RMH	Residential Mobile Home	Mobile Home Parks and Housing
MS	Industrial and Service	Industrial
M3	General Industrial	Industrial
MPT	Moffett Park Transit Oriented Development	Class A Office, R&D, and Corporate Headquarters
MPI	Moffett Park General Industrial	Office, Warehouse, and General Industrial
MPC	Moffett Park Commercial	Hotels and Retail Establishments
O	Administrative and Professional Office	Administrative-Professional Office
C1	Neighborhood Business	Commercial Neighborhood Shopping
C2	Highway Business	Commercial General Business
C3	Regional Business	Commercial Central Business
C4	Service Commercial	Commercial General Business
PF	Public Facilities	Schools, Parks, and other City-owned Facilities
DSP	Downtown Specific Plan	Sunnyvale Downtown Development Area
LSP	Lakeside Specific Plan	Lakeside Hotel and Residential Development

Notes:
1. DU = Dwelling Unit

4.2.2 Water Usage Data and City GIS Mapping

The City provided water meter usage data for all customers within the City from July 2006 to April 2012. The data was based on meter readings and associated billing information. These were primarily bi-monthly and monthly readings. The files contained data for existing recycled water services (RW), potable water services (WS), landscape services (LS), and fire services (FL), each denoted in the data files by their respective acronym. Landscape and recycled water services are metered by total consumption, while the usage data for general water service (WS) meters are sorted by the City's tiered rate structure, which includes a volumetric rate increase according to the following ranges:

- Tier 1: 0 to 6 hundred cubic feet (CCF)
- Tier 2: 7 to 20 CCF
- Tier 3: 21 to 50 CCF
- Tier 4: 51 to 500 CCF
- Tier 5: 501 to 1,250 CCF
- Tier 6: 1,251 to 2,500 CCF
- Tier 7: Over 2,500 CCF

The data was initially reduced by first removing all fire service data and then sorted by service type (i.e. RW, LS, and WS). Each service is associated with a Location Identification (LID) number, which represents individual water services or sites. Meter reading data was consolidated by meter type and associated LID. The water service meter data is represented by flows categorized by each rate tier, as detailed above. Flows were combined for each user to identify the total water usage for that user regardless of rate. Annual water usage was based on all data for all five years in order to estimate the average annual water demand in acre-feet per year for each LID. The meter data was consolidated by LID, then by Assessor Parcel Numbers (APNs) to determine annual water demands for each site. The recycled water services were tabulated separately from the potable water services (LS and WS).

Most users with large irrigation demands, such as schools and parks, have separate landscape service meters; however, there are some potential customers using water service meters for both indoor and outdoor (irrigation) uses. These customers' water services (WS) were further analyzed by their seasonal usage pattern in order to estimate annual irrigation demands.

All non-residential and high-density residential water services were isolated and summarized by overall monthly usage. The average monthly usage was determined using meter data collected between July 2006 and April 2012. The average of the two winter months with the lowest water demands, January and February, was identified as the baseline for irrigation demands. The net positive difference between the baseline demand and the monthly demand was estimated to be the irrigation demand.

The total estimated irrigation use of 25%, determined from the data provided in **Appendix E**, was applied universally to water service meters to estimate irrigation demands. The estimated irrigation demands for water services and landscape services were sorted by their respective LIDs.

The City has a well-developed and current Geographic Information System (GIS) map of the entire City. Nearly all of the parcels within the City limits are identified in the GIS map and includes information about each parcel such as the APN, square footages, and site addresses. In conjunction with the parcel data, the City has each of the LID's, which represents meter services, identified and linked to associated APNs. Using the LID numbers and associated annual average water demands developed from the metered data, we linked the demands to the associated parcels in the GIS map. For every parcel that had a landscape service, there was generally also a water service; in which case, the landscape service demand was used to estimate potential recycled water demands. For the sites with

no separate landscape service, irrigation demand estimates were based on the estimated seasonal variation described above. The irrigation use estimate of 25% was applied to the total average annual water demand for the water service to determine the average annual irrigation demand using the following formula:

Average Annual Water Demand x 25% = Estimated Average Annual Irrigation Demand

Using this method as an initial filter, we also viewed Google Maps™ and aerial imagery provided by the City to verify the potential for irrigation use and adjusted the list of potential customers and their demands as warranted for each particular site.

In a small number of cases, there were parcels within the GIS map that had no APN number or outdated APN numbers, or parcels that were not linked to the appropriate LID number. In the event that we were unable to rectify the discrepancy by manually associating the LID and demand to the appropriate parcel, we estimated the potential water usage using local climatological data and estimated irrigated areas. This method is described in the discussion about climatological data.

4.2.3 Climatological Data

Irrigation with recycled water would be limited to application at agronomic rates to prevent excessive runoff of recycled water. Agronomic rates are specific to the local climate and are dependent on evapotranspiration (ET) and precipitation rates. These criteria are used to determine the recycled water demands per acre of irrigated area for those sites in which we were unable to determine the irrigation demand from existing metered usage data. A summary of how these criteria are utilized to determine the total irrigation demand is included below.

ET Rates

ET is a measure of water usage by a particular plant or crop, and is a function of the net solar radiation, air temperature, wind speed, and vapor pressure in a particular location. ET rates for a specific crop in a specific location are calculated on a monthly basis by the following equation:

$$ET = ET_o * k_c$$

Where:

ET_o = *Normal year reference crop evapotranspiration rate for a given geographic location (California Department of Water Resources [DWR], California Irrigation Management Information System [CIMIS] database)*

k_c = *Crop coefficient for a given crop (University of California – Cooperative Extension, California Turfgrass Culture Leaflet)*

For this Feasibility Study, the reference crop is turf grasses and the normal year evapotranspiration (ET_o) rates for the region were obtained from the DWR CIMIS database. Crop coefficients for cool weather turf grasses were obtained from the UC Cooperative Extension Leaflet. Calculated ET rates and irrigation demands are presented in **Table 4-2**.

Table 4-2: Estimated Irrigation Demands for the City of Sunnyvale

Month	ET (Inches) [1]	P (Inches) [2]	ID (Inches)
January	0.98	2.88	0.00
February	1.32	2.68	0.00
March	2.74	2.31	1.21
April	3.87	1.19	4.84
May	4.98	0.45	8.42
June	5.48	0.10	9.89
July	5.95	0.02	10.88
August	5.18	0.07	9.38
September	4.06	0.19	6.60
October	2.74	0.76	3.07
November	1.42	1.50	0.16
December	0.78	2.41	0.00
Average	**3.29**	**1.21**	**4.54**
Total	**39.50**	**14.56**	**54.45**

Notes:
1. ET data source: CIMIS Monthly Evapotranspiration Report for Gilroy (Station 211), the closest active station.
2. Precipitation data from WRCC, San Jose, California (047821) for 1/1893 – 02/2012.

Precipitation

Monthly precipitation data for the region was obtained from the Western Regional Climate Center (WRCC) data. Monthly rainfall values from 1893 through 2012 were averaged to obtain typical annual rainfall data.

Estimated Unit Irrigation Demands

Typical monthly unit irrigation demands for turf grasses are summarized in **Table 4-2** and were calculated using the following formula:

$$ID = \frac{(ET - Pe_p)l_r}{e_i}$$

Where:

ID = *Monthly irrigation demand or allowable irrigation in inches.*

ET = *Evapotranspiration for turf grasses.*

P = *Average precipitation, WRCC.*

e_p = *Precipitation irrigation efficiency, 0.85. Assumes 15% of rainfall during growing season is lost to evaporation, runoff, etc.*

l_r = *Loss rate or leachate factor, equal to 1.1. This assumes that approximately 10% of the applied water passes through the grass root zone and is lost.*

e_i = *Irrigation efficiency, ranges from 0.6 to 0.95 (depending on season). This assumes that 5% to 40% of the applied irrigation water is lost to evaporation.*

As shown in **Table 4-2**, the peak monthly irrigation demand of 10.88 inches occurs in July. The allowable irrigation for any month is assumed to never fall below zero. For months during which the allowable irrigation is positive, additional water from the recycled water system can be applied. The typical season for irrigation demands stretches from March through November, with little to no irrigation demand projected from December through February.

The irrigated acreage for each parcel without metered data was calculated based on the total acreage multiplied by the estimated percent irrigation area listed below in **Table 4-3**. The irrigation demand was then calculated by multiplying the calculated irrigated acreage by the ET rates described above to develop an annual recycled water demand for landscape irrigation.

Table 4-3: Zoning Districts and Estimated Percentage Irrigation Area

Zone	Land Use Type	% Irrigation Area [1]
R4	High Density Residential	15%
R5	High Density Residential/Office District	10%
MS	Industrial and Service	5%
M3	General Industrial	5%
MPT	Moffett Park Transit Oriented Development	5%
MPI	Moffett Park General Industrial	5%
MPC	Moffett Park Commercial	10%
O	Administrative and Professional Office	10%
C1	Neighborhood Business	10%
C2	Highway Business	5%
C3	Regional Business	10%
C4	Service Commercial	5%
PF	Public Facilities	65%
DSP	Downtown Specific Plan	10%
LSP	Lakeside Specific Plan	10%

Notes:
1. Low and Medium Density Residential parcels (R0-R3) as well as Residential Mobile Home (RMH) sites were assumed to have 0% recycled water irrigation demand for the purposes of estimating demands using climatological data.

Approximate percentage of irrigated area within each zoning area was estimated based on land use type and expected level of irrigation for that particular land use type. Non-irrigated areas include hardscaped surfaces such as sidewalks, buildings, walkways, parking lots, and other areas that do not require irrigation. These percentages were applied to parcel areas to estimate irrigated areas, where necessary.

4.2.4 Customers with Large Potential Recycled Water Demands

A list of major potential recycled water users was developed. This list represents the customers that were estimated to use over 25 AFY of potable water for irrigation. This list was developed based on the data compiled using the GIS mapping, metered water use data, as well as the climatological data, where metered data was not available.

Table 4-4: Major Potential Recycled Water Users

APN	Zone	Owners	Site Address	Potential RW Use (AFY) [1]
20536006	MS	Applied Materials Inc.	974 E Arques Avenue	113
20522024	SP	Sunny Chip 15 LLC Et Al (AMD)	1090 E Duane Avenue	77
21124042	PF	City of Sunnyvale - Orchard Heritage Park /Sunnyvale Community Center	570 E Remington Drive	76
20127015	PF	City of Sunnyvale - Las Palmas Park	850 Russet Drive	66
21347009	PF	City of Sunnyvale - Sunken Gardens	1010 S Wolfe Road	58
30936051	PF	City of Sunnyvale - Ortega Park	636 Harrow Way	50
11005003	PF	S C V W D		48
16511001	PF	City of Sunnyvale - Washington Park	255 S Pastoria Avenue	40
20521001	MS	Spansion LLC	915 De Guigne Drive	39
20448028	M3	Northrop Grumman Corp	501 Hendy Avenue	39
11002070	PF	City of Sunnyvale - West Hill	1444 Borregas Avenue	35
11002015	MPT	United States Of America	1235 N Mathilda Avenue	34
20550036	MS	Industrials Sunnyvale	1090 Kifer Road	33
21635026	MS	Berg Family Partners, L.P.	1250 E Arques Avenue	31
21327001	PF	SCUSD - Ponderosa Elementary School	804 Ponderosa Avenue	31
20407001	PF	SSD - Columbia Park & Middle School	739 Morse Avenue	29
19833002	PF	SSD - Sunnyvale Middle School	1080 Mango Avenue	28
32326013	PF	City of Sunnyvale - Serra Park	730 The Dalles	28
11024038	PF	City of Sunnyvale - Lakewood Park	834 Lakechime Drive	27
11020014	PF	SSD - Lakewood Elementary	834 Lakechime Drive	27
20536006	MS	Applied Materials Inc.	974 E Arques Avenue	27
11013077	R3	WM Mission Pointe LLC	1089 Morse Avenue	27
32014001	PF	CUSD - Cupertino Middle School	1650 S Bernardo Avenue	26
31310004	PF	SCUSD - Peterson MS/Silicon Valley ES	1055 Dunford Way	25
20519002	PF	City of Sunnyvale - Fair Oaks Park	540 N Fair Oaks Avenue	25

Notes:
1. This represents the major water users that are expected to use over 25 AFY of recycled water. This total does not represent the total potential recycled water use for the City.

4.2.5 Recycled Water Incentives

The City promotes the use of recycled water through its price structure. Recycled water is priced at 90 percent of the prevailing, first-tier potable water rate. The City intends to continue this financial incentive in the foreseeable future, as possible. The TM prepared by Bartle Wells Associates, discusses potential rate structures, and is included as **Appendix F**.

Sunnyvale's use of the market technique of providing recycled water at a ten percent discount and assistance in making on-site modifications (retrofits), along with an active public education process and a user-friendly permit process have resulted in significant expansion of the system. With few exceptions, the pricing policy has been successful in encouraging prospective users to convert to the limited use of recycled water in those areas where it is available. A re-occurrence of drought conditions could be expected to further enhance interest in recycled water. Marketing efforts are discussed in more detail in **Appendix G**.

Table 4-5: Methods Used to Encourage Recycled Water Use

Methods	Check if Used
Retrofit assistance	X
Grants	
Dual plumbing standards	X
Permit process enhancement	X
Regional planning	
Incentive program	
Long-term contracts (price/reliability)	
Pricing policy (i.e. rate discounts)	X
Prohibit specific fresh water uses	
Low-interest loans	
Public education/information	X
Require recycled water use	

Source: City of Sunnyvale 2010 Urban Water Management Plan

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SECTION 5 – SYSTEM DESIGN CRITERIA AND ASSUMPTIONS

This section presents the recycled water system design criteria used to develop the hydraulic model and analyze the system.

5.1 Modeling Criteria

The City initially developed a recycled water hydraulic model in 2007 and updated this model in 2010. This hydraulic model served as the basis for the system expansion modeling effort. In order to develop infrastructure recommendations for the expansion of the recycled water distribution system, the 72-hour Maximum Day Extended Period Simulation (Dynamic/Peak Hour) 'EX_EPS' was used. A child scenario was created in order to expand the distribution system, storage, and pumping requirements while leaving the existing systems extended period simulation unchanged.

To be consistent with the existing recycled water system, the distribution system design criteria were developed based on the City's *2010 Water Utility Master Plan* (IEC, 2010) and the *2010 Technical Memorandum – Reclaimed Water System Hydraulic Modeling* (IEC, 2010). The design criteria in these two documents were established to ensure that the proposed distribution system would provide adequate, but not excessive, water pressure and so that the conveyance system would be capable of handling peak demands without excessive wear on the distribution system and without excessive energy usage.

It should be noted that the recycled water system design criteria previously developed allotted for two-thirds of the Peak Day Demand (PDD) for system storage along with emergency potable water system interties. In a small system this is sufficient; under normal operating conditions the WPCP can account for the additional one-third of the PDD, while peak days may utilize the potable water back-up connection. In order to increase system reliability, provide operational flexibility, and continue to move toward the goal of 100% reuse, the system design criteria for recycled water storage was increased to be equivalent to one peak day. The recommended design criteria are presented in **Table 5-1**.

Table 5-1: Recommended Recycled Water Distribution System Design Criteria [1,2]

Criteria	Target Design Criteria	Criteria Limit
Maximum Pressure	105 psi	150 psi
Minimum Pressure	60 psi	40 psi
Pipe Headloss	10 ft/1000 ft	15 ft/1000 ft
Maximum Pipeline Velocity	7 fps	7 fps
Hazen Williams Coefficient (C)	120	
Irrigation Period	9:00 PM to 6:00 AM (9 hours)	
Operational Reservoir Storage	Peak Day Demand (PDD)	
Pump Station – Design Capacity	Peak Hour Demand (PHD)	
Pump Station – Minimum Number of Pumps	3	

References:
1. City of Sunnyvale's Water Utility Master Plan (IEC, 2010)
2. City of Sunnyvale's Technical Memorandum – Reclaimed Water System Hydraulic Modeling (IEC, 2010)

5.2 Peaking Factors

After identifying estimated average annual usage, the usage was translated into peak day and peak hour flow rates for the purpose of sizing infrastructure. The development of peaking factors is described below.

5.2.1 Peak Day Demand (PDD)

Peak day flows are estimated by applying peak factors to calculated average day demands (ADD). Peak day flow rates account for seasonal variations in ET rates. Based on the data presented in TM #1, the average monthly irrigation demand over the year is 4.54 inches. However, the peak monthly irrigation demand occurs in July and is 10.88 inches. Thus, the monthly peak demand factor is:

$$Factor = \frac{10.88\ in}{4.54\ in}$$

$$\textit{Peak Day Demand Factor} = 2.40$$

It is assumed that the PDD is essentially the same as peak monthly irrigation demand for facility planning purposes. This is reasonable because not all customers will be irrigating during the same period. It is further assumed that “true” peak day irrigation demand conditions (all customers irrigating on the same day) would rarely occur, and the cost of providing facilities to meet these demands is not justified. Therefore, a PDD factor of 2.40 is assumed. This factor multiplied by the ADD results in the PDD.

5.2.2 Peak Hour Demand (PHD)

Peak hour delivery demands for irrigation systems are a function of the length of daily irrigation periods. As a measure of added protection for the public, it is assumed that recycled water irrigation would occur over a nine-hour period between 9:00 PM and 6:00 AM at a consistent hourly rate. Thus, the peak hour flow is the peak day flow concentrated into a nine-hour period. This factor equates to:

$$Factor = \frac{24\ hr}{9\ hr}$$

$$\textit{Peak Hour Factor} = 2.67$$

This factor is multiplied by the PDD, and assumes that the irrigation demands are uniform over the nine-hour daily irrigation period. Actual peaking requirements can be reduced by scheduling water deliveries to larger customers during off-peak hours. A summary of peaking factors assumed for landscape irrigation is provided below:

$$\textit{Peak Day Demand} = 2.40 \times \textit{Average Day Demand}$$

$$\textit{Peak Hour Delivery Demand} = 2.67 \times \textit{Peak Day Demand}$$

$$\textit{or}$$

$$= 6.40 \times \textit{Average Day Demand}$$

Table 5-2 presents the peaking factors used to size the new recycled water distribution system infrastructure in the hydraulic model.

Table 5-2: Recommended Peaking Factors

Peaking Factor	Recommended Factor
Peak Day	2.40 x ADD
Peak Hour	2.67 x PDD or 6.40 x ADD

5.3 Diurnal Curves

Two diurnal patterns were applied to recycled water usage in the hydraulic model for irrigation and industrial demands. These diurnal patterns were used to simulate the variation in demand over a 24-hour period. The irrigation diurnal pattern assumes irrigation takes place during the nine-hour window between 9:00 PM to 6:00 AM and allows for ramping down of the pump station over the final two hours. This pattern was previously developed for the recycled water hydraulic model. Currently there is no industrial diurnal pattern. However, the potable water hydraulic model has a diurnal pattern that was previously developed (IEC, 2010) in order to simulate all non-residential customers. This non-residential pattern was applied to the industrial customers in the recycled water model. Both diurnal patterns are presented in **Table 5-3** and charted in **Figure 5-1**.

Figure 5-1: Diurnal Curves

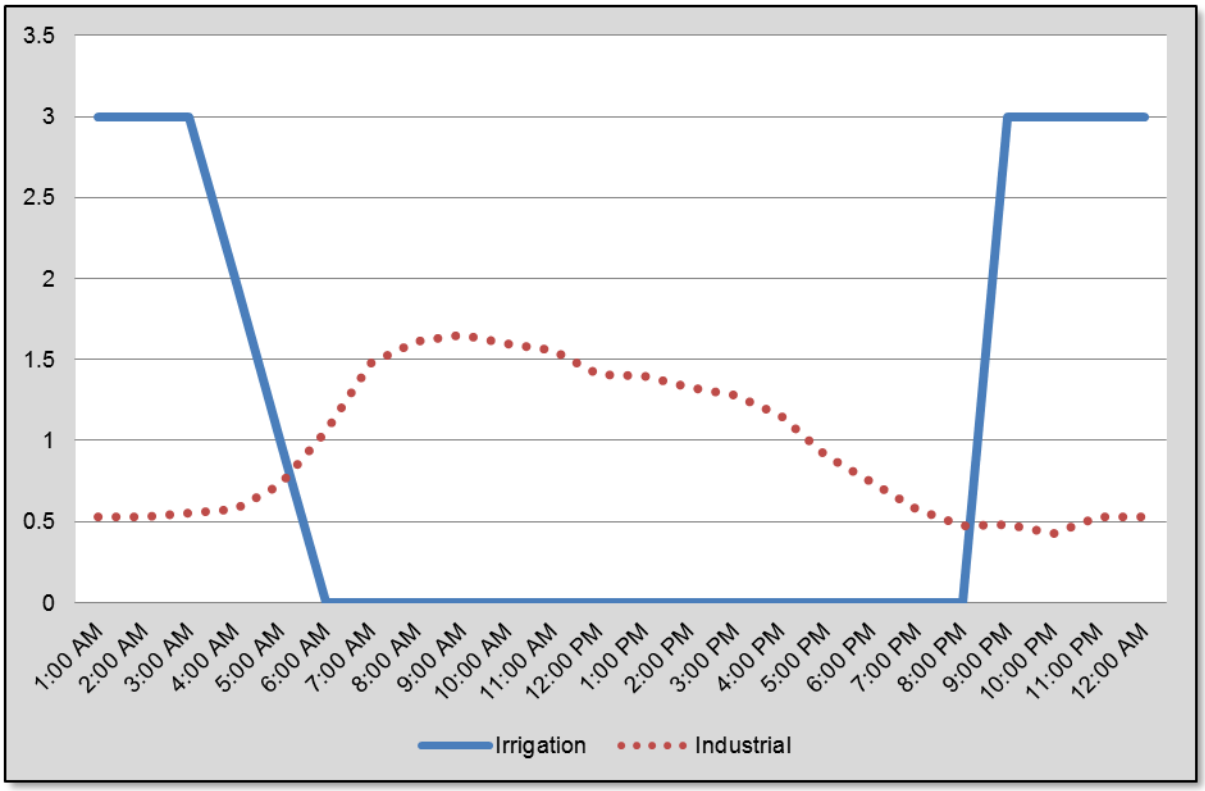

Table 5-3: Diurnal Multipliers

Time	Irrigation	Industrial
1:00 AM	3	0.53
2:00 AM	3	0.53
3:00 AM	3	0.55
4:00 AM	2	0.58
5:00 AM	1	0.73
6:00 AM	0	1.06
7:00 AM	0	1.48
8:00 AM	0	1.61
9:00 AM	0	1.65
10:00 AM	0	1.60
11:00 AM	0	1.56
12:00 PM	0	1.41
1:00 PM	0	1.40
2:00 PM	0	1.33
3:00 PM	0	1.28
4:00 PM	0	1.15
5:00 PM	0	0.91
6:00 PM	0	0.74
7:00 PM	0	0.58
8:00 PM	0	0.47
9:00 PM	3	0.48
10:00 PM	3	0.43
11:00 PM	3	0.53
12:00 AM	3	0.53

SECTION 6 – RECYCLED WATER CUSTOMERS

In the 2000 RWMP and other current modeling reports, the City has identified near-term recycled water demand in the vicinity of the City's existing recycled water distribution system. This section provides a characterization of recycled water demands that have been further developed based on expansion of the recycled water distribution system to the south and incorporating users that were previously identified as potential customers. This section describes the potential types of recycled water use and the criteria developed to select recycled water users.

6.1 Existing Recycled Water Customers

The City currently provides recycled water to approximately 120 services within the City limits as well as to Moffett Field. These customers are essentially bounded to the southeast by Highway 237 (see **Figure 2-3**), with some extensions south of the Sunnyvale Golf Course and along Wolfe Road. Major customers include the Sunnyvale Golf Course, Baylands Park, and the Twin Creeks Sports Complex.

The recycled water infrastructure is a network of pipelines running along the primary roadway arteries within the northern section of Sunnyvale as well as Moffett Park Specific Plan area providing irrigation water to a long list of industrial customers including Lockheed-Martin and Yahoo. **Appendix I** provides a detailed list of existing recycled water customers. Together, typical annual recycled water demands for these existing customers total approximately 1,062 AFY.

6.2 Types of Recycled Water Use

There are a variety of approved Title 22 uses for recycled water including both landscape irrigation and industrial uses such as cooling tower makeup and dual-plumbed use (i.e. toilet and urinal flushing). This section describes each use and the associated requirements.

6.2.1 Irrigation Use

All recycled water customers identified in this Feasibility Study were selected based on their ability to use recycled water exclusively for Title 22 approved landscape irrigation uses for non-single family residences. Typically, these sites include golf courses, parks, schools, multi-family residential, and business and industrial developments with large landscaped areas. Non-residential or multi-family residential parcels with common area irrigation are best suited for recycled water use, since knowledgeable landscape maintenance staff is responsible for operating and maintaining the irrigation system in accordance with Title 22 requirements.

To facilitate site containment, each irrigation site utilizing recycled water is required by CDPH to be inspected annually and monitored by a site supervisor. The operation of these facilities will be expected to comply with all existing CDPH Rules and Regulations regarding recycled water, which among other things, prohibit excessive unauthorized runoff, overspray, and ponding. Water fountains and designated outdoor eating areas will be protected from spray, mist, and runoff by accomplishing one of the following:

- Repositioning or relocating the irrigation system (i.e. moving a sprinkler);
- Relocating or modifying the protected facilities per the approval of the City inspector and the customer; or
- If either of the above methods cannot be performed, modifying the irrigation schedule, with the approval of the City, to limit irrigation to times when the public is not present.

All drinking water fountains will be connected to a separate domestic water supply pipeline and will not be connected to any recycled water lines. Where potable and recycled water lines are in close proximity, the separation of these lines shall comply with horizontal and vertical requirements as described in the *CCR Chapter 16. California Waterworks Standards Article 4 – Section 64572: Water Main Separation, (June 2012)*. Additionally, to reduce unauthorized runoff and ponding, the sites will be irrigated at agronomic rates. Irrigation systems will also be designed to prevent irrigation of recycled water within 50 feet of any domestic water supply wells.

It is recommended that all unsupervised irrigation with recycled water be conducted between the hours of 9:00 pm and 6:00 am. The purpose of the use of recycled water during this period is to ensure that irrigation in areas accessible to the public is conducted when the public is least likely to be present.

Advisory signs will be placed where they can be easily seen. To the extent necessary to advise passersby, signs will be posted at the property line near crosswalks, at driveway entrances, at outdoor eating areas, or as needed. For streetscapes (i.e. parkways, frontage or backup landscaping), signs will be placed at street corners as appropriate to notify passersby. Signs should be placed no further than 1,000 feet apart. For medians, a sign is usually placed at the beginning and the end of every median, and another approximately equidistant from the ends of the median for longer median areas.

The method of irrigation should be indicated on the design drawings prepared for each recycled water customer. It is expected that all irrigation customers will employ either spray or drip irrigation (or both), as required for the various types of vegetation.

6.2.2 Industrial Cooling

Recycled water can be provided to customers for industrial purposes, such as cooling tower makeup, boiler feed, or other approved uses. The use of recycled water for industrial purposes is typically sensitive to recycled water quality. Retrofitting of a customer to use recycled water in lieu of potable water requires customer considerations that are typically specific to each customer.

The City has the potential to provide customers with recycled water for cooling tower makeup or other industrial uses. However, the cost of retrofitting sites to receive water for these uses, the uncertainty of customer specific requirements, and concerns over the impacts of recycled water quality on equipment maintenance and manufacturing makes this a longer-term objective that may need to be coordinated with water quality improvements. Initiating discussions with potential industrial customers will be necessary to determine their needs to use recycled water for industrial purposes.

6.2.3 Dual-Plumbed Use

Dual-plumbed use systems are defined as systems that have separate piping for recycled water and potable water under two scenarios; to serve plumbing fixtures (toilets and urinals) within a building or for landscape irrigation for single-family residential. Landscape irrigation systems for non-single family residential parcels are specifically excluded from the definition of dual-plumbed use areas since they typically have separate irrigation systems to begin with and can be served by either potable or recycled water. According to the 2011 Annual Recycled Water Report, the City has two active dual-plumbed customers.

The City operates the recycled water system under the Master Water Reclamation Permit (Permit, Order No. 94-069) issued by the RWQCB. The Permit gives the City the authority to regulate recycled water users in accordance with Title 22 regulations. As such, the City is required to develop a program for recycled water users to assure that recycled water use is in accordance with applicable CDPH and RWQCB regulations. With respect to dual-plumbed use, typically a user would be required to provide a Title 22 Engineering Report; however, the users under the Permit are exempt from this requirement. Dual-plumbed users would be subject to the requirements of the City's Water Reclamation Program per the Permit.

In September 2010, the City evaluated the potential for developing a dual-plumbing use ordinance. The report describes the existing policies that address the use of recycled water and water conservation goals. The recommendation was to require recycled water use for irrigation, but not for dual-plumbing, for new residential and non-residential buildings that meet the identified criteria. The recommendation was also to further study ways in which to encourage recycled water use and expansion.

As part of the effort to develop the Feasibility Study, HydroScience further evaluated the potential for the City's development and implementation of dual-plumbing policies. The findings supported those presented in the September 2010 Report to Council. The TM with the detailed evaluation is included as **Appendix H**. HydroScience did not recommend that the City pursue the development of a dual-plumbing policy due to the limited incentive and opportunity, and the high cost of implementing a dual-plumbing system. However, HydroScience did support the report finding to codify a policy regarding the implementation of recycled water for landscape irrigation in new developments due to the high potential for water-savings. HydroScience further recommended that the code require a separate irrigation meter for all new multi-family and non-residential buildings that meet the proposed criteria regardless of proximity to an existing or planned recycled water pipeline. Those developments would also be required to design and construct the irrigation system to meet recycled water system design requirements per the City's and Title 22 regulations. This will assure that these systems will be ready for connection when and if, recycled water becomes available.

6.3 Potential Recycled Water Demands

This section describes the recycled water alignments identified for recycled water distribution within the City's service area and the criteria used to determine the alignments. All of the demands have been evaluated, mapped, and grouped into clusters to identify key areas where distribution system pipelines may be routed.

6.3.1 Criteria for Potential Recycled Water Use

All potential users estimated to have at least 0.5 AFY of irrigation demand were identified to establish a visual representation of all potential recycled water use within the City limits. Using the actual and estimated average annual demands, HydroScience identified areas with the highest potential for recycled water use. The intent of this analysis was to identify the most cost-effective customers to provide recycled water service to. The basis for evaluating cost-effectiveness is essentially length and size of the recycled water pipeline and the volume of recycled water demand. The following criteria were used to prioritize users and identify potential recycled water system pipeline alignments:

- **Proximity to existing recycled water pipeline:** Parcels that are located closer to the existing recycled water distribution system pipeline would require shorter pipeline extensions and are identified as potential customers.
- **Customers with dedicated landscape meters:** Customers with dedicated landscape meters, particularly schools and parks, will generally have larger irrigation demands and will have less complex retrofit designs.
- **Other major customers and demand clusters:** Customers with larger irrigation demands as well as clusters of customers whose sum would generate a large demand.

Streetscapes, medians, and other roadside landscaping were not included as potential recycled water users. This is due to the uncertainty of the source of water, which entity owns or maintains them, and the relatively low demand of these areas in the City. It is expected that either during design of the facilities, or following project startup, these users would be evaluated for connection to the recycled water alignment.

The intent of the distribution system extension alignments is to maximize recycled water use and supply recycled water to all potential irrigation customers. Essentially, identified areas along the potential alignments, except for single-family homes with private front and back yards, would be irrigated with recycled water.

In some cases, multiple meters serve a single parcel, and as such, the actual number of recycled water meter service connections may exceed the number of sites identified in the Market Assessment. This can also be attributed to variations in irrigation system design, the size of some parcels, and the phasing of construction of those parcels.

6.3.2 Recycled Water Alignments

Sixteen alignments were identified and considered as part of this Feasibility Study. The alignments are developed to meet near-term demands. City GIS and meter data, a review of potential high demand recycled water users, and the ability to pick up potential users along particular alignments were applied as criteria to develop alignments, as described previously in this document. Four types of alignments/connections were developed, which include:

- **Wolfe Road Main:** This pipeline is intended to extend the recycled water system to the south to capture potential users along the Sunnyvale-Cupertino boundary, specifically the Apple® Campus 2.

- **Main Loop:** This alignment is intended to loop the existing recycled water system to provide reliability, connect to future storage tank site(s), and provide opportunity for further expansion and recycled water use along the alignment.
- **Potential Recycled Water Alignments:** These alignments are intended to capture outlying potential high demand users that are not located along the mainline or Wolfe Road alignments. These alignments generally extend to a specific high demand user or cluster of users and attempts to pick up as many viable users along the way.
- **Infill Connections:** Customers that have been identified along the existing recycled water pipelines and do not require pipeline extensions, but rather only retrofits of the sites to receive recycled water.

Table 6-1 identifies the alignment name, the point-of-connection (POC), the estimated demand, and the targeted high demand users along that alignment.

Table 6-1: Proposed Recycled Water Alignments and Demands

Point of Connection	Demand (AFY)	Target Customers
Lakehaven Drive	86	Lakewood Park and Elementary School
Maude Avenue	36	Columbia Park and Middle School
Duane Avenue	429	Advanced Micro Devices
Kifer Road East	51	Fortinet Inc.
Kifer Road West	54	Northrop Grumman Corp
Iris Avenue	55	Pondersa Park and Elementary School
Marion Way	30	Peterson Middle School, Silicon Valley Elementary School, and Raynor Park
Dartshire Way	65	Ortega Park
Gail Avenue	39	Cherry Blossom Properties and Braly Park and Elementary School
Old San Francisco Road	26	Life's Garden Retirement Community and Ellis Elementary School
Manet Drive	86	Orchard Heritage Park and Sunnyvale Community Center
Sunnyvale-Saratoga Road	14	Fremont High School
Remington Drive	59	Sunnyvale Middle School and De Anza Park and Elementary School
Carson Drive	16	Vargas Elementary School
Main Loop	335	Las Palmas and Washington Parks
Wolfe Road Main	345	Sunken Gardens Golf Course and Apple® Campus 2 [1]
Existing System Infill Connections	335	Various Customers
Moffett Field	50	Various Customers
Total Estimated Demand (AFY)	**2,111**	

Notes:
1. Current estimated irrigation demand for the Apple® Campus 2 may vary from 15 AFY up to 160AFY depending on recycled water quality. Indoor demand is estimated to be 220 AFY. For planning purposes, it is assumed that the site will use the minimum estimated, 235 AFY.

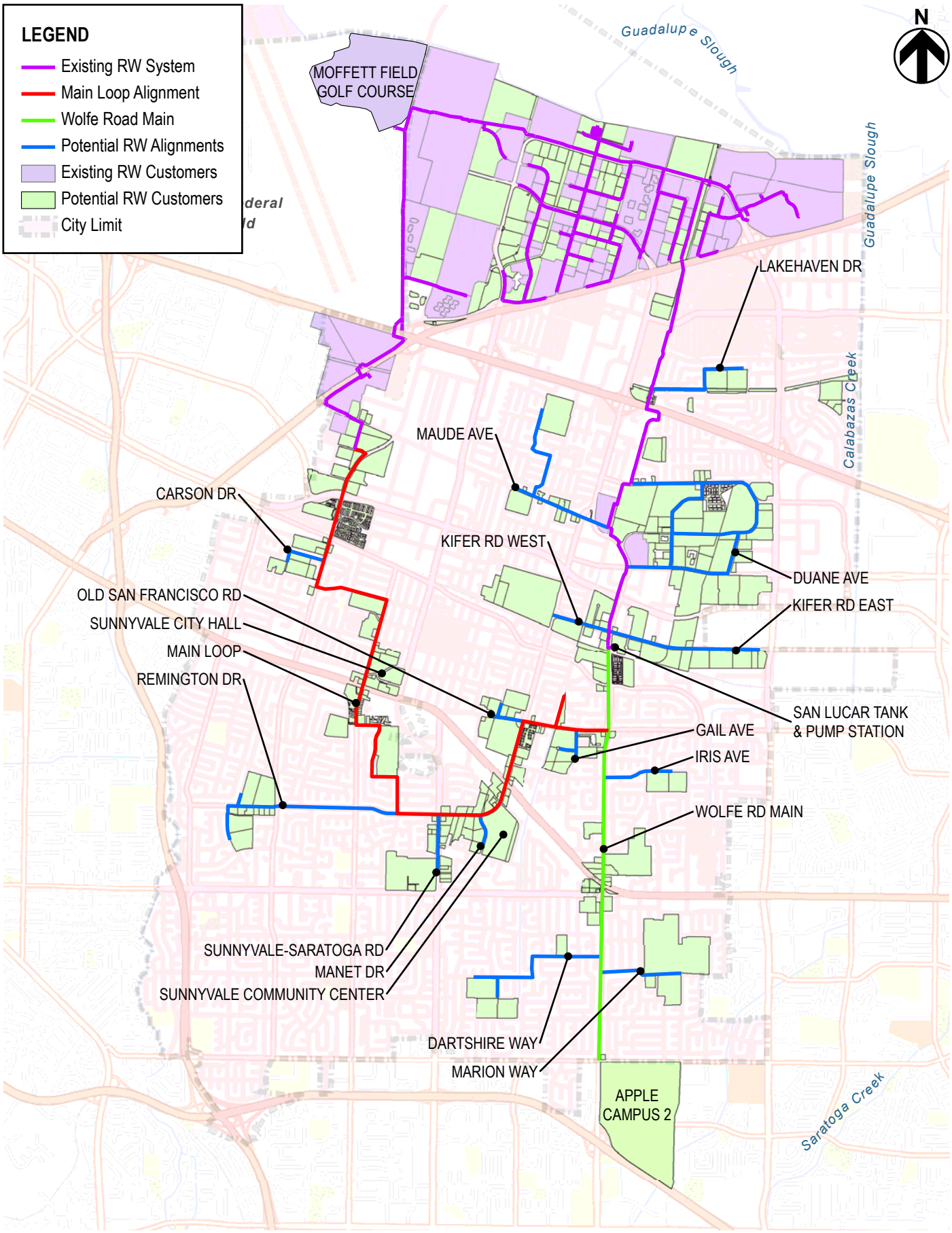

FIGURE 6-1
CITY OF SUNNYVALE
FEASIBILITY STUDY FOR RECYCLED WATER EXPANSION
PROPOSED RECYCLED WATER ALIGNMENTS

HydroScience