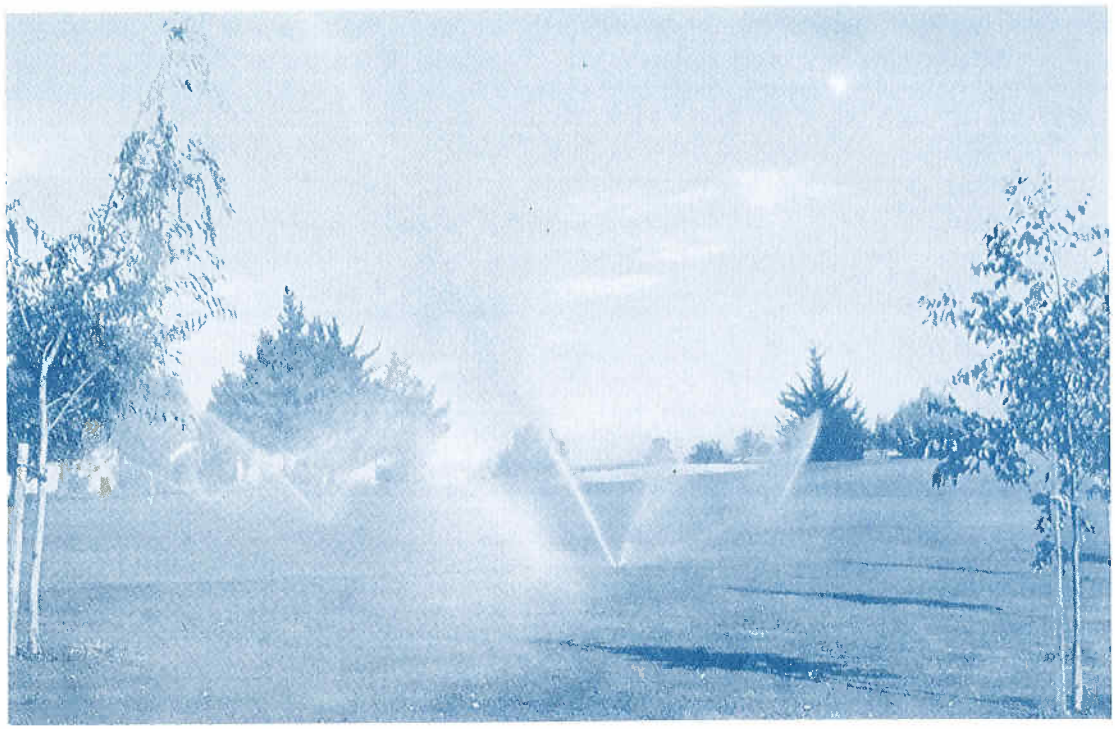


City of Fairfield

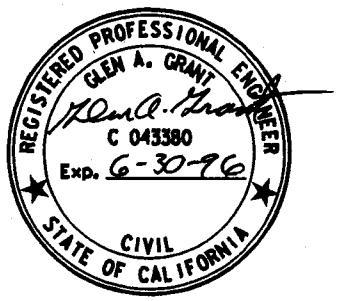
Central Solano Dual Water Systems Master Plan

JMM James M. Montgomery

CITY OF FAIRFIELD

CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

August, 1992



Prepared by:

James M. Montgomery, Consulting Engineers, Inc
1652 W. Texas
Fairfield, CA 94533

Serving the World's
Environmental Needs

Telephone
(707) 425-4793

FAX
(707) 427-0153

1652 West Texas Street
Fairfield, California 94533

JMM James M. Montgomery
Consulting Engineers, Inc.

August 25, 1992

Mr. Richard L. Wood
Assistant Director of Public Works
City of Fairfield
1000 Webster Street
Fairfield, CA 94533

Subject: Central Solano Dual Water Systems Master Plan
Final Report

File: 188.1150/3.1.1

Dear Mr. Wood:

We are pleased to transmit twenty-five copies of the Central Solano Dual Water Systems Master Plan Final Report.

In March, 1992, James M. Montgomery, Consulting Engineers, Inc. (JMM) submitted a draft of the subject report to you. That draft report initiated an involved series of meetings and discussions to define the initial reclaimed water project or projects that should be built. The discussions have included representatives of the staffs and Councils or Boards of the following agencies: City of Fairfield, Suisun City, Fairfield-Suisun Sewer District, and the Solano Irrigation District. The discussions have been productive. The participants have agreed on a series of four projects that should be constructed over the next few years to increase the use of reclaimed water in the area. Those four projects differ in several ways from any of the projects defined in the draft report. This final report reflects the results of those discussions to date.

In two cases, the projects agreed to in the discussions over the past four months are the final projects to serve an area. In two other cases, the projects agreed to are merely initial phases of a larger plan. The initial projects are to be built so they can be extended in the future. This report shows both the initial projects and the ultimate plan.

We have appreciated the opportunity to work with you and other representatives of the City of Fairfield, Suisun City, Fairfield-Suisun Sewer District, and Solano Irrigation District. We look forward to working with the various agencies to implement the recommendations of this Plan.

Very truly yours,

Glen Grant

Glen Grant
Principal Engineer

/sd

ACKNOWLEDGEMENTS

CITY OF FAIRFIELD CITY COUNCIL

Gary Falati, Mayor
Garry Ichikawa, Vice Mayor
Chuck Hammond, Council Member
George Pettygrove, Council Member
Perry Polk, Council Member

CITY OF FAIRFIELD STAFF

Ron Hurlbut, Public Works Director
Richard L. Wood, Assistant Director of Public Works for Water

PROJECT STAFF

Glen Grant, Project Manager
Annette Adams, Project Engineer
Karen Johnson, Quality Control
Jim Gossett, Project Engineer
Susan Crisfield, Graphic Artist
Jean Matuska, Graphic Artist
Ken Swenson; Creegan & D'Angelo - System Modeling
John De Boice; Bissel & Karn - Regulations Review
Asa Hanamoto; Royston, Hanamoto, Alley & Abbey - Horticultural Suitability
Rick Storey; Royston, Hanamoto, Alley & Abbey - Horticultural Suitability

TABLE OF CONTENTS

SECTION 5 - WASTEWATER RECLAMATION FACILITIES AND TREATMENT PROCESSES

SECTION 6 - ALTERNATIVE DUAL WATER SYSTEM PLANS

SECTION 7 - SELECTION OF RECOMMENDED SYSTEMS

SECTION 8 - IMPLEMENTATION

LIST OF TABLES

LIST OF TABLES

Table of Contents

LIST OF FIGURES

LIST OF APPENDICES

Executive Summary

EXECUTIVE SUMMARY

The Central Solano Dual Water Systems Master Plan (CSDWSMP) is a long range, regional plan developed to guide and facilitate the use of raw and reclaimed water in central Solano County. The Fairfield-Suisun Sewer District Wastewater Treatment Plant (Fairfield-Suisun WWTP) currently produces an effluent which meets all requirements for use as reclaimed water. This plan addresses the distribution system needed to make it possible to utilize the available reclaimed water resources. The CSDWSMP summarizes regulations governing non-potable water use, estimates existing and potential non-potable water demands, characterizes the raw and reclaimed water sources in the area, and evaluates alternative non-potable water distribution systems. The CSDWSMP includes recommendations for a non-potable water distribution system, estimates of project costs, and discussion of implementation issues.

STUDY AREA

The study area was defined based on proximity to potential non-potable water supplies, demand densities, and ground elevations. The study area for the CSDWSMP is roughly the area within the spheres of influence of the cities of Fairfield and Suisun City (excluding the area in and around Travis Air Force Base) and specific areas outside this boundary, including Suisun Valley, the proposed White Wing development, Lagoon Valley, and Tolenas. This area includes the majority of potential reclaimed water demands in central Solano County and is relatively close to the sources of supply.

WATER RECLAMATION REGULATIONS

Water reclamation and reuse is addressed and encouraged at the Federal, State, and local levels. Regulations regarding the treatment, distribution and operation of reclaimed water systems are summarized in Section 2 of this report.

The Federal Clean Water Act explicitly encourages integration of water reclamation into all pollution control projects. The California Water Code, on the State level, also encourages water reuse and prohibits potable water use when an acceptable reclaimed water source is available. The State Water Resources Control Board (SWRCB), established by the California Water Code, has primary authority for regulation of water reclamation and reuse. The SWRCB establishes policy and general guidance, and the state's nine Regional Water Quality Control Boards (RWQCB's) establish water reclamation and reuse requirements for specific projects.

The San Francisco Bay RWQCB, the agency responsible for local administration of the SWRCB's authority, adopted a revised Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) in December 1986. The Basin Plan sets forth water quality goals to be used in regulating water quality factors and includes maximum feasible reclamation or reuse of municipal, industrial, and agricultural wastewaters. The Basin Plan does not, however, list any specific requirements or regulations pertaining to reclamation projects.

The San Francisco Bay RWQCB has used the Wastewater Reclamation Criteria set forth by the California Department of Health Services (DHS) in Title 22, Division 4, Chapter 3 of the California Administrative Code, and the DHS Guidelines for Use of Reclaimed Water (June 10, 1988) as the basis for establishing water reclamation requirements for the Fairfield-Suisun WWTP. These criteria address the quality of wastewater acceptable for reuse, types of uses allowed, locations of use, monitoring requirements, and other aspects of the treatment plant and water distribution operations. The Fairfield-Suisun WWTP is currently producing water which meets Title 22 requirements for "Unrestricted Uses".

DHS requirements (Title 22) and Guidelines for Distribution of Nonpotable Water by the California-Nevada Section, American Water Works Association (CA/NV AWWA Guidelines) as accepted by DHS, are currently undergoing revision. These revisions may affect construction or operating details of a reclaimed water system, but they are not likely to necessitate substantive changes to the recommended plan for non-potable water use.

POTENTIAL NON-POTABLE WATER USERS AND DEMANDS

Section 3 identifies potential non-potable water users, discusses possible constraints to non-potable water use, and estimates potential non-potable water demands. Irrigation uses include agricultural and landscape irrigation; industrial applications include cooling, boiler feed, washing, and processing. Non-potable water supplies include reclaimed water from the Fairfield-Suisun WWTP, and untreated water conveyed through the North Bay Aqueduct (NBA), Putah-South Canal (PSC), and the Cache Slough pipeline. The focus of this study, however, is on the use of reclaimed water except as noted.

The demand analyses in this master plan assumed an average annual demand (AAD) of 2.8 acre-ft/acre/year for schools and 2.5 acre-ft/acre/year for all other turf, agricultural, and landscaped areas where historic demand figures or other estimates were not available. Industrial cooling water and process demands were developed on a case-by-case basis.

Potential Agricultural Irrigation Demands

There are over 4,000 acres of agricultural land in the study area, the majority of which are orchard crops located in Suisun Valley. Solano Irrigation District (SID) officials and Suisun Valley farmers have concerns regarding reclaimed water quality and are not likely to accept reclaimed water on a broad scale unless it is blended with raw water at a currently undetermined ratio. Two different estimates of agricultural demand for reclaimed water were made in this plan, assuming 25 percent and 50 percent, respectively, of Suisun Valley's total irrigation demand. The additional percentage of Suisun Valley's total irrigation demand is assumed to be met by blending raw water from the PSC.

Potential Industrial and Commercial Irrigation Demands

The Solano Business Park, Low Industrial Park, and Gateway Project areas present attractive sites for potential use of non-potable water for landscape irrigation. Both the southwest central and the northeast areas of the City of Fairfield (City) have a significant amount of land designated for future industrial and commercial uses. The Busch Corporate Center, the Gentry-Pierce Business Park, and Fairfield Redevelopment Agency areas are located in the southwest central area of the City. The northeast area is only partially developed. Proposed revisions to the City's General Plan Land Use Element designate additional lands in the northeast area for future industrial and commercial uses.

Potential Schools and Public Facilities Irrigation Demands

There are over 25 schools with a total estimated landscaped acreage of over 190 acres within the study area. Other public facilities include medical facilities, cemeteries, and city and county government facilities. Non-potable water could be used to irrigate landscaping at these facilities and at highway interchanges and along major streets (streetscapes).

Potential Recreational Area Demands

Recreational areas include parks, park maintenance areas, and golf courses, among others. There are over 25 parks and four existing or proposed golf courses that are considered to be potential users of non-potable water in the study area. Suisun City is planning construction of an 80-acre sports complex along Scandia Road that could be irrigated with reclaimed water.

Potential Industrial User Demands

In addition to allowing for landscape irrigation with reclaimed water, Pacific Bell, who is constructing a new facility in the Solano Business Park, has incorporated provisions for use of non-potable water as cooling water for the building's air conditioning system. Another firm considering building a facility in Solano Business Park has expressed a similar intent to utilize reclaimed water as cooling water. Several other businesses throughout the area have expressed interest in utilizing reclaimed water in their processes or as cooling water.

Potential Suisun Marsh Salinity Control Demand

An additional potential use of non-potable water is for salinity dilution in the Suisun Marsh, located south and east of the study area. This is most important from December through March, coinciding with a period of minimal non-potable irrigation requirements. Hence, salinity control of the marsh and agricultural and landscape irrigation could be complementary uses of non-potable water.

The California State Department of Water Resources (DWR) is preparing an environmental impact report regarding alternative ways to control salinity in the western Suisun Marsh. DWR has estimated that a fresh water flow of 30 to 50 cubic feet per second (cfs) into the marsh would achieve the desired salinity levels. Possible discharge points include Green Valley Creek and Suisun Valley Creek. The proposed non-potable water systems in the area could be used to route reclaimed and raw water into those creeks, however, due to the uncertainty of this demand, the recommended facilities were not sized to accomodate it.

Potential Non-Potable Water Users Not Considered

This master plan does not include non-potable water demands for single-family and multi-family residential users and small commercial users due to public health concerns that would be raised should non-potable water be served to these users. Monitoring use of non-potable water would be extremely difficult for these types of users due to the great number of potential individual customers. There is sufficient demand within the study area to utilize the available reclaimed water without including these user types.

Summary of Potential Demands

The study area logically splits into eleven geographic subareas when viewed from the perspective of non-potable water distribution piping. The nature of the piping systems serving these subareas is discussed in Section 6. The eleven subareas are defined in Section 3. Table ES-1 presents a summary of the potential demands for reclaimed and raw water in the study area. The potential demands are tabulated by geographic subarea. The subareas were then complied into service areas which correspond to more practical delivery units. These service areas are discussed in Section 6.

TABLE ES-1

SUMMARY OF POTENTIAL NON-POTABLE WATER DEMANDS

Subarea	Average Annual Demand (acre-ft/yr)
Central Fairfield	2,014
Rancho Solano	858
Lagoon/Paradise Valley	2,130
Northeast Fairfield	161
Suisun Valley	3,610
Lower Suisun Valley	542
White Wing	718
Green Valley	112
Cordelia	182
Suisun City	411
Tolenas	700
Total	11,438

WATER QUALITY AND SOIL CONDITIONS

Section 4 of this report evaluates the water quality of several potential non-potable water sources, including the Fairfield-Suisun WWTP, NBA, PSC, Vallejo Cache Slough Pipeline, and groundwater. Water quality is evaluated with regard to irrigation and industrial uses. Limitations on these uses as a result of water quality are identified. Study area soil characteristics, soil monitoring, and mitigation measures are also discussed.

Water Quality Requirements of Non-Potable Water for Irrigation Uses

Primary water quality parameters that were evaluated include total dissolved solids (TDS), boron, chlorides, sodium adsorption ratio (SAR), turbidity, and total coliform. Irrigation problems are usually associated with salinity (the single most important factor in determining suitability), soil permeability (related to high SAR and salinity), specific-ion toxicity, and bicarbonate. Alternating water sources, blending with higher quality water, and/or modifying irrigation practices will frequently make it possible to irrigate with non-potable water, even when the quality of a given water is less than ideal.

Water Quality Requirements of Non-Potable Water for Industrial Uses

Industrial users are generally most concerned about high levels of chlorides, ammonia, phosphates, sulfates, heavy metals, and silica; these contaminants become concentrated in cooling processes. Industrial users generally require ammonia levels less than 1 mg/l; phosphate levels less than 3 mg/l if calcium salts are used for corrosion inhibitors; silica levels less than 30 mg/l; and low levels of chloride, sulfate, and metals.

Water Quality of Water Supply Sources

The surface waters available in the study area have been widely used for crop and landscape irrigation and have been found to be quite acceptable. Of the potential water sources discussed in this plan, only the reclaimed water and groundwater are considered to have possible quality problems when considered for irrigation use. The primary concern with the Fairfield-Suisun WWTP treated effluent is with its excess sodium content relative to low levels of calcium and magnesium. The boron level is also slightly high, but not high enough to cause serious concern for most plants.

Soils in the area are generally clay loams to silty clay loams. These are soils with high water-holding capacity which accumulate salts and heavy metals more rapidly than coarse-textured soils. A proper sodium balance must be maintained with soils of this type. An alternate raw water source should be available if reclaimed water is used for irrigation. The alternate raw water source can be used to leach salts from the soil when soil chemistry monitoring indicates soil permeability has declined to unacceptable levels.

ALTERNATIVE DUAL WATER SYSTEM PLANS

Several alternative systems of pumps, pipes and reservoirs to distribute non-potable water are presented in Section 6. Distribution system modeling of the alternative non-potable water systems was performed to determine sizing of system components (pumps, pipes, and reservoirs).

Each of the alternatives would have at least two possible sources of water: (1) reclaimed water from the Fairfield-Suisun WWTP, (2) raw water from one or more of the following sources: the Cache Slough Pipeline, NBA, or PSC or treated potable water from either the City of Fairfield or the Suisun City treated water system.

Description of Service Areas

Several alternatives were developed for each of five separate service areas, which are composites of the eleven geographic subareas defined in Section 3 of this report:

Service Area	Geographic Subareas Included
• Central Fairfield	Central Fairfield; Paradise and Lagoon Valleys
• Suisun Valley	Suisun Valley; Rancho Solano
• Lower Suisun Valley	Lower Suisun Valley; White Wing; Lower GreenValley
• Cordelia	Cordelia
• Suisun City	Suisun City; Tolenas

The alternatives include a separate distribution system for each of these service areas. Due to the distance from the Fairfield-Suisun WWTP, no alternatives have been defined for service to Northeast Fairfield.

SELECTION OF RECOMMENDED SYSTEMS

Section 7 of this report presents the evaluation of alternatives, and the resulting recommended systems. In addition to a present worth analysis of each of the alternatives, an evaluation of non-economic considerations was conducted focusing on criteria such as system reliability, water quality, environmental considerations, institutional concerns, user acceptance, and miscellaneous planning concerns. The recommended systems include networks of pump stations, pipes, and reservoirs. A system is recommended in each of the five service areas.

The selected alternatives, including sizes of recommended pipes and areas served by each recommended system are described in Section 7. The potential water demands that could be met by the recommended non-potable water systems and the estimated costs of the systems are listed in Table ES-2.

TABLE ES-2

RECOMMENDED NON-POTABLE WATER SYSTEM ESTIMATED COSTS AND WATER DEMANDS

Service Area	Capital Cost	Annual Operating ($/yr)	Potential Demand (Acre-ft/yr)	Unit Cost ($/Acre-ft)
1. Central Fairfield	$20,700,000	$310,000	4,030	$455
2. Suisun Valley	$5,480,000	$151,000	2,910	$191
3. Lower Suisun Valley	$2,270,000	$23,700	630	$302
4. Cordelia	$3,460,000	$60,000	182	$1,730
5. Suisun City	$5,660,000	$89,400	1,040	$487

IMPLEMENTATION

Institutional and financial decisions necessary to implement the Dual Water Systems Master Plan are complex. This plan did not attempt to recommend all of the details of the implementation process. That can only come from discussion and negotiation amongst all the parties involved, including the public, the City of Fairfield, the City of Suisun City, FSSD, and SID. Section 8 of this report describes the issues that must be resolved and the options available for implementation of dual water systems. Subjects addressed include the role each agency should play, design standards for the new systems, funding possibilities, public information procedures, and the steps needed for implementation.

Section 1

SECTION 1

INTRODUCTION

The Central Solano Dual Water Systems Master Plan is a continuation and expansion of the City of Fairfield Water Reclamation Study (JMM, September 1987). The need for an updated and more detailed dual water systems plan has arisen for several reasons, including the continuing drought, increasing water demands, new water quality regulations and an interest by the City and other agencies in exploring a regional approach. This section provides introductory information, including authorization, purpose, and scope of this study. Recommended goals and objectives regarding reclaimed and raw (non-potable) water use are identified. In addition to reviewing existing data, planning assumptions are defined, including the study area boundary, land use classifications and water duties.

AUTHORIZATION

This report has been completed in accordance with an agreement between the City of Fairfield (City) and James M. Montgomery, Consulting Engineers, Inc. (JMM) dated February 5, 1991.

GOALS AND OBJECTIVES OF DUAL WATER SYSTEMS

Dual water systems incorporate the use of separate networks for potable and non-potable water. The potable water is used for common domestic uses, such as drinking, washing and bathing, while the non-potable water is used for irrigation or industrial uses. Non-potable water available in the study area includes reclaimed water from the Fairfield-Suisun Sewer District Wastewater Treatment Plant (Fairfield-Suisun WWTP) and water from three raw water sources (Putah South Canal (PSC), North Bay Aqueduct (NBA), and Cache Slough Pipeline). The need for additional water supplies continues to increase due to the continued growth in Solano County. The present drought underscores these needs. The cost of additional water supplies continues to increase, as water resources grow more and more precious. The City is, therefore, considering dual water systems to expand existing uses of raw and reclaimed water.

The City of Fairfield is considering dual water systems for several reasons, including those listed below.

- Existing raw water entitlements could be reserved for higher uses, reducing the need for future water projects.

- The potable water demand could be reduced by the amount of non-potable water used for irrigation and industrial uses, reducing the need for future water treatment and reservoir capacity.

- Higher quality raw water sources (e.g., PSC) could be reserved for potable water uses by using lower quality raw water sources and reclaimed water for landscape irrigation and industrial uses.

- Industries may be attracted to the area if less expensive non-potable water is available.

- The City would gain a reputation as a prudent user of water, which could be a signficant factor in the preservation and allocation of water supplies in the future.

- Fairfield-Suisun Sewer District (FSSD) may benefit through reduction of effluent discharges.
- Using reclaimed water is environmentally sound, reducing potable water demands and reducing wastewater effluent discharges.

STUDY PURPOSE AND SCOPE

This study consisted of the preparation of a dual water systems master plan in consultation with local agencies. The master plan will provide long-term guidance for the implementation of dual water systems in central Solano County. The master plan includes alternative development, recommendations, and program staging; identifies regulatory and institutional concerns; and provides the basis for design of recommended facilities. This study emphasizes planning for the distribution and use of reclaimed water from the Fairfield-Suisun WWTP. The available raw water sources are also discussed as potential supplies to supplement the reclaimed water supply. The scope of the study include the tasks described below.

Review Existing Data and Define Planning Assumptions

This task involved the review of existing data, including the 1987 Water Reclamation Study and other water supply studies, water usage and water quality data, land use information and existing and planned non-potable water distribution systems. Chapter 1 summarizes the results of this task with Appendix A providing further details.

Identify Regulatory Requirements for Use of Reclaimed Water

Current versions of and proposed revisions to Title 22 and Title 17 of the California Administrative Code were addressed. Factors such as level of treatment, reliability, cross-connection control, monitoring and inspection procedures, identification, administration, supervision and reclamation standards were identified for compliance with primary regulations. Permit approval requirements which could affect the central Solano County dual water systems were identified. A synopsis of pertinent regulations as they apply to non-potable water use is presented in Section 2.

Estimate Potential Raw and Reclaimed Water Demands

Major potential non-potable water users were identified. Average annual and peak demands for potential non-potable water users were estimated based on water use records, results from the 1987 Water Reclamation Study, and application of appropriate water demand factors (water duties). User requirements, including water quality, minimum or maximum pressures, and special requirements for integrating dual system components, were identified. The results of this task are documented in Section 3.

Evaluate Raw and Reclaimed Water Sources and Water Quality

Raw water from PSC, Cache Slough, NBA and groundwater, and reclaimed water from the Fairfield-Suisun WWTP were evaluated as non-potable water supplies for dual water systems. The sources were evaluated based on location, availability, quantity and quality. Water quality was evaluated with regard to irrigation and industrial uses and with regard to health concerns. Section 4 summarizes the results of this task.

Examine Wastewater Treatment Plant Reclamation Capabilities

Section 5 discusses the results of work performed by JMM under a separate agreement with the Fairfield-Suisun Sewer District, including review of the existing plant's reclamation capacity, potential use of dual force mains in the reclaimed water system, and potential remote reclamation facilities.

Develop a Computer Model and Map of Alternative Non-Potable Water Systems

Planning criteria were determined for non-potable water system facilities development; criteria include system pressures, pipeline flow rates, storage requirements, backup water supplies, and distribution system routing. Alternative non-potable water systems were defined and distribution system modeling of the various alternatives was conducted. Capital and operating costs were estimated for each alternative. Section 6 details the results of this task.

Identify Necessary Facilities

A plan of the recommended non-potable water systems, containing conceptual locations of turnouts, pumping stations, reservoirs, and pipelines, was developed based on the alternatives analysis. This plan is presented in Section 7 of this report.

Identify Institutional Issues

Section 8 summarizes institutional issues related to use of non-potable water. Required or recommended safety precautions, primary regulatory requirements, funding alternatives, and other institutional concerns relating to project implementation were identified and discussed. A staging plan was prepared, recommending a sequence of steps to implement the Central Solano Dual Water Systems Master Plan.

Develop a Plan for Public Notification

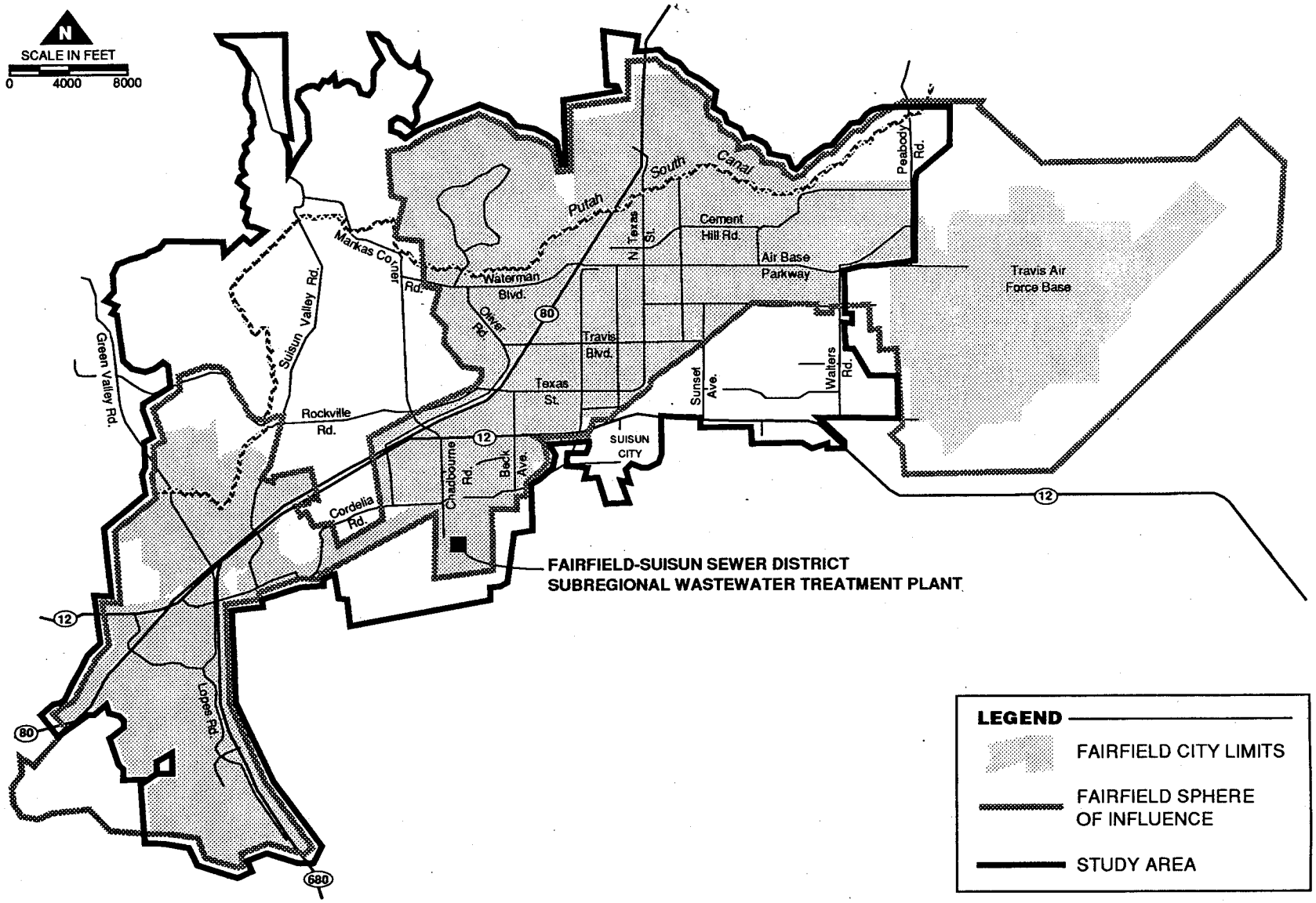
A public relations subconsultant aided City staff in creating a public information plan for the City to implement a dual water systems program. Proposed future activities and strategies for implementation of the plan are summarized in Section 8 of this report.

STUDY AREA

The area to be served by the non-potable water system should be limited to that where the benefits of the project meet or exceed the cost to serve the area. Proximity to supply, demand density, and elevation are primary factors used to define the study area. Portions of the Solano Irrigation District (SID) and the Suisun/Solano Joint Powers Authority systems and/or service areas may be considered for future possible conversions to a dual water system.

The study area considered for the Central Solano Dual Water Systems Master Plan (Master Plan) is the area within the spheres of influence of Fairfield and Suisun City (excluding the area in and around Travis Air Force Base) and specific areas outside this boundary, including Suisun Valley, the proposed White Wing Development, Lagoon Valley and the area around SID's Lawler lateral east (Tolenas) as shown in Figure 1-1. This area includes the majority of potential reclaimed water demands, is relatively close to the sources of supply, and most of it is at a reasonably low elevation.

Lagoon Valley is inside the City of Vacaville. It is included in this study because an existing raw water irrigation system pumps raw water from Paradise Valley, which is in Fairfield, into Lagoon



CITY OF FAIRFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

STUDY AREA

FIGURE 1-1

Valley. This system could be used for reclaimed water. Thus, if reclaimed water could be brought to Paradise Valley, it could be transported on to Lagoon Valley without further improvements.

Several agencies may be affected by the implementation of dual water systems in the Central Solano study area. The City of Fairfield has initiated this study effort and will play a major role in the implementation of dual water systems. FSSD will provide treated wastewater for use as reclaimed water in any future dual water system. SID currently provides raw water for agricultural and landscape irrigation uses and will likely continue to be involved in delivery of raw water for use in the dual water system. Finally, Suisun City has shown an interest in participating in the establishment of a dual water system.

WATER SUPPLY SOURCES

Figure 1-2 shows the locations of the region's non-potable water supply sources. Each of them is briefly described here.

Fairfield-Suisun Sewer District Subregional Wastewater Treatment Plant Reclaimed Water

The 17.5 mgd Fairfield-Suisun WWTP serves the City of Fairfield and the City of Suisun City. The largest industrial discharger is the Anheuser-Busch brewery. The Fairfield-Suisun WWTP, located on Chadbourne Road, provides biological organic removal, tertiary filtration, and chlorination. The plant effluent meets all state regulatory requirements for unrestricted reclaimed water use.

Raw Water Supply Sources

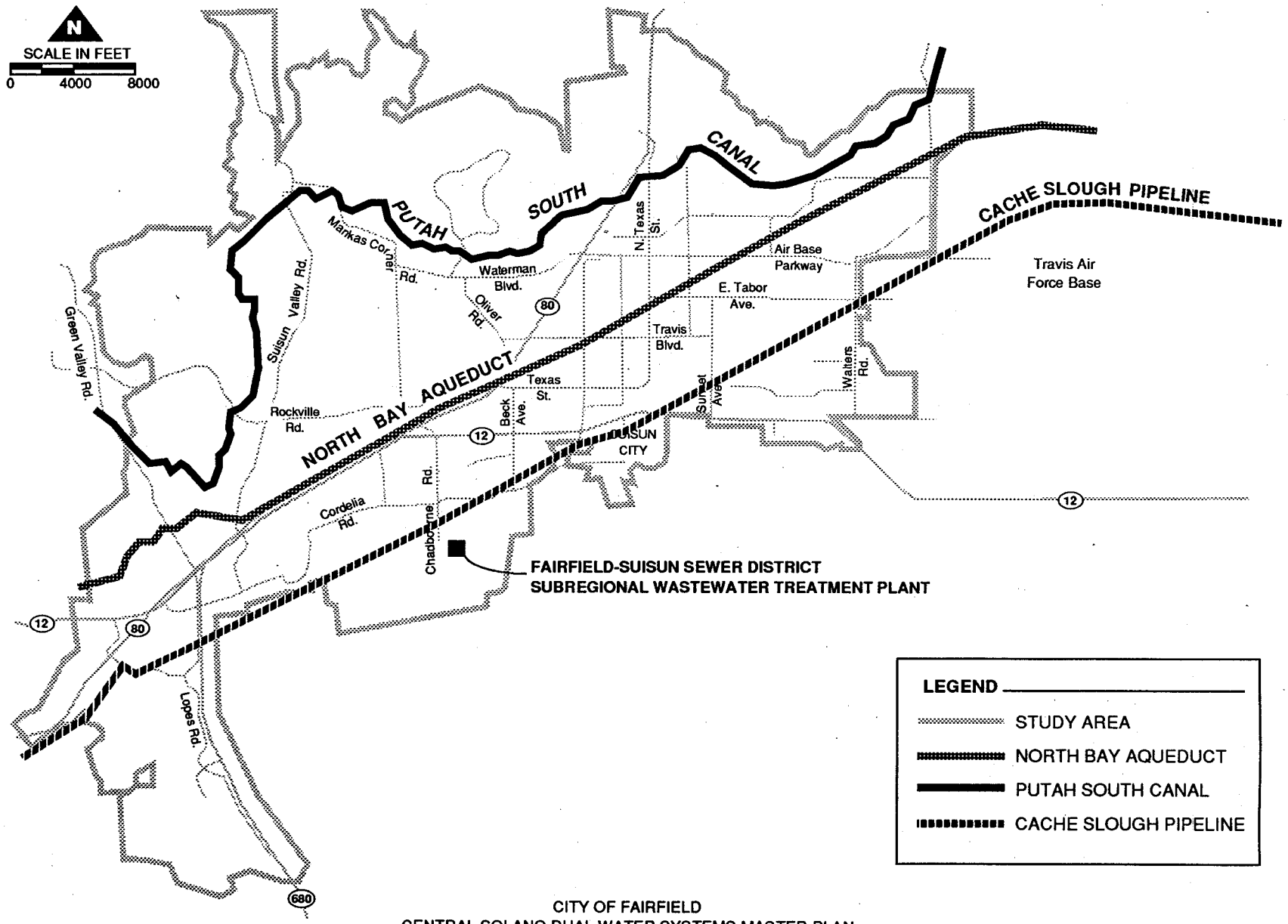
Potential raw water supply sources for the Central Solano Dual Water Systems project include the NBA, PSC, Vallejo Cache Slough Pipeline, and groundwater wells.

North Bay Aqueduct. The NBA, a pressurized pipeline constructed by the California Department of Water Rescuing (DWR), pumps State Water Project water from Barker Slough near the Sacramento River to Solano and Napa counties. The NBA is a 72-inch diameter pipeline from Barker Slough to the eastern edge of the study area and is a 60-inch diameter pipeline through the study area. The City owns turnouts on the NBA at the North Bay Regional Water Treatment Plant (NBR Plant), at the intersection of the NBA and Cement Hill Road, and near the intersection of Beck Avenue and Linear Park. Only the NBR Plant turnout is functioning.

Putah South Canal. The PSC, an open canal in operation since 1959, is part of the United States Bureau of Reclamation (USBR) Federal Solano Project. It is operated by the Solano Irrigation District (SID). It transports water from Lake Berryessa to several users in Solano County.

Vallejo Cache Slough Pipeline. The City of Vallejo put its Cache Slough water supply system on standby with the start-up of the NBA in 1988. The Cache Slough Pipeline is a 36-inch pipeline running over 20 miles from a pump station at Cache Slough in the Sacramento River Delta to a terminal reservoir west of Cordelia. Portions of the Cache Slough pipeline are now used to deliver NBA water to the Tolenas area.

Groundwater. The best aquifers in Solano County are several miles northeast of Fairfield in the Vacaville, Elmira, and Dixon areas. The better quality groundwater is in the higher valleys away from the tidal influence of the marsh. Wells in Vaca Valley, Suisun Valley and Green Valley are generally low producing and of varying quality.



CITY OF FAIRFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

NON-POTABLE WATER SUPPLY SOURCES

FIGURE 1-2

REVIEW OF 1987 WATER RECLAMATION STUDY

In September, 1987, JMM prepared a water reclamation study to investigate the feasibility of a reclaimed water system and to provide preliminary standards for reclaimed water use. At that time, FSSD was producing approximately 11 million gallons per day (11 mgd) of treated effluent, and was expanding treatment capacity to 17.5 mgd. SID was using 2,000 to 3,000 acre-feet (ac-ft) per year of its 6,000 ac-ft per year reclaimed water entitlement. The study projected that the City would have up to 11.5 mgd available for reclaimed water use by 1992.

The then current regulatory requirements of several agencies, including the San Francisco Bay Regional Water Quality Control Board (RWQCB Board), the California Department of Health Services (DHS), and the Solano County Department of Health, were identified. Water quality requirements related to public health, landscape irrigation and industrial uses were also identified and evaluated with respect to the supply source.

Potential reclaimed water demands were developed for the central Fairfield study area. Potential reclaimed water demands included irrigation users, industrial/commercial users and residential users (existing and anticipated). A summary of potential reclaimed water demand as estimated and presented in the 1987 report is presented in Table A-1 of Appendix A of this report. Proposed reclaimed water facilities were identified, project benefits and costs were evaluated, and a preliminary project implementation plan was developed. The reclaimed water system project recommended and presented in the 1987 study is included in Appendix A of this report as Figure A-1. Proposed facilities included a high service pump station, about 94,000 lineal feet of transmission and distribution piping, an elevated storage reservoir, and associated control facilities.

DATA REVIEW

Land use information, historical water usage data, water duties, water quality data, raw water supply information, and information regarding existing and planned non-potable water distribution systems were collected and reviewed for this study. A summary of the information gathered is presented in Appendix A.

ABBREVIATIONS

In order to conserve space and improve readability, the following abbreviations have been utilized throughout this report.

AAD	annual average demand
ABAG	Association of Bay Area Governments
acre-ft	acre-foot, acre-feet
acre-ft/yr	acre-feet per year
AID	average irrigation demand
CA/NV AWWA	California-Nevada Section, American Water Works Association
cf	cubic feet
City	City of Fairfield
DHS	California Department of Health Services
ds/m	decisiemens per meter
DWR	State of California Department of Water Resources
EC	electrical conductivity
EDA	Economic Development Association
fps	feet per second
FSSD	Fairfield-Suisun Sewer District
ft	foot, feet
gpm	gallons per minute

gpm/sq ft	gallons per minute per square foot
HGL	hydraulic grade line
hp	horsepower
JMM	James M. Montgomery, Consulting Engineers, Inc.
meq/l	milliequivalents/liter
mgd	million gallons per day
mg/l	milligrams per liter
mil gal	million gallons
ml	milliliters
MPN	most probable number
NBA	North Bay Aqueduct
NTU	nephalometric turbidity units
O&M	operations and maintenance
psi	pounds per square inch
ppm	parts per million
PSC	Putah South Canal
psi	pounds per square inch
RWQCB	Regional Water Quality Control Board
SAR	sodium adsorption ratio
SAR_{adj}	adjusted sodium adsorption ratio
SID	Solano Irrigation District
sq ft	square foot, square feet
SWRCB	State Water Resources Control Board
TDH	total dynamic head
TDS	total dissolved solids
ULF	ultra-low-flow
UWMP	City of Fairfield Urban Water Management Plan, March, 1991
Title 17	Drinking Water Supplies, Title 17, Group 4, California Administrative Code
Title 22	Wastewater Reclamation Criteria, Title 22, Division 4, Environmental Health, California Administrative Code
µg/l	micrograms per liter
USBR	United Staes Bureau of Reclamation
WTP	water treatment plant
WWTP	wastewater treatment plant

Section 2

SECTION 2

WATER RECLAMATION REGULATIONS

This section summarizes the regulations governing potential reclamation projects. The regulations cover treatment, distribution and operation of reclaimed water systems. The complete texts of several applicable State of California criteria and guidelines are included in Appendix B.

INTRODUCTION

Water reclamation and reuse is addressed at the Federal, State, and local levels. The Federal Clean Water Act specifically encourages water reclamation as an integral part of water pollution control projects. The California Water Code states that all possible steps should be taken to encourage water reuse and it allows for prohibition of the use of potable water when an acceptable source of reclaimed water is available. State law requires CalTrans to use reclaimed water whenever possible and to permit local agencies to place reclaimed water transmission lines in freeway rights-of-way.

In California, two agencies have primary responsibility for regulation of water reclamation and reuse: (1) the Regional Water Quality Control Boards (RWQCB's) and (2) the Department of Health Services (DHS). CalTrans has regulatory authority regarding installation of facilities in CalTrans rights-of-way and use of reclaimed water for irrigation of freeway landscaping.

Local agencies having jurisdiction over water reuse include the Solano County Department of Environmental Health and Department of Agriculture, the City of Suisun City, and the City of Fairfield. All regulatory authority of Federal agencies has been delegated to the various state agencies. The specific requirements of each of these State and local agencies are discussed below.

STATE REGULATORY AGENCIES

The majority of state regulations concerning water reclamation and reuse address acceptable reclaimed water quality requirements for various uses. DHS regulations also relate to details of the distribution of reclaimed water and requirements for vector control. The following paragraphs summarize the requirements of each agency that are relevant to this project. Complete copies of relevant sections of the regulations are included in Appendix B.

Regional Water Quality Control Board

The California Water Code establishes the State Water Resources Control Board (SWRCB) as the agency with primary authority for regulation of water reclamation and reuse. The nine RWQCB's are also established as the agencies responsible for administration of the SWRCB's authority. In effect, then, the SWRCB establishes policy and general guidance, and the RWQCB's establish water reclamation and reuse requirements for specific projects.

For the Central Solano Dual Water Systems Master Plan, the San Francisco Bay RWQCB is the agency with the responsibility to establish specific requirements for reclaimed water production and use. In general, the RWQCB requirements relate to the quality of reclaimed water, the uses it may be put to, and reliability of the treatment process. The San Francisco Bay RWQCB adopted a revised Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) in December 1991. The water quality goals to be used in regulating water quality factors as set forth in the Basin Plan include maximum feasible reclamation or reuse of municipal, industrial, and agricultural wastewaters. However, it did not list any specific requirements or regulations pertaining to reclamation projects. The Basin Plan also does not provide numerical groundwater objectives for any of the San Francisco Bay Basin Aquifers. The RWQCB uses the Wastewater Reclamation

Criteria set forth by the DHS in Title 22, Division 4, Chapter 3 of the California Administrative Code, and the DHS Guidelines for Use of Reclaimed Water, June 10, 1988, as the basis for establishing specific requirements for a water reclamation and reuse project. These regulations are incorporated into the water reclamation requirements established by the RWQCB's for reclaimed wastewater producers and users. For any proposed project or aspect of a project that does not fit within the DHS guidelines, the RWQCB would seek the guidance and direction of DHS. It is expected that, if DHS changes its requirements, the RWQCB would follow the new criteria.

In the context of this study, the RWQCB has established water reclamation requirements for the Fairfield-Suisun Sewer District Wastewater Treatment Plant (Fairfield-Suisun WWTP). These address the quality of wastewater acceptable for reuse, types of uses allowed, locations of use, monitoring requirements, and other aspects of the treatment plant and reclaimed water distribution operations. Because the plant is presently producing water which meets the requirements of Title 22 for "Unrestricted Uses," there will be little or no change in treatment requirements. The level of detail and specificity of the water reclamation requirements will depend on the type of use. For a permanently installed piping system, the requirements will list specific users and types of use allowed. For more casual uses, such as tank truck deliveries, blanket requirements may be established. The proposed project may include both types of uses and requirements.

During the recent drought, the San Francisco Bay RWQCB adopted one-year blanket requirements for reuse of wastewater from the various publicly-owned treatment plants under its jurisdiction. In 1989 and 1990, the users covered under these requirements were primarily tank trucks which were filled at the treatment plant. The water was used for irrigation and construction. For such uses, the operators of the treatment plants have been given the responsibility of administering and monitoring water reuse. This approach is intended to facilitate water reuse and is an indication of the RWQCB's positive attitude toward reclamation.

It should be understood that there is no "permit" as such associated with a reclaimed water operation, only the water reclamation requirements established by the RWQCB. DHS is consulted in the process of developing the requirements, and will issue a letter noting their approval of the RWQCB requirements. There is no fee associated with this process.

State Department of Health Services

DHS is the state agency which has established the majority of the regulations and guidelines for water reuse. Section 13521 of the California Water Code (Porter-Cologne Water Quality Control Act) gives DHS the authority and responsibility to "establish statewide reclamation criteria for each varying type of use of reclaimed water where such use involves the protection of public health." As almost all uses of water involve protection of public health to one degree or another, DHS is the state agency responsible for establishing regulations related to water reclamation.

STATE REGULATIONS

The two primary documents prepared by DHS that set forth water reclamation and reuse criteria are the Title 22 Wastewater Reclamation Criteria and the 1988 Guidelines for Use of Reclaimed Water. Copies of each of these are presented in Appendix B. In addition, DHS has also accepted the Guidelines for Distribution of Non-potable Water by the California - Nevada Section, American Water Works Association (CA/NV AWWA). As discussed below, Title 22, the DHS Guidelines, and the CA/NV AWWA Guidelines are all currently in revision.

Basic Reclaimed Water Quality Criteria

The Title 22 Wastewater Reclamation Criteria establish acceptable levels of treatment, treatment reliability, and resulting water quality for various uses. A summary of those requirements is

presented in Table 2-1. As noted in footnote(a) to Table 2-1, alternative treatment processes that will assure an equivalent degree of treatment and reliability are acceptable. In general, it is the intent of Title 22 to specify an acceptable level of treatment, reliability, and effluent quality. The treatment processes listed are considered adequate, but other processes that can be demonstrated as producing the same level of treatment and reliability would be acceptable.

Requirements for a preliminary engineering report, and operational monitoring and reporting are also specified. Note that all possible uses of reclaimed water are not covered in the Title 22 criteria.

In May 1990, the DHS distributed Working Draft for Public Comment which is a revised version of the Title 22 Criteria. The proposed revisions received severe criticism from wastewater agencies. Rather than promoting reclamation, the revisions would have terminated many existing reclamation projects. As of this date, those revisions have not been implemented. Based on a telephone conversation with Mike Kiado of DHS, it is expected that the final version will be significantly different from the draft. Several revisions to the draft have been prepared with an October 1991 version receiving widespread circulation. There is no firm schedule for finalizing the revisions to Title 22, however it is expected that by 1994, Title 22 will be revised. The proposed revisions to Title 22 include guidelines for a number of uses that are not covered in the current version, including toilet flushing, car washing, and street cleaning. It should be emphasized that these are proposed regulations that will probably undergo many changes before they become final. Because the regulations are in flux, it would be advisable to apply conservative judgment in planning a water reclamation system at this time. JMM believes, based on the information currently available, that the new regulations would not necessitate any structural changes in the systems proposed in this report. The new regulations may affect the way those systems are operated.

Alternative Treatment Processes

DHS criteria for acceptance of alternative treatment processes, in particular direct filtration, are presented in the DHS Policy Statement For Wastewater Reclamation Plants with Direct Filtration, June 10, 1988, which is included in Appendix B. The following is taken from that document:

> Approved Alternatives-- The Wastewater Reclamation Criteria include provisions for methods of treatment other than those included in the regulations. The determination of equivalency is made by the State DHS. DHS considers both treatment effectiveness and reliability during evaluation of alternative treatment methods. If, in the opinion of DHS, adequate data are not available to determine equivalency, studies will be required. Generally, data developed by equipment manufacturers are not sufficient, and independent studies conducted in California by qualified researchers, consulting engineers, or other, will be necessary. Pilot plant studies involving seeded virus sampling may be required. ... Once an alternative method of treatment is approved for a specific installation, it generally will be acceptable at other locations in the state.

The Direct Filtration Policy Statement goes on to discuss specific requirements for the acceptance of direct filtration which include the following.

- Secondary effluent having a turbidity of 10 NTU or less.
- Provisions for coagulation and flocculation, with adequate dosing, mixing and contact time, prior to filtration.
- A maximum filtration rate of 5 gpm/sq ft or less, depending on the type of filter.

TABLE 2-1
SUMMARY OF TITLE 22
WASTEWATER RECLAMATION CRITERIA

Reuse	Required Treatment[a]	Allowable Coliforms[b] (MPN/100 ml)
Irrigation of Crops		
• Spray Irrigation of Food Crops	Bio-oxidation, coagulation/clarification, filtration, disinfection	2.2
• Surface Irrigation of Food Crops	Bio-oxidation, disinfection	2.2
• Surface Irrigation of Orchards and Vineyard	Primary treatment[c]	---
• Fodder, Fiber, and Seed Crops	Primary treatment	---
• Pasture for Milking Animals	Bio-oxidation, disinfection	23
Landscape Irrigation		
• Golf Courses, Cemeteries, and Freeways	Bio-oxidation, disinfection	23
• Parks, Playgrounds and Schoolyards	Bio-oxidation, coagulation/clarification, filtration, disinfection	2.2
Recreational Impoundments		
• Non-Restricted Access	Bio-oxidation, coagulation/clarification, filtration, disinfection	2.2
• Restricted Access	Bio-oxidation, disinfection	2.2
• Landscape Impoundment	Bio-oxidation, disinfection	23
Groundwater Recharge	Individual case basis	---

[a] Primary effluent must not contain more than 0.5 milliliters per liter per hour of settleable solids. Filtration must provide an effluent with a turbidity that does not exceed an average of 2 turbidity units and does not exceed a maximum of 5 turbidity units. Alternative methods of treatment may be accepted if the applicant demonstrates to the satisfaction of DOHS that they will assure an equal degree of treatment and reliability.

[b] Median as determined from result of last 7 days for which analyses have been completed.

[c] Primary treatment is acceptable provided that no fruit is harvested that has come in contact with the irrigating water or the ground.

- A maximum filtration rate of 5 gpm/sq ft or less, depending on the type of filter.
- Filter media design parameters (depth, size) are specified for a variety of filters.
- Turbidity monitoring and post-disinfection.

It is expected that these requirements will be incorporated, in some form, into the revisions to Title 22 currently being developed.

Requirements for Specific Uses

The major potential uses for reclaimed water in the study area are landscape and agricultural irrigation. Other potential uses include construction water, industrial cooling, and vehicle washing. Specific requirements for these uses are discussed in the following paragraphs.

Treatment Required for Landscape Irrigation. There are many potential landscape irrigation uses within the study area. The level of treatment required by Title 22 varies depending on the degree of human contact associated with the use. Regulations are more stringent for uses with high public contact and correspondingly less stringent for uses with low public contact.

With High Public Contact.

Potential landscape irrigation uses with high public contact fall under the regulatory category of Irrigation of Areas with High Risk of Public Exposure. A few examples of such areas are school yards, parks and playgrounds. High public exposure includes the potential for inhaling aerosols and accidental drinking of reclaimed water. The existing regulations for uses of reclaimed water with high public exposure require the following treatment: bio-oxidation, coagulation, clarification, filtration, and disinfection to limit coliforms to 2.2 MPN/100 ml.

With Low Public Contact.

Landscape irrigation with low public contact is under the category of Irrigation of Areas with Limited Public Access. Examples of this category are golf courses, cemeteries, and highway landscaping which are not adjacent to areas with public access. Title 22 regulations for this type of landscape irrigation require bio-oxidation and disinfection to limit coliforms to 23 MPN/100 ml.

Treatment Required for Agricultural Irrigation. Agricultural irrigation is the most common use for reclaimed wastewater in California. The level of treatment required by Title 22 varies depending on the potential for human exposure to food products that have been in contact with reclaimed wastewater. Regulations are more stringent for food crops that may come in contact with the irrigation water than for fodder, fiber or seed crops.

Food Crops.

Spray irrigation of food crops, where there is a high potential for reclaimed wastewater to contact the crop, requires the same level of treatment as landscape irrigation with high public contact. Surface irrigation, where there is a much lower potential for the reclaimed wastewater to come into contact with the crop, requires only bio-oxidation and disinfection to limit coliforms to 2.2 MPN/100 ml. For surface irrigation of orchards and vineyards where no fruit is harvested that has come in contact with the irrigation water or the ground, primary effluent is acceptable. Quality requirements may also be reduced for irrigation of crops that will be commercially processed to a degree sufficient to destroy pathogens.

Fodder, Fiber and Seed Crops.

With the exception of irrigation of pasture to which milking cows or goats have access, primary effluent is acceptable for irrigation of non-food crops. Bio-oxidation and disinfection to limit coliforms to 23 MPN/100 ml is required for irrigation of pasture for milking cows or goats.

Construction Water Criteria. DHS has established specific guidelines for use of reclaimed water for construction purposes such as soil compaction, dust control and other uses with similar public and worker exposure. A copy of these guidelines is included in Appendix B. The more important requirements are:

- The wastewater must be an adequately disinfected, oxidized wastewater with a median MPN of 23 per 100 milliliters and with no two samples above 240 per 100 milliliters.
- Sites must be approved by the RWQCB, DHS and local health department.
- Tank truck drivers must be instructed in the regulatory requirements and the trucks must be clearly labeled as containing reclaimed wastewater.
- Reclaimed wastewater may not be introduced into any permanent piping nor shall there be any connection between tank trucks and the domestic water system.
- Tank trucks must be cleaned prior to use, cleaned and disinfected following the project, and cannot be used to carry domestic water.
- The use cannot create a nuisance, water must be confined to the site, and application should be so as to avoid ponding, formation of aerosols, or other public or employee exposure.

Dual Water Systems. With dual water systems, there are two sets of water supply pipes going into a building or property. One line is for reclaimed water, which could be used for irrigation, industrial process uses, and toilet flushing. The other line conveys potable water, which is used for all other demands. Precautions are taken to prevent a cross connection between potable water and reclaimed water. The reclaimed water line is generally a different color pipe and may be located on the outside of the building to further protect the potable water supply.

The existing regulations allow for dual water systems for irrigation but do not address the use of reclaimed water to flush toilets. The DHS is currently considering guidelines for the use of reclaimed water for toilet flushing. This and other uses are also addressed in the CA/NV AWWA Guidelines. It is anticipated that the regulations will allow this use at business complexes which are professionally maintained and have a low probability for children contacting the reclaimed water. A conservative water quality estimate would be the full Title 22 criteria: bio-oxidation, coagulation, clarification, filtration, and disinfection to limit coliforms to 2.2 MPN/100 ml.

Additional Title 22 Water Quality Criteria

Some of the potential uses in the Central Solano Dual Water Systems Master Plan study area that are not included in the current Title 22 are industrial uses, vehicle washing and other wash-down applications, and toilet flushing in public or commercial buildings. Industrial uses have been allowed, with requirements set on a case-by-case basis. For example, reclaimed wastewater use for industrial cooling has been allowed with water quality and treatment requirements matching those for spray irrigation of food crops. While DHS has not established specific criteria for industrial applications in Title 22, DHS has required reclaimed water used in cooling towers to treated to the most stringent requirements specified by Title 22 to protect workers or the public from wind-blown spray.

Use of reclaimed water for wash-down applications or toilet flushing is not addressed in current regulations. However, the DHS is currently working with Irvine Ranch Water District on their first case study in California using reclaimed water for toilet flushing in office buildings. Irvine Ranch Water District has also developed a case study of dual water systems for front-yard residential irrigation. The irrigation system has dual timers to prevent irrigation during the daytime.

Reclaimed Water Implementation Guidelines

The DHS Guidelines for Use of Reclaimed Water and the CA/NV AWWA Guidelines for Distribution of Non-potable Water deal with requirements for the distribution of reclaimed water, primarily focused on ensuring that the system is adequately separated from potable supplies, clearly labeled, and that the use is controlled so as to prevent potential health hazards. Both of those documents are currently being revised. DHS may adopt the revised CA/NV AWWA Guidelines in lieu of developing a separate set of guidelines. Those requirements that relate to distribution facilities are to be incorporated into the City of Fairfield standards for non-potable water systems and are discussed at the end of this section.

The current DHS requirements that should be considered in planning the Central Solano Dual Water Systems include the following.

- Designation of the area of use of reclaimed water and establishment of methods for confining reclaimed water to those areas.
- Public notification that reclaimed wastewater is being used.
- Control of public contact with reclaimed water.
- Adequate separation of reclaimed water lines from domestic water lines.
- An air-gap separation between the reclaimed water system and any connection to the domestic system (for supplemental supply). An air-gap separation will be required for any connection to the Putah South Canal or other untreated supply that is used for domestic supply.
- Designation of a supervisor for each use area (e.g., golf course, industrial facility or other point of use). The designated supervisor will be responsible for all aspects of the on-site system installation and operation.
- Use of materials and labeling to clearly identify piping and systems containing reclaimed wastewater.

These Guidelines will be incorporated, with possible modifications, into the proposed Title 22 modifications. A 1991 draft of the CA/NV AWWA Guidelines includes all of the above items as well as the following.

- Guidelines for a planning study for a nonpotable water system. The current study meets the recommendations.
- Guidelines for seasonal, operational and emergency storage. An alternative supply, such as from the Putah South Canal, can meet the requirements for emergency storage.

- Recommendations that the agency delivering reclaimed water maintain regulatory control over the user, including procedures for enforcement of the guidelines for use and penalties for violations.

- An appendix discussion of institutional considerations relative to water reuse. These include contractual requirements between the supplier and user, potential water rights issues and inter-agency and inter-department communications.

The 1991 Draft CA/NV AWWA Guidelines generally address requirements for "conventional" types of reuse such as irrigation and construction water. However, they include an appendix that briefly discusses use for cooling tower supply, interior uses in commercial and industrial buildings, fire fighting, and use on large residential estates. All of these uses are recommended for consideration in water reclamation planning and specific features of interior use applications, as established by Irvine Ranch Water District and two other Southern California water agencies, are presented. These are not established guidelines but practice which has been accepted in those cases. Significant features of interior use systems are reported to be:

- All piping within the building is copper pipe. The reclaimed water piping is wrapped with purple warning tape imprinted with warning statements.

- An interior separation is installed in the walls to make sure that reclaimed water and domestic water pipes are shielded from each other and mitigate the potential for inadvertent cross-connections.

- All reclaimed water control valves are locking lever handle ball valves which are locked after the system is checked for cross-connections and placed in service.

- Warning signs are placed in the valve access panels and in the equipment rooms to notify maintenance personnel that reclaimed water is in use and advise them as to necessary safety precautions.

- Signs are installed in bathrooms to advise users that reclaimed water is being used for toilet flushing.

- Annual testing and a comprehensive system management plan are required.

Vector Control. The DHS is also concerned with the potential for disease transmission by mosquitoes that may breed in planned or unintentional impoundments of reclaimed wastewater. To address this potential, the DHS Vector Biology and Control Branch, in cooperation with the California Mosquito and Vector Control Association, has established Criteria for Mosquito Prevention in Wastewater Reclamation or Disposal Projects. A copy is included in Appendix B. In general, these criteria require the control of reclaimed wastewater to prevent or minimize the potential for breeding mosquitos. This is accomplished by avoiding standing water, minimizing shallow water with vegetation, use of mosquito fish in impoundments, and variation in water depth to interrupt the mosquito life cycle. Specific requirements relevant to this project are as follows.

- Sites should be graded to minimize ponding, maintain velocities in ditches or other open channels, and drain when not in use.

- Water control devices should be provided in any wetland or pond to allow draw down to interrupt the mosquito life cycle.

- Ponds should have steep side slopes and minimum shallow water areas to limit growth of vegetation. Small coves or irregularities in the sides should be avoided.

- Ponds should have provisions for maintenance access including small boat launching for midge sampling and control. A maintenance program including weed control and removal of dead algae and debris should also be provided.

Sampling and Analysis. The Title 22 regulations also have requirements concerning sampling and analysis. Samples for settleable solids and coliform bacteria must be collected at least daily and at times when the wastewater treatment characteristics are most demanding on the treatment facilities and disinfection procedures. Effluent turbidity must be recorded with a continuous recording turbidimeter.

The laboratory methods used are dependent upon the level of treatment required. If primary effluent is required, an approved laboratory method of settleable solids should be used. When adequately disinfected, oxidized wastewater is required, samples should be analyzed using approved laboratory methods for coliform bacteria. Uses requiring adequately disinfected, oxidized, coagulated, clarified, and filtered wastewater should use approved laboratory methods for analyzing turbidity and coliform bacteria content.

Engineering Report and Operational Requirements. An engineering report is required of any agency that produces or supplies reclaimed water for direct reuse from a proposed reclamation plant. The report must be prepared by a registered engineer in the State of California who has experience in wastewater treatment. Specific requirements for the engineering report are given in "Guidelines for the Preparation of an Engineering Report on the Production, Distribution and Use of Reclaimed Water" (DHS, Environmental Management Branch, June 10, 1988). In general, the report must contain the following items.

- A description of the proposed design of the reclamation system.
- A clear demonstration of the means to meet the Title 22 regulations.
- Plant reliability features.
- Supplemental water supply.
- Monitoring program.
- A contingency plan to ensure that no untreated or partially treated wastewater will enter the distribution system.
- A description of the transmission and distribution systems.
- A use area description.
- Use area inspection and monitoring plans.

The water reclamation facility's operations personnel must be properly qualified with respect to the requirements established pursuant to Chapter 9 (commencing with Section 13625) of the California Water Code. An adequate number of personnel to ensure proper operation of the treatment plant must be employed. Reliable operation of all equipment must be ensured by providing a preventive maintenance program at the water reclamation plant.

All operating records must be maintained at the water reclamation plant or a central depository within the operating agency. The operating records should include the following information.

- Analyses specific to reclamation criteria.
- Records of operational problems, plant and equipment breakdown, and diversions to emergency storage or disposal.
- Records of corrective or preventive actions.

A separate file must be maintained for all process or equipment failures which trigger an alarm. The time, cause, and corrective action taken for the alarm must also be recorded. A monthly report summarizing the operation of the plant must be submitted to the RWQCB and DHS. Any untreated or partially untreated discharges to the distribution system and cessation of the same must immediately be reported by telephone to the RWQCB, DHS, and County Health Department.

Criteria for the Separation of Sewers and Reclaimed Water Lines. On June 10, 1988, DHS issued Criteria for the Separation of Water Mains from Sanitary Sewers and Pipes Carrying Reclaimed Water. The purpose of this document was to establish criteria to help prevent the possibility of sewage contaminating a reclaimed water line through a cross-connection. Most of the criteria are based on that used for water supply systems. The basic separation standards are listed below.

> The 'California Waterworks Standards' sets forth the minimum separation requirements for water mains and sewer lines. These Standards, contained in Section 64630, Title 22, California Administrative Code, specify:
>
> (c) (1) Parallel Construction: The horizontal distance between pressure water mains and sewer lines shall be at least 10 feet.
>
> (2) Perpendicular Construction (Crossing): Pressure water mains shall be at least one foot above sanitary sewer lines where these lines must cross.
>
> (d) Separation distances specified in (c) shall be measured from the nearest edges of the facilities.
>
> (e) (2) Common Trench: Water mains and sewer lines must not be installed in the same trench.

The criteria also list exceptions and special provisions to the basic criteria if site conditions require a variance. Alternative criteria for construction of sewer lines or water mains where the basic separation standards cannot be attained are also provided.

Department of Food and Agriculture

Mr. Mark Pepple of the Environmental Monitoring section of the Department of Food and Agriculture advised that they do not have any regulations relative to the use of reclaimed wastewater for agriculture or food processing. The Department of Food and Agriculture would enforce DHS requirements.

CalTrans

Section 92.3 of the Streets and Highways Code was amended, effective January 1, 1991, to require that CalTrans use reclaimed water for irrigation and permit local agencies to use freeway rights-of-way for reclaimed water transmission lines, subject to several conditions and restrictions. A copy of the amended section is presented in Appendix B.

The relevant conditions include the following.

- Adequate supplies of reclaimed water should be available and the use must be approved by the RWQCB. CalTrans must also have first priority of use of reclaimed water.
- CalTrans must receive some benefit.
- The local agency must install and maintain the facilities at their cost and agree to relocate the facilities if necessary.
- The local agency and all customers using the reclaimed water must agree to allow temporary service interruptions. Hold harmless agreements to this effect are required.
- There must be no unreasonable increase in the hazard to vehicles due to the installation, or unreasonable problems of highway maintenance.
- The plans must be approved by CalTrans prior to construction.

Construction of a transmission line either following the freeway right-of-way or crossing the freeway would require an encroachment permit and approval from CalTrans. CalTrans has specific provisions for utility encroachments that address methods of construction, limits of excavation, traffic protection and maintenance access. These requirements should be considered during design of any facilities either crossing or paralleling a freeway or other state highway.

LOCAL AGENCIES

Solano County Department of Environmental Health

Mr. Ron Schefler of the Solano County Department of Environmental Health stated that the County has no regulations relative to the use of reclaimed wastewater. Such use would be regulated by DHS.

City of Suisun City

The Solano Irrigation District operates the potable water system that serves the City of Suisun City. Neither SID nor the City of Suisun City has regulations relative to the use of reclaimed wastewater. Such use would be regulated by DHS.

City of Fairfield

In 1989, in preparation for possible future construction of a reclaimed water system, Bissell & Karn prepared Standard Specifications and Details for Nonpotable Water Service Facilities for the City. A final draft was completed but has not yet been incorporated into the City Standards. The standards include engineering standards for planning and design, materials of construction, and installation requirements for nonpotable water distribution and irrigation systems. Several standard details for location of lines, separation from potable water lines, and other features are also included. These standards will apply to design and construction of dual water systems in the City of Fairfield.

In general, the standards deal with requirements for on-site facilities that will use nonpotable water. The only requirements that would affect planning at the level of this study are those dealing with location of pipelines and minimum pipe size (6-inch). Provisions are included that allow the City to determine which areas of the City are to be served and what uses are to be allowed. The only

specific uses that are not allowed are fire fighting (hydrants are not to be installed on nonpotable water mains), and irrigation of enclosed private rear yards, indoor atriums or planters.

The standards were prepared to conform to the AWWA Guidelines for Distribution of Non-potable Water and the DHS Guidelines in effect at that time. Some modifications may be necessary when the DHS guidelines are modified. Provided below are two items that are included in the current draft of the CA/NV AWWA Guidelines that differ from the City of Fairfield draft standards.

- The current Guidelines have selected purple as the color to be used for identification of nonpotable water piping and systems. The City of Fairfield standards call for red or green markings.

- Potable water lines in the same area as nonpotable water lines must also be identified with marking tape.

The CA/NV AWWA Guidelines also recommend regulations regarding the use and management of on-site reclaimed water systems. The City should consider development of appropriate regulations as a part of implementation of dual water systems. These regulations would address such issues as the administrative procedure for obtaining reclaimed water service, monitoring of reclaimed water use, management responsibilities, and penalties for violations of use permit conditions.

Section 3

SECTION 3

POTENTIAL NON-POTABLE WATER USERS AND DEMANDS

In California, non-potable water is primarily used for irrigation, industrial cooling tower makeup water, and dust control on construction sites. This section identifies potential non-potable water users, discusses possible constraints to non-potable water use, and identifies demand criteria, water duties (the water use per acre used to estimate demand), and potential non-potable water demands. The estimates of non-potable water demands become the primary factor determining the sizes of the components of the porposed non-potable water distribution systems discussed in Sections 6 and 7. The emphasis in this sectiopn is on the potential demand for reclaimed water, with raw water sources as potential supplemental supplies.

POTENTIAL NON-POTABLE WATER USERS

Within the study area, potential non-potable water users purchase potable water from the cities or raw water from SID or both. A list of potential non-potable water users was developed from Fairfield water billing records; information gathered from SID, Suisun City, the Fairfield-Suisun Unified School District, and the two cities' parks departments; and information presented in the City of Fairfield Water Reclamation Study (JMM, September 1987). The list of potential uses included agricultural irrigation; irrigation of city parks and public facilities, schools, golf courses, highway landscaping, business and industrial park landscaping; and industrial process applications.

Survey

The list of potential users was reduced to several representative users. The potential users on this refined list were contacted by City staff through an initial telephone survey. Collected data included type of business, interest in a reclaimed water program, perceived benefits of reclaimed water use, potential uses of reclaimed water, types of information required by the user to make an informed decision, and an overall program rating. The telephone survey results are shown in Table 3-1.

All surveyed potential users were cooperative and interested in participating in the survey; all indicated they were interested and generally enthusiastic about using reclaimed water. Perceived benefits identified during the survey included reduced water costs, reliable water source, and improved public perception of their operations. The identified potential uses included irrigation, process water and cooling water. All or most of the potential users indicated that information regarding cost and water quality would be needed to make an informed decision regarding reclaimed water use at their facility.

Irrigation Uses

Irrigation uses include agricultural irrigation and irrigation of parks, schools, golf courses, highway landscaping, and business and industrial park landscaping. There are over 4,000 acres of agricultural land in the study area; over 30 parks and park maintenance areas; over 25 schools in the Fairfield-Suisun Unified School District; several golf courses and highway and street landscaping areas; and several major business/industrial parks.

Reclaimed water has somewhat different water quality characteristics then the region's raw water. These characteristics can affect its suitability for irrigation. Irrigation problems are usually associated with salinity, soil permeabiliy, specific ion toxicity, and bicarbonate. These water quality issues are discussed further in Section 4.

TABLE 3-1

RECLAIMED WATER SURVEY SUMMARY
Jul-91

			Perceived Benefits				Potential Uses				Type of Information Needed			
Customer	Type of Business	Interested in Program	Cost	Water Source	Public Relations	Other	Irrigation	Process	Cooling	Other	Cost to Customer	Water Quality	Other	Program Rating (1-10)
Our Lady of Mt Carmel	Service	Yes	X				X				X			9
Kaiser Permanente	Service	Yes	X	X	X		X				X	X		8
Hofmann Company	Contractor	Yes	X				X		X	X	X			7
Solano County	Service	Yes	X	X	X		X		X	X	X	X		9
LDS Church	Service	Yes	X				X				X	X		6
Peach Tree Villa Apts	Apartment	Yes	X	X	X		X				X	X		8
Solano Garbage	Service	Yes	X	X	X		X			X	X	X		8
Clorox	Manufacturer	Yes	X	X	X		X	X	X	X	X	X		8
Solano Concrete	Manufacturer	Yes	X	X	X		X	X			X			9
R. Dakin & Company	Wholesaler	Yes	X	X	X		X		X		X	X		7
Ball Metal	Manufacturer	Yes	X	X	X		X	X	X		X	X		9
Mission Village	Retailer	Yes	X				X				X			8
Breuner's	Retailer	Yes	X				X		X		X			8
Solano Mall	Retailer	Yes	X	X	X		X		X		X			9
Total Count/Average		14	14	9	9	0	14	3	7	4	14	8	0	8
Percent of Total Surveyed		100.0	100.0	64.3	64.3	0.0	100.0	21.4	50.0	28.6	100.0	57.1	0.0	

The City of Fairfield Parks Department and the Fairfield-Suisun Unified School District provided lists of the landscape plants used at their facilities. JMM's subconsultant, Royston, Hanamoto, Alley and Abey (RHAA), supplemented those lists by visiting representative sites around the area and investigating the plants observed. The resulting combined list identifying the commonly used landscape plants in the study area is included in Appendix D. The list includes 168 different plant species subdivided into the following four categories based on their expected tolerance to irrigation exclusively with reclaimed water:

- Good tolerance -- plants that would typically exhibit reasonable growth characteristics, and normal appearance and color.
- Moderate tolerance -- plants that may exhibit light to moderate leaf burn, or yellowing on older leaves, especially during the drier months, but whose overall appearance would remain reasonably good.
- Low to poor tolerance -- plants that may exhibit retarded growth, significant leaf burn and, in some cases, early leaf drop, and whose overall aesthetics may be noticeably reduced.
- Unknown tolerance -- plants for which little is known regarding their tolerance of reclaimed water.

When categorizing the plants into these four categories, RHAA considered the quality of reclaimed water available, prevailing soil types in the area, and the local climate. Hence, the categorization is unique to the Central Solano area.

Whenever reclaimed water us used for irrigation, an alternative, higher quality water should also be available. This permits switching sources whenever problems caused by irrigation with poorer quality reclaimed water are noted.

Industrial Uses

Industrial uses for non-potable water include cooling, boiler feed, washing, and processing; cooling is the predominant industrial application. The study area includes several major business/industrial parks; Pacific Bell, along with a few other industries, have been initially identified for use of reclaimed water as cooling or process water.

Use for Suisun Marsh Salinity Control

The Suisun Marsh is located south and east of the study area. It is the largest brackish water marsh in the United States. Water impoundments and diversions have decreased the freshwater flow into the marsh, and raised the salinity level in the marsh, particularly in the winter and spring. One potential use for reclaimed and raw water in the area is for Suisun Marsh salinity dilution.

Presently, all reclaimed water in the area is discharged to the marsh and hence dilutes the marsh somewhat. With dual water systems, it might be possible to optimize the effectiveness of that reclaimed water by piping it to a point where it would most effectively help control marsh salinity.

Marsh salinity control is most important from December through March. This coincides with a period of minimal irrigation. Hence marsh salinity control and irrigation could be complementary, not competing, uses of reclaimed water.

POTENTIAL NON-POTABLE WATER DEMANDS

Estimating the potential demand for reclaimed and raw water involves the consideration of existing and future water users. To account for various types of demand, potential reclaimed water users were grouped in general land use categories as defined in the Cities' General Plan Land Use Elements: agricultural, industrial, commercial, public facilities, and recreational. Industrial process water demands were developed on a case-by-case basis. Figure 3-1 shows the locations of these land uses.

Potential Irrigation User Demands

Potential irrigation demands were estimated based on water use records as well as 1987 Water Reclamation Study results. Where data from actual water use records were not available, potential demands were estimated from landscaped acreage and a unit demand factor. Landscaped acreage was determined for developed properties by planimetry of October 1989 aerial photographs of the City of Fairfield and for areas to be developed in the future from general plan land use information and discussions with City staff.

Demand Evaluation Criteria. Historical water use records from the Fairfield-Suisun Unified School District support a unit demand factor or average annual demand (AAD) of 2.8 acre-ft/acre/yr for school landscaped areas, which are primarily turf. This is equivalent to a daily application rate of 0.16 inches based on a seven month irrigation season. Unit demand factors for landscaped areas including trees, bushes and ornamental plants, are somewhat less than that for turf irrigation. Historical water use records for City of Fairfield parks suggest an average annual demand for urban landscaped areas other than schools of about 2.5 acre-ft/acre/yr. This is equivalent to a daily application rate of 0.14 inches based on a seven month irrigation season. The demand analyses in this plan assume an AAD of 2.8 acre-ft/acre/yr for schools and 2.5 acre-ft/acre/yr for all other agricultural, turf and landscaped areas.

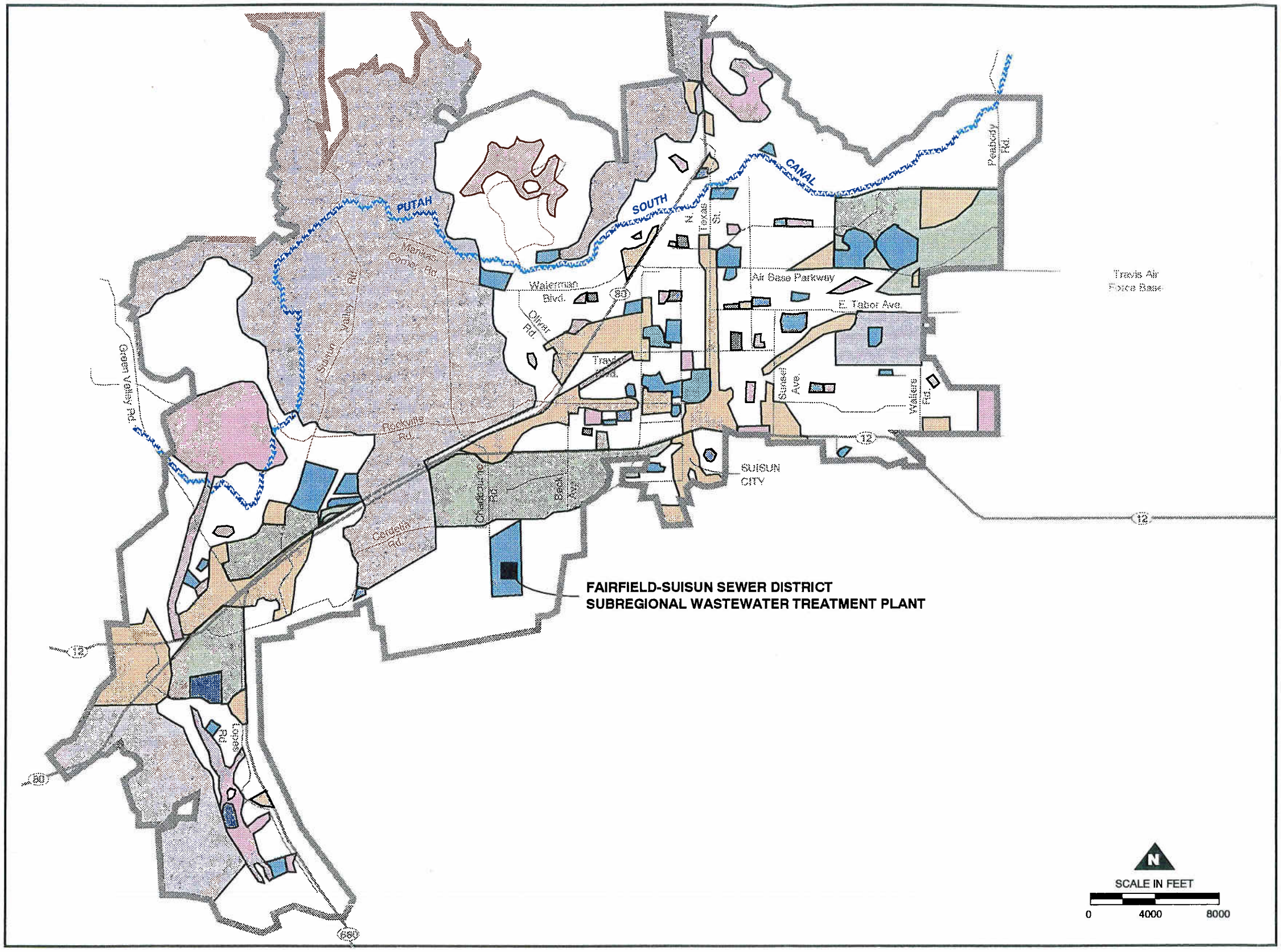
As mentioned above, potential reclaimed water users were grouped into five general land use categories. The irrigation demands associated with each of these categories are identified below.

Agricultural. According to City and County General Plans, the Suisun Valley area is planned to remain intensive agriculture usage. The majority of the 4,000 acres of agricultural land within the study area is in Suisun Valley.

Crops currently grown in Suisun Valley include orchards, row crops and vines. Approximately 80 percent of the production is from orchards. Orchard crops include pears, peaches, prunes and plums.

Existing agricultural irrigation demands were developed using the 1990 delivery schedule provided by SID staff. SID delivered the following amounts of nonpotable water to the Suisun Valley from each main lateral:

Chadbourne Lateral	2,446 acre-ft
Pierce Lateral	2,119 acre-ft
Lambert Lateral	1,342 acre-ft
Lambert A Lateral	1,172 acre-ft
Lateral 49 Lateral	607 acre-ft
Young Lateral	595 acre-ft
Solano Community College Lateral	119 acre-ft
Total	8,400 acre-ft



LEGEND

- AGRICULTURAL OR RURAL RESIDENTIAL
- INDUSTRIAL
- PUBLIC FACILITIES
- RECREATION
- COMMERCIAL

CITY OF FAIRIFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS PLAN
GENERAL LAND USES

FIGURE 3-1

SID officials and farmers in Suisun Valley have expressed concerns about the quality of reclaimed water for crop irrigation. It seems likely that they will not accept reclaimed water for crop irrigation on a broad scale unless it is blended with raw water from the Putah South Canal. It is not known what blend ratio will be acceptable. In this report two different estimates of agricultural demand for reclaimed water were made assuming two different percentages of the total irrigation demand were met with reclaimed water. The percentages of total demand used for the two estimates were 25 percent and 50 percent. For example, the Chadbourne Lateral AAD is 2,446 acre-ft/yr. This study uses AAD's of 612 acre-ft/yr (25%) for the Chadbourne Lateral in some alternatives and 1,223 acre-ft/yr (50%) for the Chadbourne Lateral in other alternatives.

The other significant agricultural area in the study area is Tolenas, an area of 2.5 and 5 acre rural residential parcels. SID maintains existing dual water systems in the Tolenas area. SID serves irrigation water to the area using water from the Cache Slough Pipe (via a distribution system used only for irrigation water). SID serves potable water to the area via a separate system. The following are the irrigation AAD's in Tolenas over the past three years:

Year	Tolenas AAD
1989	480 acre-ft
1990	672 acre-ft
1991	531 acre-ft

This study uses an AAD of 700 acre-ft/yr for Tolenas.

Typical unit demand factors for agricultural irrigation are 3.5 acre-ft/acre/yr for row crops, 2.5 acre-ft/acre/yr for orchards, and 1.25 acre ft/acre/yr for vines. Demands for agricultural areas not located in Suisun Valley or Tolenas and for future agricultural areas were developed by applying an average unit water use demand of 2.5 acre-ft/acre/yr.

Industrial and Commercial Demands. The most attractive industrial area for reclaimed water use is the Solano Business Park/Low Industrial Park area, located near the Fairfield-Suisun Sewer District Wastewater Treatment Plant. The Solano Business Park maintenance district has expressed an interest in utilizing reclaimed water; Pacific Bell, which owns a new facility in the Solano Business Park, has entered information on agreement with the City of Fairfield to use reclaimed water for industrial cooling and landscape irrigation in the future.

The Gateway project area, which includes the Solano Mall, is located northeast of the Solano Business Park. The Gateway area has extensive landscaping and is a potential user of reclaimed or raw water.

The southwest central area of the City has a significant amount of land designated for future industrial and commercial uses. This land is located within the Busch Corporate Center, the Gentry-Pierce Business Park, and the Fairfield Redevelopment Agency area. The Busch Corporate Center is currently supplied with nonpotable irrigation water by SID.

The northeast area of the City although remote from the source of reclaimed water, also has a significant amount of land designated for industrial and commercial uses. This area is partially developed; the proposed revisions to the City's General Plan Land Use Element designate additional lands in this area for future industrial and commercial uses. This area has good access to the Putah South Canal and NBA sources of nonpotable water.

Nonpotable water can be used to irrigate landscaping at some of the larger office and industrial parks in the study area. Existing and future irrigation demands for office and industrial parks were estimated by applying a unit water demand of 2.5 acre-ft/yr to landscaped acreage. The total

projected average annual irrigation reclaimed water demand for office and business parks is about 1,100 acre-ft/yr.

Schools. The list of potential non-potable water users includes 25 schools within the study area. Each of these has some landscaped area. Fairfield High School is currently served non-potable irrigation water from SID, but could convert to reclaimed water, were it available and acceptable. The total estimated landscaped acreage of the schools in the service area is over 190 acres.

Public Facilities. Public facilities include medical facilities, cemeteries, public rights-of-way, and city and county government facilities. Potential public uses include the County Jail and Juvenile Hall Complex, the Civic Center, Suisun-Fairfield Cemetery, the County Detention Facility, and the Animal Shelter. The Suisun-Fairfield Cemetery District has on agreement with the City of Fairfield to use reclaimed water on the District Union Avenue property, if reclaimed water available near the property.

Non-potable water could also be utilized for irrigation of landscaping at highway interchanges and landscaping along major streets (streetscapes). Non-potable water could replace potable water currently used by CalTrans for the Highway 12, West Texas Street, Air Base Parkway and Travis Boulevard interchanges at Interstate 80. Potential streetscape irrigation uses include areas along Highway 12, Travis Boulevard, Pennsylvania Avenue, Beck Avenue, Air Base Parkway, North Texas Street, Scandia Road, Walters Road, and Lawler Ranch Parkway.

Recreational Are Recreational areas include parks, park maintenance areas, and golf courses among others. [redacted]are over 25 parks and four existing and planned golf courses that are considered to be p[redacted]l users of reclaimed water in the study area. Some of those areas already use non-potable irri[redacted] water. Existing and future demands for irrigation of landscaping at recreational areas w[redacted]eloped by applying a unit water use duty of 2.5 acre-ft/acre/yr to landscaped acreage.

Potential Industrial User Demands

Pacific Bell is constructing a new facility in the Solano Business Park. In addition to allowing for landscape irrigation with reclaimed water, Pacific Bell has constructed the facility so reclaimed water could be used as cooling water for the building's air conditioning system. Other firm considering building facilities in Solano Business Park have expressed interest in utilizing reclaimed water as cooling water. Several other businesses throughout the area have expressed interest in utilizing reclaimed water in their processes or as cooling water.

Industrial process and cooling water flows vary widely. Pacific Bell has defined the amount of reclaimed water they would use to be 90 acre-ft/yr or more. Estimates of potential non-potable water use by other industries are not available.

Industrial process and cooling water flows have a much lower peak flow to average flow ratio than do irrigation flows. As a result, even relatively large annual usage for process or cooling water purposes results in peak demands that are small compared to peak irrigation demands. The peak industrial demands also rarely occur at the same time as the peak irrigation demands. The pumps and pipes described in this master plan are sized for the peak flows (peak hour or maximum day, which will be largely irrigation flows). As a result, even if fairly large industrial demands are unaccounted for in the plan's demand estimates, there will probably be sufficient capacity in the pumps and pipes to handle those industrial demands. In other words, this plan makes the assumption that industrial uses of reclaimed and other non-potable water will be easily accommodated by a system designed primarily to deliver peak irrigation flows.

Potential Marsh Salinity Control Demand

The California State Department of Water Resources (DWR) is preparing an environmental impact report on various alternative ways to control salinity in the western Suisun Marsh. They have estimated that a fresh water flow of 30 to 50 cfs (19 to 32mgd) into the western marsh would achieve the desired salinity levels. Possible discharge points include Green Valley Creek and Suisun Creek. Use of the reclaimed water from the Fairfield-Suisun WWTP for marsh salinity control is only one of several options being investigated by DWR. Whether it will become a reality is very uncertain. Thus, marsh salinity dilution flows were not considered when the reclaimed water distribution systems were sized.

Potential Users Not Considered

This analysis does not consider three major types of properties to be potential users of reclaimed or other non-potable water. The property types are:

- Single family residential
- Multi-family residential
- Small commercial

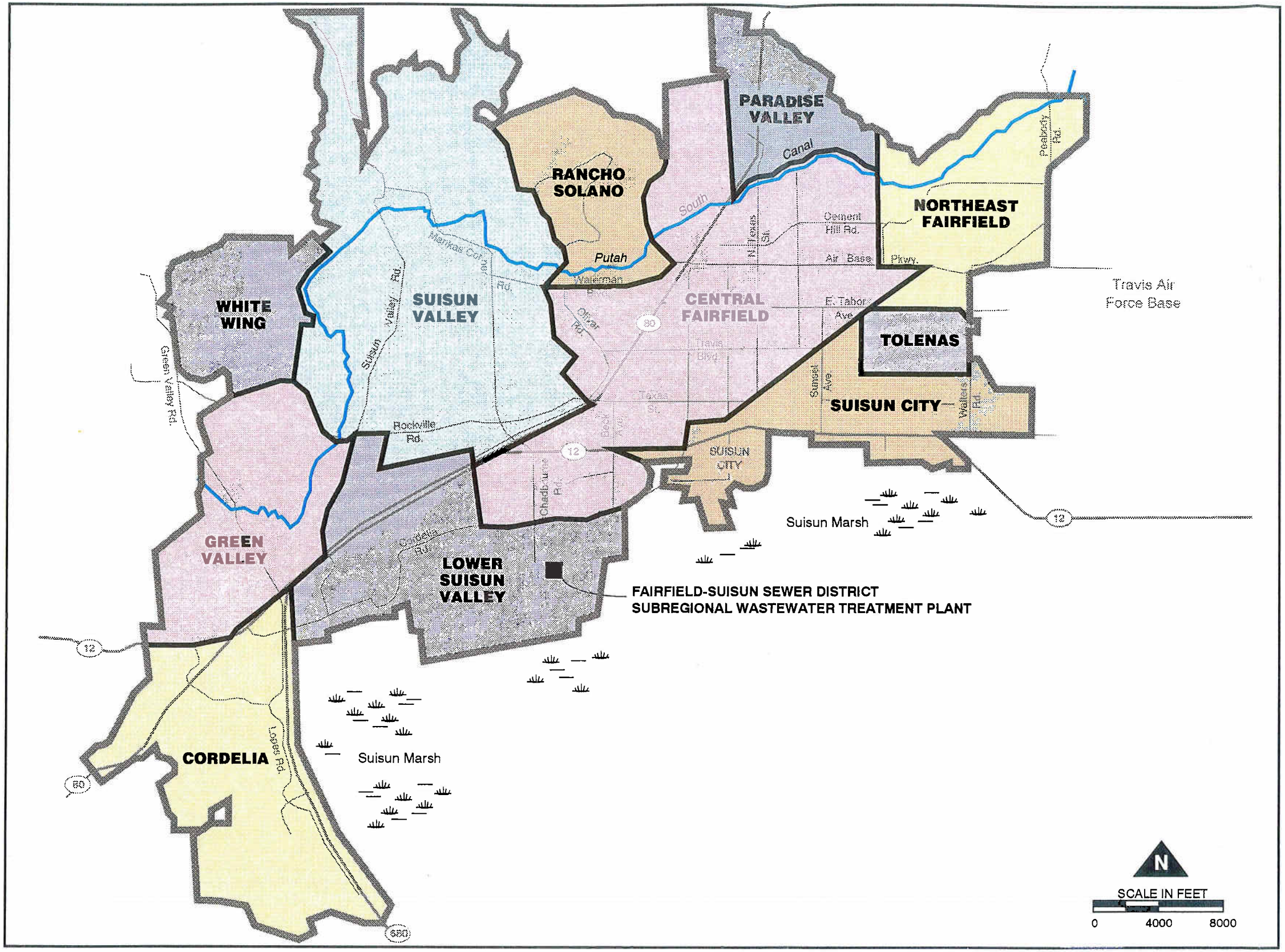
Reclaimed or other non-potable water must not be used improperly nor interconnected with the potable water system or it may endanger public health. With agricultural users, large commercial or industrial users, and public facilities, it is possible to monitor the use of reclaimed and raw water and be fairly sure that it is being used properly. Such monitoring is extremely difficult with residential and small commercial users due to their shear numbers. Within the study area there is sufficient potential demand to use up all the available reclaimed water without including demands from residential and small commercial properties. Since serving residential and small commercial properties would raise some public health concerns, this plan does not consider them potential reclaimed or other non-potable water users.

SUMMARY OF POTENTIAL DEMANDS

The study area logically splits into eleven geographic subareas when viewed from the perspective of non-potable water distribution piping. The nature of the piping systems serving these subareas is discussed in Chapter 6. The subareas are the following:

- Central Fairfield
- Rancho Solano
- Paradise Valley and Lagoon Valley
- Northeast Fairfield
- Suisun Valley (Middle and Upper Suisun Valley)
- Lower Suisun Valley (Lower Suisun Valley, Solano Community College, and Fairfield Corporate Commons)
- White Wing
- Lower Green Valley (incorporated area of Green Valley only)
- Cordelia (Cordelia Villages)
- Suisun City
- Tolenas

Figure 3-2 is a map showing the boundaries of the eleven subareas. Table 3-2 presents a summary of the potential demands for reclaimed and raw water in the study area. The potential demands are tabulated by land use category and by geographic sub-area.



LEGEND

- STUDY AREA
- SUB-AREA BOUNDARY

CITY OF FAIRFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

GEOGRAPHIC SUB-AREAS FOR DEMANDS ANALYSIS

FIGURE 3-2

TABLE 3-2

POTENTIAL NON-POTABLE WATER DEMANDS SUMMARY

AVERAGE ANNUAL DEMAND (acre-ft/yr)

Sub-Area (a)	Agriculture	Industrial	Commercial	Public Facilities	Recreation	Streetscapes Highways	Total
Central Fairfield	0	892	2	389	415	316	2,014
Rancho Solano	0	0	0	120	738	0	858
Lagoon/Paradise Valley	0	0	0	0	2,130	0	2,130
Northeast Fairfield	0	0	0	152	9	0	161
Suisun Valley	3,610	0	0	0	0	0	3,610
Lower Suisun Valley	300	53	0	188	0	1	542
White Wing	0	0	0	0	718	0	718
Lower Green Valley	0	27	0	4	80	1	112
Cordelia	0	97	10	47	20	8	182
Suisun City	0	0	8	84	267	52	411
Tolenas	671	0	0	29	0	0	700
Total	4,581	1,069	20	1,013	4,377	378	11,439

(a) Refer to Figure 3-2 for sub-area delineation

Section 4

SECTION 4

WATER QUALITY AND SOIL CONDITIONS

Water quality can significantly affect the use of non-potable water in Central Solano County. This section discusses several of the most important water quality characteristics and why those characteristics are important in terms of irrigation and/or industrial uses of non-potable water. Data on the water quality characteristics for the available sources of raw and reclaimed water in the area are summarized. Finally, the site specific implications of using the available raw or reclaimed water for irrigation at each of ten sample sites in the area are discussed.

WATER QUALITY REQUIREMENTS OF NON-POTABLE WATER FOR IRRIGATION USES

The following discussion considers water quality requirements and relates those requirements to potential uses of non-potable water. Reclaimed water quality will have a major effect on the water's potential for irrigation and industrial use. Irrigation represents the largest potential water reuse market within the Central Solano Dual Water Systems Master Plan study area. Quality of irrigation water has, historically, been determined by salt content; i.e., the concentration of specific chemical elements that affect plant growth or soil permeability. As salinity increases above certain tolerance levels, the probability of soil permeability and plant growth problems increases as well. Whether a given irrigation water has acceptable water quality depends in part on other factors such as soil type, type of plants, and climate. Only very general guidelines for what makes water acceptable for irrigation are given. Table 4-1 presents one such set of general guidelines prepared by the State of California Department of Water Resources (DWR).

Table 4-2 presents additional water quality acceptability guidelines based on definitive agricultural studies carried out over the last several decades. Irrigation problems are usually associated with salinity (the single most important factor in determining suitability), soil permeability (related to SAR and salinity), specific-ion toxicity, and bicarbonate. Footnotes to the table are intended to provide a cursory assessment of problem constituents; elaboration is found in the referenced reports.

Total Salt Content

Salinity problems, most pronounced in heavy soils, occur when the salts dissolved in irrigation water accumulate in the root zone to levels intolerable to the species being grown. A high salt level in the soil may affect plants by increasing osmotic pressure of the soil solution, thus making water less available to the plants. Where salinity is very high, grass roots wilt and plants may eventually die. Nutritional imbalances and mineral toxicities may also occur at high salinity levels.

When discussing impacts of salt content, it is necessary to know the salt content in the irrigation water and in the soil solution. Salinity is measured as electrical conductivity (EC). As a general rule, salinity problems are associated with irrigation waters with EC's greater than 0.75 decisiemens per meter (dS/m). Although salinity problems may occur when waters with salinity levels of 0.75-3.0 dS/m are used, severe problems are caused by waters with EC's greater than 3.0 dS/m. Therefore, water with salinity that exceeds 3.0 dS/m is generally not recommended for irrigation.

The extent of salt uptake and its consequent effects on plant growth are directly related to the salt concentration of the soil solution. Turfgrasses are more tolerant to salt than other plants. Table 4-3 gives a general guide to individual turfgrass salt tolerances. Specific conditions may yield different results.

TABLE 4-1

DEPARTMENT OF WATER RESOURCES
CRITERIA FOR CLASSIFICATION OF IRRIGATION WATERS[a]

Factors	Class 1[b]	Class 2[c]	Class 3[d]	PSC Water[f]	Rec. Water from FSSD[g]
Total dissolved solids, mg/l	<700	700 - 2100	>2100	169-244	720-820
Boron, mg/l	<0.5	0.5 - 2.0	>2.0	<0.1	0.7-1.2
Chloride, mg/l	<175	175 - 350	>350	4.3-15	140-210
Sulfate, mg/l	<950	950 - 1900	>1900	18-40	83-110
Sodium, %[e]	<60	60 - 75	>75	8.6-45	53-63

(a) Adapted from Bulletin No. 104-7, Planned Utilization of Water Resources in the San Juan Creek Basin Area, California State Deptartment of Water Resources

(b) Excellent to Good. Regarded as safe and suitable for most plants under any conditions of soil or climate.

(c) Good to Injurious. Regarded as possibly harmful for certain crops under certain conditions of soil or climate, particularly in the higher range of this class.

(d) Injurious to Unsatisfactory. Regarded as probably harmful to most crops under certain conditions of soil or climate, particularly in the higher range of this class.

(e) Percent sodium (Na) = 100 Na/(Na+Ca+Mg+K); all ions expressed in milliequivalents per liter.

(f) Range of values reported for water from the Putah South Canal. Given here for comparison to the classifications.

(g) Range of values reported for reclaimed water from the Fairfield-Suisun WWTP. Given here for comparison to the classifications.

TABLE 4-2

WATER QUALITY ACCEPTABILITY GUIDELINES[a]

Potential Irrigation Problem and Related Constituent	Acceptability Criteria[a]			Values in Local Waters	
	No Problem	Increasing Problems	Severe	PSC Water[h]	Rec Water from FSSD[i]
Salinity [b]					
Electroconductivity (EC), dS/m	<0.7	0.7 - 3.0	>3.0	0.33-0.35	1.1-1.3
TDS, mg/l	<450	450 - 2000	>2000	169-244	720-820
Permeability[c]					
Adj. SAR[d]	<6.0	6.0 - 9.0	>9.0	0.4	4.3-5.2
Specific ion toxicity,[e]					
From root absorption					
Sodium (evaluated by Adj. SAR)	<3	3.0 - 9.0	>9.0	0.4	4.3-5.2
Chloride,mg/l	<140	140 - 350	>350	4.3-15	140-210
Boron, mg/l	<0.7	0.7 - 3.0	>3.0	<0.1	0.7-1.2
From foliar absorption[f]					
Sodium, %	<70	>70	-	8.6-4.5	53-63
Chloride, mg/l	<100	>100	-	4.3-15	140-210
Miscellaneous[g]					
Nitrogen (NO_3^-), mg/l	<5	5 - 30	>30	0-1.2	11-18
Bicarbonate (HCO_3), mg/l	<90	90 - 520	>520	13-198	160-240
Residual Chlorine, mg/l	<1.0	1.0 - 5.0	>5.0	<1	<1
pH	Normal range 6.5-8.4	Outside range	-	8.4	6.9-7.2

(a) Adapted from "Irrigation with Reclaimed Municipal Wastewater - A Guidance Manual," U.C. Davis, July 1988.

(b) Affects plant water availability; assumes water for plants plus needed water for leaching requirement will be applied; plants vary significantly in tolerance to salinity.

(c) Affects infiltration rate of water into soil.

(d) Adjusted SAR (sodium adsorption ratio) is calculated from a modified equation developed by U.S. Salinity Laboratory to include added effects of precipitation and dissolution of calcium in soils and is related to $CO_3 + HCO_3$ concentrations; at a given SAR, infiltration rate increases as salinity increases.

(e) Affects sensitive plants; most tree crops and woody ornamentals are sensitive to sodium and chloride; most annual crops are less sensitive.

(f) Leaf areas wet by sprinklers may show leaf burn due to sodium or chloride absorption under low humidity/high evaporation conditions.

(g) Affects susceptible plants; excess N may effect production or quality of certain crops; e.g., sugar beets, citrus, avocados, apricots, etc. HCO_3 with overhead sprinkler irrigation may cause a white carbonate deposit to form on fruit and leaves. Residual chlorine can also damage plant foliage when sprayed on leaves.

(h) Range of values reported for water from Putah South Canal. Given here for comparison to the acceptability criteria.

(i) Range of values reported for reclaimed water from the Fairfield-Suisun WWTP. Given here for comparison to the acceptability criteria.

TABLE 4-3

APPROXIMATE SALINITY TOLERANCES OF TURFGRASS

Specie	Maximum Acceptable Electrical Conductivity of Soil Saturation Extract (dS/m)
Kentucky Bluegrass	<4
Highland Bentgrass	<4
Red Fescue	<4
Meadow Fescue	<4
Tall Fescue	4-8
Perennial Ryegrass	4-8
Hybrid Bermudagrass	8-16
St. Augustine Grass	8-16
Seaside Bentgrass	8-16
Zoysia	8-16
Common Bermudagrass	8-16

Source: University of California Cooperative Extension, Water Quality: Its Effects on Ornamental Plants, Leaflet 2995.

Growth of most turfgrasses is not significantly affected by soil salt levels below 2 dS/m, while at salt levels of 2 to 8 dS/m the growth of some turfgrasses is restricted. At 8 to 16 dS/m, the growth of most turfgrasses is restricted, and above 16 dS/m, only very salt-tolerant turfgrasses can survive.

If high salinity is expected to create a problem, impacts can be reduced with management techniques, including: blending high saline water with low saline water, planting salt-tolerant plants, applying extra water to leach excess salt, irrigating more frequently to maintain a higher soil moisture content, modifying soil to improve water percolation, and installing artificial drainage to improve leaching.

Sodium Hazard (Permeability)

The presence of sodium in the irrigation water is a particularly important water quality indicator. When sodium comprises a high proportion of all cations (positively charged ions) in the water, it causes a breakdown of the soil aggregates which reduces water infiltration into and through the soil. Soil permeability is reduced when water high in sodium concentration is used. Due to decreased permeability, irrigation water containing excessive amounts of sodium can be injurious to vegetation. The effects can be lessened if the soil is periodically treated with a calcium-rich compound such as gypsum, which removes sodium from soil particles and replaces it with beneficial calcium.

The sodium adsorption ratio (SAR) is an important indicator of wastewater suitability for reuse in irrigation practices as it relates to soil permeability. The SAR indicates the relative activity of sodium ions as they react with clay. The adjusted SAR (SAR_{adj}) is a refinement which includes the added effects of precipitation and solution of calcium in soils, as related to carbonate and bicarbonate (alkalinity) concentrations. The SAR_{adj} is a more correct estimate of the calcium that can be expected to remain in the soil water after irrigation.

The following two formulas apply:

$$SAR = \frac{Na}{[(Ca + Mg)/2]}\ 1/2,$$

where the cations Na, Ca, and Mg are expressed in milliequivalents per liter (meq/l); the meq/l equals the concentration (mg/l) divided by the equivalent weight; and,

$$SAR_{adj} = SAR\ [1 + (8.4 - pHc)] = SAR\ (9.4 - pHc),$$

where pHc = p (Na + Ca + Mg) + p (Ca + Mg) + p (CO3 + HCO3) and CO3 and HCO3 are expressed in meq/l, and p is the base 10 logarithmic function.

If the SAR is less than 6.0, there are seldom problems (affecting plants) with either sodium or soil permeability. In the range of 6.0 to 9.0, adverse conditions can occur in some soils. If the SAR is greater than 9.0, soil permeability and plant growth problems are commonly experienced in many soil types. However, for turfgrasses planted in coarse-textured soils (sandy soils) permeability is not usually a problem and a SAR greater than 9.0 can be tolerated. Sodium does not usually cause direct injury to turfgrasses, which, in comparison with other plants, are relatively tolerant of sodium. If waters high in sodium are to be used, management practices which increase permeability should be adopted. These include blending with a water low in sodium, frequent acidification, and either increasing calcium content of the water (by adding gypsum or some other soluble calcium salt), or reducing bicarbonate by adding sulfuric acid, sulfur dioxide, or some

other acidifying amendment. Calcium prevents excess accumulation of sodium on clay or organic matter particles. Leaching is then practiced to flush out sodium salts accumulated in the root zone. These remedies, however, can also further increase concentrations of TDS in the reclaimed water.

Toxic Ions

Problems can occur when certain elements accumulate in the soil to levels toxic to turfgrass and other plants. Toxicities can occur due to an accumulation of boron, chloride, copper, nickel, zinc or cadmium. Since turfgrasses are mowed regularly and accumulated boron is thus continuously removed from the leaves, most regularly mowed turfgrass can tolerate high concentrations of boron in irrigation water. However, this high boron content of poor quality irrigation water poses a greater toxicity problem for non-turf plants, such as trees, shrubs, ground cover, etc. Boron concentrations of 1.0 ppm or less are considered low and will affect very few plants; the most sensitive plants may exhibit some sort of leaf burn. A general reference regarding boron and its affect on plant materials is provided below:

- Boron <0.5 ppm — No known problem to ornamental plant materials.
- Boron <1.0 ppm — The most sensitive plants may exhibit some sort of leaf burn.
- Boron >1.0 ppm — Sensitive plants will exhibit leaf burn.

Chloride is not particularly toxic to turf, but most trees and shrubs are quite sensitive to a chloride content of 10 meq/l (355 mg/l) or greater. Copper, nickel, zinc, and cadmium are trace metals that may occur in reclaimed water. High concentrations of zinc and copper are usually beneficial to turf; nickel and cadmium are a concern only if the land will be used for agricultural purposes (e.g., crop production). The National Academy of Sciences recommendations for metal limits are listed in Table 4-4.

Practices that reduce the effective concentration of potentially toxic elements include: blending poor quality water with better quality water, irrigating more frequently to maintain a higher soil moisture content, and applying additional water for leaching. Boron is difficult to leach. Leaching boron takes three times the amount of water required to leach chloride.

Bicarbonate

An irrigation water's bicarbonate content can also affect soil permeability and must be evaluated along with the sodium, calcium and magnesium content of both soil and water. The bicarbonate ion may combine with calcium and/or magnesium and precipitate as calcium and/or magnesium carbonate. High levels of bicarbonate in the water may require blending with lower bicarbonate water or acidification of irrigation water with sulfuric or phosphoric acids to correct the problem.

Soil Considerations

The ability to successfully use reclaimed water for irrigation is not a matter solely determined by water quality. The physical and chemical properties of the soil are a component of the analysis. Important soil factors include soil texture, cation exchange capacity, exchangeable sodium percentage, infiltration rate, percolation rate, water holding capacity and soil fertility. The condition of a soil must be considered when developing an irrigation management program.

Coarse-textured soils such as sandy loams are best for the use of reclaimed water; heavier soils are acceptable as long as changes in soil chemical properties are evaluated regularly. The soil's water-holding capacity is also important in determining its suitability for reclaimed water irrigation. Frequent application of reclaimed water on soils with high water-holding capacity, such as clay soils, will contribute significantly to their accumulation of salts and heavy metals. Shallow soils

TABLE 4-4

RECOMMENDED LIMITS FOR METALS IN TURF IRRIGATION WATERS

Metal	Maximum Level mg/l	Values in Local Waters	
		PSC Water[a]	Rec. Water from FSSD[b]
Cadmium	0.005	No Data[c]	No Data[c]
Copper	0.2	0-0.0004	0.0033-0.0012
Nickel	0.5	No Data[c]	No Data[c]
Zinc	5.0	<0.00007	0.016-0.082

Source: The National Academy of Sciences as reported in California Turfgrass Culture, Vol. 32, Number 3 and 4, Cooperative Extension, University of California, 1982.

(a) Range of values reported for water from the Putah South Canal. Given here for comparison to the maximum levels.

(b) Range of values reported for reclaimed water from the Fairfield-Suisun WWTP. Given here for comparison to the maximum levels.

(c) No Data indicates no data collected for this study.

overlaying rock, hard pan, or clay pan restrict water percolation and drainage. The resultant perched water tables will promote accumulation of soluble salts and toxic ions considerably.

Summary

Table 4-5 summarizes water quality criteria for landscape irrigation. These criteria are a compilation of the data presented previously. The table lists values which are desirable, acceptable, and unacceptable.

Use of "desirable" wastewater for irrigation may still require special irrigation management techniques to control problems relating to chlorides and sodium. Alternating water sources, blending with higher quality water, and/or modifying irrigation practices will frequently make it possible to irrigate with "acceptable" reclaimed water.

WATER QUALITY REQUIREMENTS OF NON-POTABLE WATER FOR INDUSTRIAL USES

Industrial uses for reclaimed water include cooling, boiler feed, washing, and processing; cooling is the predominant industrial reuse application. Many cooling towers use a "once-through" process in which cooling water is pumped through heat exchangers only once and is discharged. Others use a "recirculating" process in which cooling water is continually recirculated for many cycles. During each cycle, a large amount of water evaporates from the cooling water stream. However, chlorides, ammonia, phosphates, sulfates, and heavy metals remain in the cooling water stream at higher concentrations. The number of cooling water cycles is determined by the maximum chemical concentrations which do not cause adverse impacts. The concentrated cooling water, or "blow-down" water is periodically discharged and additional water is added as make-up water. Generally, cooling towers use the water for an average of four to seven cycles prior to discharge.

Industrial users are generally most concerned about high levels of chlorides, ammonia, phosphates, sulfates, heavy metals and silica; these constituents become concentrated in cooling processes. Provided below are descriptions of the most common industrial water quality concerns.

- High chloride levels can adversely impact some industrial processes; ion exchange and reverse osmosis may be used to reduce chloride levels. Chloride levels in the raw waters in the area are low. Chloride levels in the reclaimed water are high enough that they may cause problems for certain uses.

- Ammonia levels in excess of 1 mg/l may cause stress corrosion cracking of copper alloys in admiralty brass heat exchangers. Ammonia can be removed through several processes, including nitrification, selective ion exchange, or modification of the disinfection process to provide "break-point" chlorination. Ammonia levels in the raw and reclaimed water in the area are well below 1 mg/l.

- High phosphate levels can cause calcium phosphate scale on pipes and may promote biological growth in cooling towers. If the phosphate concentration in the make-up water is greater than 3 mg/l, as phosphate, and calcium salts are used for corrosion inhibitors, scaling becomes a serious problem. To reduce scaling, the number of times water can be cycled through the cooling tower must be reduced or the phosphate levels must be decreased. Phosphate can be removed using ion exchange or lime precipitation. Phosphate levels in the local reclaimed water are considerably above 3 mg/l. Phosphate levels in the area's raw water are well below 3 mg/l.

- High sulfate levels can cause corrosion of metals, including stainless steel. Sulfate-reducing bacteria which grow in cooling tower pipes convert sulfate to hydrogen sulfide, a

TABLE 4-5

SUMMARY OF WATER QUALITY CRITERIA FOR LANDSCAPE IRRIGATION

Parameter	Desirable[a]	Acceptable[b]	Unacceptable[c]	PSC Water[e]	Rec Water[f]
Total Salts					
TDS, mg/l	<700	700-2100	>2100	169-244	780-820
EC, dS/m	<0.7	0.7-3	>3	0.33-0.35	1.1-1.3
Permeability					
Sodium, %[d]	<60	60-75	>75	8.6-45	53-63
SAR_{adj}	<6	6-9	>9	0.4	4.3-5.2
Toxic Ions					
Boron, mg/l	<0.5	0.5-1.0	>1.0	<0.1	0.7-1.2
Chloride, mg/l	<175	175-350	>350	4.3-15	140-210
Copper, mg/l		≤0.2	>0.2	<0.0004	0.0033-0.0012
Nickel, mg/l		≤0.5	>0.5	No Data	No Data
Zinc, mg/l		≤5.0	>5.0	<0.00007	0.016-0.082
Cadmium, mg/l		≤0.005	>0.005	No Data	No Data
Bicarbonate					
Bicarbonate (HCO_3), mg/l	<90	90-520	>520	13-198	160-240

[a] Desirable water quality is that considered safe and suitable for turf and most plants under varied conditions of soil or climate.

[b] Acceptable water quality is that regarded as possibly harmful for certain plants or crops under certain conditions of soil or climate.

[c] Unacceptable water quality is that considered as probably harmful to most plants and crops under certain conditions of soil or climate.

[d] Percent Sodium = 100 Na/(Na + Ca + Mg + K), all ions expressed in milliequivalents per liter.

[e] Range of values reported for water from the Putah South Canal. Given here for comparison to the water quality criteria.

[f] Range of values reported for reclaimed water from the Fairfield-Suisun WWTP. Given here for comparison to the water quality criteria.

corrosive acid. To prevent corrosion, biocides are used to control the bacteria and the sulfate concentration in the make-up water must be decreased. Sulfate levels are higher in the local reclaimed water than the raw water but still probably low enough to not cause serious problems.

- Silica combines with calcium, magnesium, and aluminum to form scales in high-pressure boilers. In addition, silica volatilizes at high temperatures, travels with the steam, and forms glass-like coatings on equipment. Silica can be removed by ion exchange, lime-soda softening, ferric hydroxide adsorption, and magnesium hydroxide softening. Most industrial uses require silica to be less than 30 mg/l. No data are available on the silica content of the local water supplies.

- High metal concentrations are not necessarily harmful to cooling tower operations, however, industries would require very low levels of metals to meet most industrial discharge requirements. Metals may be removed through ion exchange, reverse osmosis, or lime precipitation.

WATER QUALITY OF WATER SUPPLY SOURCES

Data on the quality of water from the five non-potable water sources were collected from several agencies including the City of Fairfield, the City of Vallejo, SID, and the Fairfield-Suisun Sewer District. These data were supplemented by tests run specially for this project where historical data were not available. Table 4-6 summarizes the water quality data collected for all five water sources.

The surface waters available in the study area have been widely used for crop and landscape irrigation and found to be quite acceptable. Filtration of the raw waters has been needed in some cases to prevent clogging of some irrigation equipment such as drip irrigation emitters. Of the waters discussed in this plan, only the reclaimed water and the groundwater are considered to have possible quality problems for irrigation use. Little water quality information is available for the area's groundwater. The discussion in this section concentrates on the suitability of the area's reclaimed wastewater for crop and landscape irrigation and industrial reuse. Raw water supply sources were also evaluated to provide reliability in proposed dual water systems and to help mitigate effects of reclaimed water use.

The primary concern with the treated wastewater effluent is with its excess sodium content relative to low levels of calcium and magnesium. Use of only reclaimed water for irrigation may not be acceptable for some soils. The sodium level is high enough that irrigation design should avoid overhead application to broadleaf plant material. The boron level is also slightly high, but is not high enough to cause serious concern. Boron concentrations of 1.0 ppm or less are considered low and will affect very few plants; the most sensitive plants may exhibit some sort of leaf burn.

The four raw water sources have generally favorable chemical characteristics. NBA and PSC have similar water quality, but PSC water is favorable due to its slightly lower sodium level and lower salinity. Cache Slough and groundwater qualities are nearly identical, although groundwater has a higher bicarbonate content and slightly higher boron level. The boron level, if consistently maintained at its average level, would not be expected to cause significant problems, but the maximum is undesirably high. The higher bicarbonate level would slightly lessen its efficiency in correcting a sodium imbalance, therefore, Cache Slough water would be preferable to groundwater. The four raw water sources, ranked in order of preferred water quality, are as follows:

1) PSC
2) NBA
3) Cache Slough
4) Groundwater

SUMMARY OF AVAILABLE RAW WATER QUALITY AND WATER QUALITY REQUIREMENTS OF POTENTIAL USERS

Water quality data, as summarized in Table 4-6, along with the United States Department of Agriculture Soil Conservation Service soil classification information were given to Soil and Plant Laboratory, a subconsultant to JMM. The laboratory was asked to determine water quality compatibility with irrigation water quality requirements and to determine the horticultural suitability of the reclaimed and raw waters. Ten representative study sites, as shown in Figure 4-2, were identified for analysis of soil characteristics:

- Rancho Solano Golf Course
- Linear Park
- Fairfield High School
- Laurel Creek Park
- Tolenas Farms
- Tolenas Industrial Park
- Solano Community College
- Allan Witt Park
- Solano and Low Business Parks
- Highway 80/West Texas Street Interchange

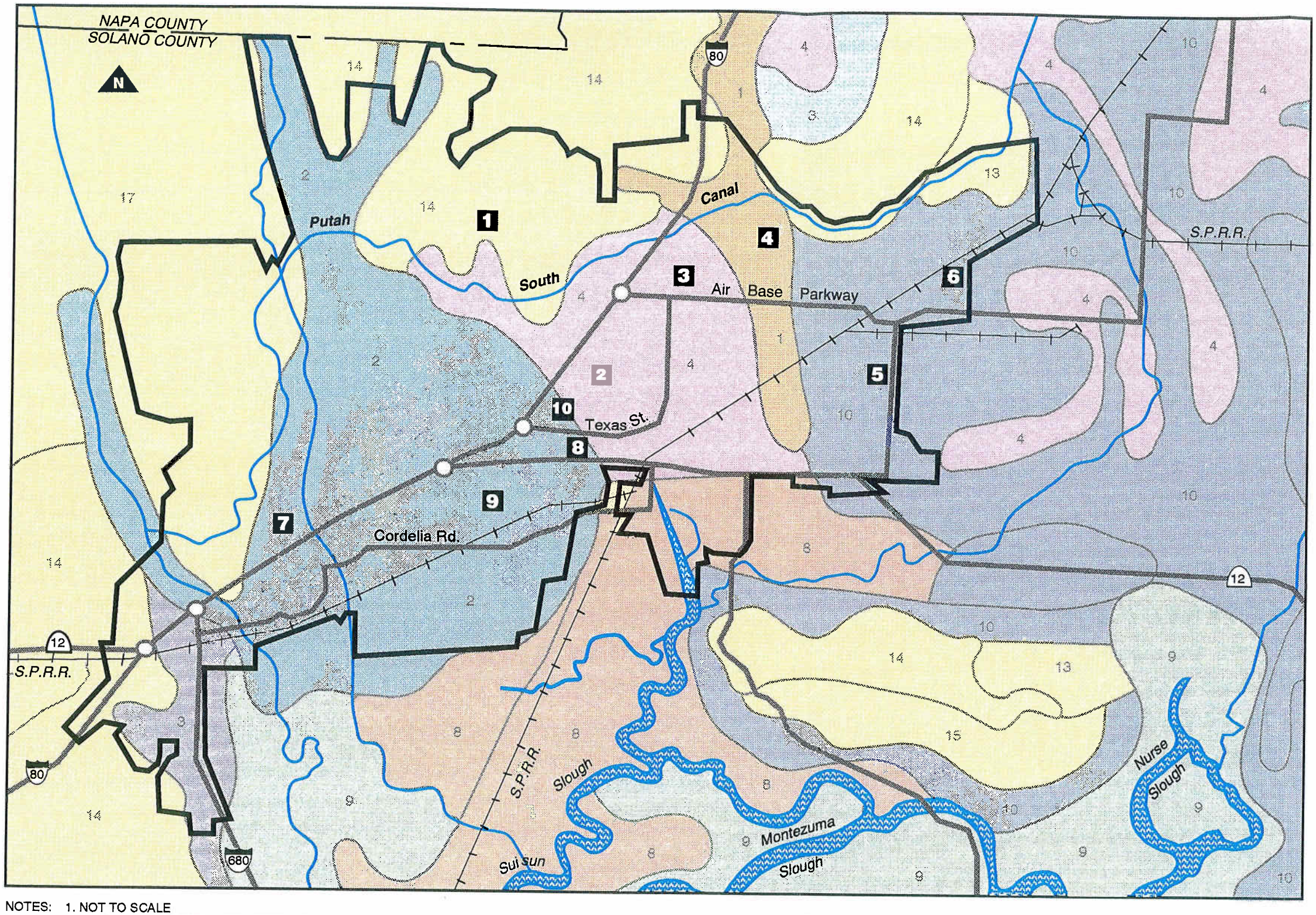
The following sections provide a discussion of the implications of the data and the results of the analysis.

Soil Characteristics

As discussed earlier in this section, soils with high water-holding capacity, such as clay soils, accumulate salts and heavy metals more rapidly than coarse-textured soils. The ten study sites are dominated by soils in the clay loam to silty clay loam classification, therefore, there is significant concern that a proper sodium balance be maintained.

High sodium levels, expressed as the SAR, can deflocculate soil aggregates and significantly impair the soil's infiltration rate. Soils at the various study sites have slow to very slow infiltration rates already, indicating that there is some potential for salts to accumulate. Sites 5 and 6, and portions of sites 7 and 9 have the most problematic soil characteristics; soils of these types typically have a sodium imbalance in the subsoil. Soils at site 6 are diverse and cementatious and are, therefore, prone to salt accumulation. The high clay soils at site 9 have undesirable characteristics of very slow permeability and sodium excess. Soils at the other study sites, sites 1, 2, 3, 4, 8, and 10, also have relatively slow permeability rates, but they are fairly deep and are adequately drained. These sites, therefore, are expected to have fewer problems when irrigated with reclaimed water.

An alternate raw water source should be available if reclaimed water is used for irrigation at any of the ten study sites. The alternate raw water source can be used to leach salts from the soil when soil chemistry monitoring indicates soil permeability has declined to unacceptable levels. Any of the raw water sources (PSC, NBA, Cache Slough or groundwater) could be used to leach salts at the sites with the highest quality soils; i.e., sites 1, 2, 3, 8 and 10. The sites with variable soil conditions, sites 4, 7, and 9, could probably be successfully irrigated with any of the raw water sources, but the lower salinity PSC or NBA water would be preferred. For sites with the worst



LEGEND

APPROXIMATE STUDY AREA BOUNDARY

SLOUGHS

CREEKS

1 CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN SOILS STUDY SITE

SOIL ASSOCIATIONS WITHIN STUDY AREA

NEARLY LEVEL TO MODERATELY SLOPING, WELL-DRAINED TO SOMEWHAT POORLY DRAINED SOILS ON ALLUVIAL FAN

1 Yolo-Brentwood: Nearly level to moderately sloping, well-drained loams to silty clay loams; on alluvial fans

2 Yolo-Sycamore: Nearly level, well-drained and somewhat poorly drained silty clay loams; on alluvial fans

3 Rincon-Yolo: Nearly level to moderately sloping, well-drained loams and clay loams; on alluvial fans

NEARLY LEVEL TO GENTLY SLOPING, MODERATELY WELL-DRAINED TO VERY POORLY DRAINED SOILS ON BASIN RIMS, ALLUVIAL FANS, AND DELTAS, AND IN BASINS, DREDGE SPOIL AREAS AND SALT WATER MARSHES

4 Capay-Clear Lake: Nearly level to gently sloping, moderately well-drained and poorly drained silty clay loams to clays; on basin rims and in basins

8 Joice-Suisun: Nearly level, very poorly drained mucks and peaty mucks; in salt water marshes

9 Reyes-Tamba: Nearly level, poorly drained and very poorly drained silty clay loams, silty clays, and mucky clays; in salt water marshes

NEARLY LEVEL TO MODERATELY STEEP, WELL-DRAINED TO SOMEWHAT POORLY DRAINED SOILS ON TERRACES AND IN BASINS

10 San Ysidro-Antioch: Nearly level to moderately sloping, moderately well-drained sandy loams and loams; on terraces

13 Altamont-Diablo: Gently sloping to steep, well-drained clays formed from weakly consolidated sediments; on dissected terrace

14 Dibble-Los Osos: Gently sloping to steep, well-drained loams and clay loams formed from sandstone, on mountainous uplands

17 Hambright-Toomes: Strongly sloping to very steep, well-drained and somewhat excessively drained loams and stony loams formed from basic igneous rocks; on mountainous uplands

NOTES: 1. NOT TO SCALE
2. THE TERMS FOR TEXTURE USED IN THE DESCRIPTIVE HEADINGS OF THE ASSOCIATIONS APPLY TO THE SURFACE LAYER.
3. EACH AREA OUTLINED ON THIS MAP CONSISTS OF MORE THAN ONE KIND OF SOIL. THE MAP IS THUS MEANT FOR GENERAL PLANNING RATHER THAN A BASIS FOR DECISIONS ON THE USE OF SPECIFIC TRACTS.

SOURCE: U.S. DEPARTMENT OF AGRICULTURE-SOIL CONSERVATION SERVICE; UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION, COMPILED IN 1972.

CITY OF FAIRFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

GENERAL SOIL MAP

Solano County, California

FIGURE 4-2

JMM

soils, sites 5 and 6, leaching of salts could probably only be achieved with the lower salinity PSC or NBA water.

Soil Monitoring and Mitigation Measures

The degree of elemental buildup in the soil depends on several factors:

- The amount of water that is applied during irrigation. Application of excessive irrigation water increases leaching of elements from the soil.
- The duration of the irrigation period. As the irrigation period increases, more water is applied, therefore, more elements will be leached from the soil.
- The frequency of irrigation. Frequent, shallow watering will tend to increase the elemental buildup in the soil.

Whenever reclaimed water is used for irrigation, soil chemistry should be monitored periodically. Monitoring can determine what practices of leaching and blending should be implemented to mitigate conditions in the soil that may adversely affect soil permeability or that may impose stressful conditions on the plants. Soil samples should be collected in April, June, August, and October for analysis to determine pH, salinity, boron and SAR. The recommended procedure for soils collection is as follows:

1. Collect one composite sample per acre unless there is noticeable variability in the soil or in the plants grown. When the soil or the plants vary, sample from each soil and plant type.
2. Select four spots to collect samples from. Sample soil down to the root zone depth of the plants grown. Thoroughly mix the four samples together if the field and plants are uniform.
3. Remove one quart of the mixed soils for testing.
4. Repeat process as necessary for each acre of the site.

Sampling and soil analyses need to be tailored to the conditions observed in the field. If percolation problems are observed, samples should be taken to a depth of 2 to 3 inches for an SAR analysis. If leaf burn is observed, samples should be taken to the root zone depth. Should sampling indicate there are soil problems, the remediation procedures need to fit the specific problem. It is recommended that a trained observer be consulted in carrying out the irrigation program. The observer can advise on site-specific sampling procedures and on appropriate remediation measures when problems are noted.

TABLE 4-6
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
WATER QUALITY DATA (a)

SOURCE / PARAMETER	Sodium	Calcium	Magnesium	Potassium	Ammonium	Chloride	Sulfate	Bicarbonate	Carbonate	Nitrate	Phosphate	pH	pHc	ECw (a)	SARadj (a)	Copper (a)	Zinc (a)	Manganese	Iron	Boron	Fluoride	TDS	Turbidity (a)	Total Coliforms(a)
Putah South Canal (b, c, h)																								
Minimum	8.5	9.3	9.2	0.96	0.05	4.3	18	13.3	0	<.04	0.01	7.78		0.33		0	<0.01	<0.01	<0.02		0	169	0.6	2
Maximum	23	28	30	2	0.28	15	40	198	8.4	1.2	0.05	8.72		0.35		0.04	0.07	0.04	2.2		0.26	244	820	2,400
Average	10.8	19.1	24.2	1.2	0.11	7.9	25	173	1	<.44	0.03	8.38	8.40	0.34	0.4	0.02	0.02	0.02	0.3	<0.1	0.13	187	13.8	106
Cache Slough (b, d, h)																								
Minimum	26	28.8	19.9	1.6		20	37	23	0	0		7.3		0.43		0	0	0.01	0.21		0.1	242	3.2	5
Maximum	93	68	47	4		89	130	244	0	4.5		8.8		1.04		30	0.09	0.22	1.1		0.5	630	82	54,000
Average	53.8	41.8	33.4	2.9	NA	52	70	238	0	2	NA	8.2	8.30	0.67	1.7	10	0.01	0.11	0.59	<0.1	0.3	388	22	1,000
North Bay Aqueduct (e, h)																								
Minimum					0.07	28					0.12	7.2		0.28		<10	<10	<0.03	0.43		0.01	90	4.8	6
Maximum					0.20	96					0.40	9.2		100		<50	<50	0.69	1.70		0.4	237	100	>240,000
Average	32	21.3	18	1.5	0.12	45	26.5	123	0	0.7	0.23	7.8	8.43	1.3	1.2	<28	<34	<0.42	1.12	<0.1	0.1	148	26	10,578
Groundwater Quality (f)																								
Minimum	16	18.9	8	0		5	13	192	0	0		7.5		0.41						0	0	247		
Maximum	84	79	105	7.4		65	109	698	26	63		8.8		1.42						6.1	0.4	683		
Average	47.7	41.7	42.1	1.7	NA	25	38	325	3.5	14.3	NA	8.1	3.08	0.69	2.3	<50	<10	0.47	<0.05	0.7	0.2	403	<1	<2.2
FSSD WWTP (g, h)																								
Minimum	150	32	33	10	<0.1	140	83	160	<0.1	11.2	14.2	6.9		1.1	4.3	3.3	16			0.7	0.2	720	0.2	<2
Maximum	180	46	40	12	0.6	210	110	240	<1	17.9	18	7.2		1.3	5.2	12	82.5			1.2	1.1	820	1.1	<2
Average	160	39.1	36	10.9	0.2	174	95.1	200	<1	15.1	16	7.1	8.39	1.2	4.8	6.6	48.8	<0.02	0.05	0.9	0.7	750	0.7	<2

NA = Not available.

(a) Units are mg/l except as noted here:
ECw (dS/m) Turbidity (NTU)
SARadj (units) Total Coliform(MPN/100ml)
Copper, Zinc (µg/l)

(b) Source: Joint Powers Policy Committee, North Bay Regional Water Treatment Plant Project, Compilation of Available Raw Water Quality Data, JMM, May, 1987.

(c) Monthly averages for (1/83 - 5/86); additional data for (11/79 - 12/85).

(d) Data for (4/83 - 4/84); yearly averages for (1969 - 1982).

(e) Data for (1988-1990); Source: City of Vallejo Laboratory Data Sheets, Raw Water Data, "NBA" North Bay Aqueduct at Cordelia.

(f) Data for (1912 - 1987); Source: Solano Irrigation District, Groundwater Resources, Summers Engineering, Inc., June, 1988.

(g) Monthly and yearly data for 1990; Source: Fairfield-Suisun Subregional Wastewater Treatment Plant 1990 Annual Report.

(h) Source for all single value data: NBRWTP Laboratory Data, May, 1991.

Section 5

SECTION 5

WASTEWATER RECLAMATION FACILITIES AND TREATMENT PROCESSES

This section summarizes the results of work performed by JMM under a separate agreement with the Fairfield-Suisun Sewer District (FSSD). The tasks associated with the agreement between FSSD and JMM include identification of disinfection and filtration limitations of the existing FSSD treatment facilities, evaluation of the potential use of existing dual force mains in a reclaimed water system, and evaluation of the potential for construction of remote reclamation facilities. The results of each of these tasks have been summarized in detail in technical memoranda submitted to FSSD.

RECLAIMED WATER FACILITIES

The following sections describe the existing wastewater treatment facilities and their capacities. The limitations of existing facilities related to reclamation are addressed and the impacts of potential changes in the regulations are evaluated.

Fairfield-Suisun Sewer District Wastewater Treatment Plant

The original FSSD Wastewater Treatment Plant (Fairfield-Suisun WWTP) facilities, constructed in 1976, consisted of grit removal, primary sedimentation, intermediate biological treatment with oxidation towers and intermediate clarifiers, activated sludge secondary treatment, filtration, chlorination and dechlorination. Disinfected effluent was conveyed through a 54-inch pipeline to the utility/outfall pump station, which operated in conjunction with three final effluent holding ponds to provide final effluent to the Solano Irrigation District (SID) for reclamation and to the plant utility water system. Final effluent flows beyond SID's reclamation requirements and plant utility water requirements were dechlorinated and discharged through a gravity outfall to Boynton Slough. A diversion box was provided along the outfall where treated effluent could be diverted to an irrigation ditch (Center Ditch) for reclamation purposes. Design average dry weather flow (ADWF) capacity of the original plant was 10.35 mgd.

A 1979 plant expansion to an ADWF capacity of 15.6 mgd incorporated several features to increase plant capacity and enhance the reclamation capabilities of the tertiary treatment facilities. The tertiary treatment improvements included the addition of four new filter cells, a jet injection chlorine mixing system, a new sulfur dioxide diffuser and Parshall flume at the chlorine contact basin outlet, and expansion of the two existing chlorine contact tanks. Following completion of this expansion project, the plant facilities met all requirements for unrestricted use of reclaimed water as defined in Title 22.

An effluent bypass pipe and sluice gate were added to the discharge end of chlorine contact tank No. 2 as part of the 1986 Flow Equalization Facilities project to modify the flow pattern through the chlorine contact basins. The purpose of the 1986 modification to the chlorine contact basin was to provide additional operating flexibility.

Reclamation Conveyance Facilities

Following coagulation, filtration, and disinfection, water to be reused is conveyed through a 54-inch pipe to the utility/outfall pump station. The water surface in the wet well of this pump station is common with that of three effluent holding ponds; the wet well and ponds provide a total effective effluent storage volume of over 20 million gallons. This volume can be pumped by the utility water pumps for reuse on the plant site as utility water (treated effluent used for washdown or process purposes at the plant); lifted by the effluent pumps to the inlet of the irrigation effluent pump station; or backfed by gravity through the 54-inch feed pipe to the chlorine contact tank

discharge and through the outfall to Boynton Slough. The utility water pumps and the effluent pumps are in the utility/outfall pump station. It can also be discharged by gravity to the Center Ditch west of the plant. At present, effluent can be reclaimed by pumping from the effluent holding pond system to either the in-plant utility water system or through the irrigation effluent pump station to SID. This effluent meets Title 22 requirements for unrestricted use. Additional effluent can be reclaimed through the diversion box on the Boynton Slough outfall which permits flows to be diverted to the Center Ditch for sod irrigation. This effluent meets Title 22 requirements for unrestricted use and exceeds the requirements for sod irrigation; current regulations for sod irrigation require only an oxidized wastewater, disinfected to achieve a 2.2 MPN/100 ml coliform level at some point in the treatment process.

Plant flow can either be dechlorinated at the entrance to the Boynton Slough outfall pipe or just ahead of the Parshall flume which conveys all flow to the 54-inch pipe to the utility/outfall pump station and the effluent holding ponds. The normal mode of operation is to dechlorinate only flows going to the outfall. Even if only flow entering the outfall is dechlorinated, however, the relatively long detention time with exposure to sunlight in the effluent holding ponds, along with the presence of algae, aquatic life, and waterfowl in these ponds, likely eliminate any chlorine residual in these ponds prior to reclamation.

Limitations to Reclamation at the Fairfield-Suisun Sewer District Wastewater Treatment Plant

The Fairfield-Suisun WWTP currently has a rated capacity (average dry weather flow -ADWF) of 17.5 mgd. This limitation is based primarily on the capacity of the secondary treatment facilities. The existing tertiary facilities at the Fairfield-Suisun WWTP currently meet all regulatory requirements for unrestricted reclaimed water use as defined in Section 2 of this report for maximum day plant flows up to 20.8 mgd. For flows above 20.8 mgd, reclamation capacity is limited by chlorination basin capacity and filter size.

In 1986, a bypass pipe was installed from the outlet end of chlorine contact tank No. 2 to the Boynton Slough outfall. The intent of the 1986 modification was to provide the option to operate the chlorine contact basin so that, during periods when plant flow exceeded 20.8 mgd, water to be reclaimed flowed only through contact tank No. 1. Flows in that tank were to be regulated to maintain a contact time greater than 120 minutes. Currently, it is not possible to accurately control the flow split between the two contact basins. Thus, unrestricted reclamation capacity is limited by the size and configuration of the chlorine contact tanks to 20.8 mgd when total maximum day plant flow is 20.8 mgd or less. Reclamation at peak flows exceeding 20.8 mgd is limited to uses not requiring 120 minutes of chlorine contact time. A minor modification to the bypass from Chlorine contact tank No. 2 would allow more accurate splitting of the flows between the two contact basins. This would allow disinfection as required for unrestricted use of up to 10.4 mgd when total plant flow exceeds 20.8 mgd.

At the current plant design capacity of 17.5 mgd ADWF and the current combined reclaimed water/utility water demand of less than about 7 mgd, only the chlorine contact basin bypass modification is required to meet all current requirements for unrestricted use of reclaimed effluent. Two additional filters must be added to handle maximum filter hydraulic loads when the plant is expanded to an average daily design load of 20 mgd to meet the Title 22 filter loading criteria of 5 gpm/sq ft of filter area with one filter out of service. The Fairfield-Suisun WWTP is currently limited to a combined reclaimed water/plant utility water average day supply of 17.5 mgd and a maximum day supply of 20.8 mgd.

POTENTIAL USE OF DUAL FORCE MAINS IN RECLAIMED WATER SYSTEM

The FSSD now has in place over five miles of dual raw sewage force mains serving Cordelia and Central Fairfield. The 2.2-mile long, 48-inch central force main conveys flows from the central pump station, located between Highway 12 and Illinois Avenue, near the southern end of Jackson Street, to the Fairfield-Suisun WWTP. The 3.2-mile long, 27-inch Cordelia force main extends from the Cordelia pump station, located at the intersection of Pitman Road and Cordelia Road. These new force mains parallel older force mains; they were installed to handle peak wet weather pumping conditions. A single force main from each pump station is adequate to handle peak dry weather flows for the foreseeable future. Therefore, during periods when most demand for irrigation occurs, one of the two parallel force mains from each pump station is not needed for transporting raw sewage. The design concept for each of the new force mains from each pump station included provision to flush the entire pipeline back into the wet well of its respective pump station and fill the pipeline with chlorinated plant utility water. During the 1991 irrigation season, the FSSD used the central force main to convey reclaimed water (utility water) to a newly installed landscape irrigation system at the central pump station.

The existing reclaimed water transport capacity of the two dual force main systems is dependent upon the capacity of the plant utility water system to deliver water to the connections to the force mains. As summarized in JMM's October 15, 1991 technical memorandum entitled "Evaluation of Chemical Feed and Utility Systems," the existing utility water pump station has a design capacity of 4.75 mgd at 65 pounds per square inch (psi) with three pumps operating. Current operation of the pump station is at a discharge pressure of 85 psi to accommodate demand at the Dissolved Air Flotation thickeners; this reduces the utility water system capacity to approximately 2.6 mgd with three pumps operating.

If the utility water system is returned to its original design pressure of 60-65 psi, which could be accomplished by installing a booster pump for the Dissolved Air Flotation Thickener flow and modifying the utility water piping, the full 4.75 mgd design capacity would be available to meet basic utility water demands, turf farm irrigation, and reclaimed water demand along the dual force mains. If this were done, approximately 1.5 mgd would theoretically be available for delivery through the dual force mains. Approximately 3.1 mgd would be available if the standby utility water pump were also used to pump reclaimed water. Addition of a new pump in the expansion slot available at the utility water pump station could increase the reclaimed water pumping capacity another 1.6 mgd.

The Regional Water Quality Control Board and DHS have stated they expect no regulatory obstacles to the use of these dual force mains for transport of reclaimed water as long as FSSD can demonstrate that the entire pipeline has been adequately disinfected to ensure public health and safety. FSSD would have to disinfect the dual force mains one time each year, when use is changed from sewage collection to reclaimed water transmission, to meet Title 22 requirements. This has been accomplished on an experimental basis by FSSD staff.

POTENTIAL REMOTE RECLAMATION FACILITIES

The City of Fairfield Planning Department has proposed revisions to the City's General Plan Land Use Element. These revisions identify special study areas surrounding the community which have the potential to become urban areas. These special study areas are known as Phasing Areas. Current expansion plans for the Fairfield-Suisun WWTP do not consider all projected wastewater flows from these Phasing Areas; wastewater treatment capacity beyond that now planned will be needed to handle these new flows, and will be addressed in a future study by the FSSD. One way to handle the new flows would be to construct remote wastewater reclamation facilities at one or more locations in the area. Remote wastewater reclamation facilities could draw from major sewer interceptors and treat the wastewater for reuse near the remote facility. The following paragraphs

summarize the results of a very preliminary analysis of possible locations for remote wastewater reclamation facilities.

Potential average irrigation demands for reclaimed water were compared to projected ADWF of the Phasing Areas to evaluate potential locations for remote reclamation facilities. These demands and flows were compared because they occur during the spring and summer, the times during which the Fairfield-Suisun WWTP is required by the National Pollutant Discharge Elimination System (NPDES) permit to maximize reclamation, thereby reducing the amount of effluent disposed of through the outfall to Suisun Marsh.

Several issues were taken into consideration during the evaluation, including possible reduction of load on the FSSD treatment and collection facilities, reduction of transmission costs for a reclaimed water system and siting considerations. In consideration of remote treatment facilities, reduction of wastewater flows in the collection system and of treatment plant peak hydraulic flows is a valid evaluation factor only if the remote plant can be operated year-round to relieve the treatment plant and collection system during critical wet-weather periods. This is only possible if FSSD can obtain a surface water discharge permit for remote reclamation facilities during periods outside of the reclamation season. There is no assurance that such a permit could be obtained. Descriptions of the potential remote reclamation facilities that appear the most promising are presented below.

Potential Remote Reclamation Facility No. 1

Phasing Area B of the current proposed revision of the City of Fairfield's General Plan Land Use Element is bound to the south by Highway 12 and to the west by the Napa County/Solano County line. It extends slightly east of Green Valley Road, and stops slightly south of Rockville Road. Several options are available for treating wastewater flows and serving reclaimed water demand in this area:

- A remote reclamation facility in this area, at the intersection of Suisun Valley Road and Highway 12/80, could collect flows from, and serve reclaimed water to, Phasing Area B and the surrounding lower Green Valley area.

- The wastewater treatment facility proposed in the draft Environmental Impact Report (EIR) for White Wing Estates could be expanded to treat the projected wastewater flow from the lower Green Valley area and Phasing Area B, in addition to the projected White Wing wastewater flow.

- A remote reclamation facility could be constructed to serve the White Wing irrigation demand not met by the treatment facility proposed in the draft EIR.

Potential Remote Reclamation Facility No. 2

Phasing Area D (located along the northeast border of Travis AFB) adds the greatest potential increase in ADWF of all the Phasing Areas. Placement of a remote reclamation facility in the northeast area of Fairfield could allow for collection and treatment of the Phasing Area D flow in addition to the projected flow from Northeast Fairfield. The remote facility could serve the reclaimed water demand in Northeast and Central Fairfield. Reclaimed water could be delivered from this plant to meet the demands of a majority of the portion of Central Fairfield north of Woolner Avenue. Variation in the actual point of flow diversion upstream or downstream along the FSSD interceptor would, of course, vary the potential capacity of a remote reclamation plant in this area.

Potential Remote Reclamation Facility No. 3

A remote reclamation facility located east of the intersection of Honker lane and Highway 12, could collect the projected wastewater flows from Travis Air Force Base (AFB), Suisun City, and Phasing Area E (located along the southeast border of Travis AFB) and could serve reclaimed water demand in the Suisun City area.

Areas Not Considered Feasible for Remote Reclamation Facilities

JMM considered two other areas, Cordelia and Suisun Valley, for location of remote reclamation facilities. An initial evaluation indicated that neither area would be suitable for the location of such facilities. The use of a remote reclamation facility for possible production of fresh water as part of the Western Suisun Marsh Salinity Control Project has not been investigated.

Cordelia, excluding lower Green Valley, has a fairly high projected wastewater flow. The potential ultimate reclaimed water demand, however, is minimal, and the wastewater flow would far exceed reclaimed water demand. If significant wastewater flows were to be diverted in this area, a discharge point and permit would be required for year-round discharge. Although it is feasible to construct a remote reclamation facility in this portion of Cordelia, the potential benefits which could be derived are much less than those for other potential remote facilities.

While Suisun Valley has a very high potential reclaimed water demand, projected wastewater flows are extremely low; the available wastewater flow would be unable to meet the reclaimed water demand. This area is primarily used for intensive agriculture, a land use which does not contribute significantly to wastewater flows; therefore, the wastewater is treated by septic systems, and no sewer system infrastructure exists.

Evaluation of Potential Remote Reclamation Facilities

Evaluation of the alternative potential remote reclamation facilities is based on several factors as listed below:

- Siting considerations.
- Balance of projected wastewater flows and potential reclaimed water demands.
- Reduction of peak wet weather flow to collection facilities.

The following sections evaluate the alternative potential remote reclamation facilities with regard to these criteria.

Potential Remote Reclamation Facility No. 1. Proposed Remote Reclamation Facility No. 1 could be located near the intersection of Suisun Valley Road and Highway 12/80, a commercial/industrial-zoned area.

The relatively close balance of wastewater flow and reclaimed water demand favors location of a remote facility in this area. A remote reclamation facility at this location could easily be connected to the non-potable water distribution piping recommended in Section 7 of this plan. It could replace or supplement the regional plant as a reclaimed water source. However, because capacity limitations of trunk sewers in the Cordelia basin are not expected to be reached in the future (FSSD INTERC Model Update, JMM, June 1991), location of a remote reclamation facility in this area would not serve to relieve wet-weather collection system flows in the areas that require load reduction.

As stated above, the reduction of wastewater flows on the Fairfield-Suisun WWTP and collection facilities is a valid evaluation factor only if the plant can be operated year-round. For the plant to be operated on a year-round basis, a discharge permit would be required for the plant to discharge into Dan Wilson Creek.

Potential Remote Reclamation Facility No. 2. Proposed Remote Reclamation Facility No. 2 could be located near the intersection of Walters Road and Huntington Drive, primarily an industrially-zoned area. The projected wastewater flow for this area could serve the potential reclaimed water demand for much of Central Fairfield. A plant at this location would make it feasible to deliver reclaimed water to Northeast Fairfield, something that is less feasible from the regional WWTP. Northeast Fairfield is an area with significant potential reclaimed water demand. Thus, a remote plant at this location could supplement the regional plant in serving reclaimed water to Central Fairfield and/or serve reclaimed water to an entirely separate reclaimed water distribution system in Northeast Fairfield.

If operated year-round, location of the facility in this area would reduce flows to the Walters Road trunk sewers, and, subsequently, to the Highway 12 trunk sewers (FSSD INTERC Model Update, JMM, June 1991). These areas are identified in the INTERC Model Update as being capacity-limited reaches even without the addition of flows from Phasing Area D. For operation of the remote facility on a year-round basis, however, a discharge permit and discharge location would be required.

Potential Remote Reclamation Facility No. 3. The area near Honker Lane at Highway 12, the proposed location of Remote Reclamation Facility No. 3, is a low density residential zone. While public perception of a facility in this area may be negative, housing the remote plant in a building that has the appearance of a single-family residence that blends in with the surrounding architecture and landscaping may minimize the potential visual impact and negative perception.

Collection and treatment of all or part of the projected wastewater flow in this area could meet the Suisun City and Tolenas area's potential reclaimed water demand, primarily agricultural irrigation in the Tolenas areas. A plant at this location could be easily connected to the non-potable water distribution piping recommended in Section 7, for the Suisun area, to supplement or replace the regional plant as a reclaimed water source. However, the nature of the soils in this area, as described in Section 4, makes it questionable how feasible reclaimed water use would be in this area.

Placement of the remote facility at the proposed location would reduce loads on the Highway 12 trunk sewers, which are slated for expansion (FSSD INTERC Model Update, JMM, June 1991). If the plant could be operated year-round, treated effluent could potentially be discharged in McCoy Creek, downstream of all planned development.

Common Considerations

The three potential remote reclamation facilities have several advantages and disadvantages in common; as listed below.

- Construction of new facilities in any of the proposed locations would impact local traffic flow and the local community in general.
- Remote facilities would reduce pumping costs associated with distributing reclaimed water.
- Operation & maintenance costs of treatment facilities are likely to increase due to the operation of multiple facilities.

- If year-round operation of the remote facilities is possible, future expansion at the existing Fairfield-Suisun WWTP could be minimized.
- If year-round operation of the remote facilities is possible, the wet-weather load on the existing outfall to Suisun Marsh, which has a firm 40 mgd peak flow capacity limitation, could be reduced.

Potential Remote Reclamation Facilities Recommendations

Each of the proposed remote reclamation facilities has some potential to provide reclaimed water to the non-potable water distribution system. More detailed study of costs, siting, and regulatory constraints is recommended to fully evaluate the feasibility of actual construction. The following questions should be answered regarding the feasibility of remote facilities:

- What are the overall financial impacts of constructing and operating each of these facilities?
- Would the Regional Water Quality Control Board permit wet weather discharges from any of the proposed remote facilities.
- What are the potential site constraints, and can they be mitigated?

Each of the three proposed sites has advantages and disadvantages. Any further investigation of remote reclamation facilities should include the three sites discussed in this Section.

Section 6

SECTION 6

ALTERNATIVE DUAL WATER SYSTEM PLANS

The primary impediment to expanded use of reclaimed and raw water in the area is the absence of the pumps, piping, and storage needed to get the water where it is needed. In this Section, we develop several alternative systems of pumps, pipes and reservoirs to distribute non-potable water. This Section also includes a brief discussion of the alternatives to expanded non-potable water use; i.e., expanded use of potable water and/or increased conservation.

Distribution system modeling for alternative non-potable water systems was performed utilizing the FAAST computer model. The models included transmission mains, critical parts of distribution piping, pump stations, and reservoirs for existing and proposed non-potable water systems. Sufficient models were run to determine sizing of system components based on compliance with the planning criteria presented below.

PLANNING CRITERIA

Planning criteria establish a minimum level of performance for properly sized, properly operated and efficient systems. Computer modeling is used to select the sizes of the system components necessary to meet the planning criteria.

The planning criteria selected for the Central Solano dual water distribution systems computer hydraulic modeling analysis conform with generally recognized criteria for potable water systems in the United States and various City of Fairfield design standards and specifications. These criteria are appropriate for master planning level analyses and should be revisited throughout development of each project. A summary of planning criteria used in this study is presented in Table 6-1.

Distribution System Pressure

The performance of a distribution system is partly measured based on the ability of the system to provide adequate pressures at a specific, uninterrupted rate of flow. Two types of non-potable distribution systems have been modeled: low pressure and high pressure. Low pressure dual water systems have been modeled assuming that, after delivery to the customer, water would be pumped by the customer to meet its final requirements. Minimum distribution system pressure for a low pressure system is 0 psi. High pressure systems have been modeled so that the customer would not be required to pump the water. Minimum distribution system pressure for a high pressure system is 45 psi, similar to that required for a potable water system.

Piping System Roughness Factors

The Hazen-Williams coefficient, C, is a measure of the roughness of the pipe wall, i.e., its resistance to flow; it is a function of the material and age of a pipe. A C=120, an average, conservative value based on industry standards, was used for analysis of the proposed non-potable water distribution systems. This C factor is a conservative value typical of older distribution systems. The roughness of the new non-potable water system pipes is likely to be less (i.e., a higher C value), but as the system ages, the C value is likely to approach 120.

Pipe Diameter

Pipe sizes are selected so that high velocities are avoided. The minimum size for non-potable water distribution mains is 6 inches, as stipulated in Section 8 of the City of Fairfield, Standard Specifications and Details for Nonpotable Water Service Facilities. The 6-inch minimum pipe size

TABLE 6-1

CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
SUMMARY OF PLANNING CRITERIA

PARAMETER	PLANNING CRITERIA(a)
System Pressure	
Low Pressure System	0 psi minimum
High Pressure System	45 psi minimum
Hazen-Williams "C" Factor	120
Minimum Line Size	6 inches (b)
Maximum Flow Velocity	5 fps
Irrigation Demands	
Unit Demand Factors	
Turf Irrigation and Agricultural	2.5 acre-ft/acre/yr or historical usage where data were available
Schools	2.8 acre-ft/acre/yr
Average Irrigation Demand (AID) =	1.7 x Average Annual Demand (AAD)
Maximum Day Demand (MDD) =	2.0 x AID = 3.4x AAD
Maximum Day Demand (MDD) in Suisun Valley =	2.4 x AAD
Maximum Day Demand (MDD) in Tolenas =	3.0 x AAD
Maximum Day Demand (MDD) in White Wing =	2.0 x AAD
Peak Hour Demand (PHD) =	3.0 x MDD = 10.2x AAD
Peak Hour Demand (PHD) in Suisun Valley =	1.0 x MDD
Peak Hour Demand (PHD) in Tolenas =	1.6 x MDD
Industrial Process Demand	Case-by-case basis
Maximum Day Demand (MDD) =	1.1 x AAD (Pacific Bell Cooling Water)
Peak Hour Demand (PHD) =	1.0 x MDD (Pacific Bell Cooling Water)
Pump Stations	
Capacity with Storage in Distribution System	Maximum Day Demand
Capacity with no System Storage	Peak Hour Demand
Pump Efficiency	80 percent
Total Efficiency (wire-to-water)	70 percent
Distribution Storage	
Minimum Capacity	0.67 x MDD
Computer Runs	Peak hour analysis for minimum service pressure
	Reservoir filling condition for pump operations and transmission main size

(a) See text for explanation.
(b) May be reduced on a case-by-case basis during design.

helps ensure that minor demands not identified in this plan can also be met. The line size may be reduced on a case-by-case basis during design.

Flow Velocity

Maximum velocities are set to minimize pressure transients (water hammer), pipe wall erosion, and excessive head loss. These usually remain below an acceptable level when velocities in the distribution systems are less than 5 feet per second (fps), the maximum velocity criteria for this plan.

Demand Evaluation Criteria

Average annual demand (AAD) estimates are presented in Section 3, Potential Non-Potable Water Users and Demands. Peaking factors must be applied to these average demands to develop the flows that determine system element sizes. Peak demand estimates are required to size various facilities such as pipes, pumps, and storage facilities. Pipe sizes were evaluated on the basis of peak hourly demand.

The primary irrigation season is seven months (210 days) from April through October. Thus, the peaking factor between the seasonal average irrigation demand (AID) and AAD is 1.7 (365 days/210 days).

Reclaimed water demand will exhibit both seasonal and daily fluctuations, with maximum demands occurring in July and August. Peaking factors between maximum day demand (MDD) and AID typically range from about 1.6 to 2.5 for reclaimed water systems. A MDD/AID peaking factor of 2.0 has been used in this study, when historical data were not available.

All demand in urban areas is assumed to occur in an 8-hour period between 9:00 p.m. and 5:00 a.m. This implies a peaking factor between peak hour demand (PHD) and MDD of 3.0 (24 hours/8 hours); this factor has been used in this study. The total peaking factor between the peak 8-hour demand and the average annual demand is 10.2. This is consistent with the operational records of Irvine Ranch Water District's reclaimed water system which has a total peaking factor of about 9.

SID has delivered irrigation water to the agricultural users in Suisun Valley and Tolenas for many years. Their experience in Suisun Valley has been that 20% of the irrigation demand occurs in the peak month and that demand during that peak month is nearly constant. Thus in Suisun Valley the MDD/AAD ratio is 2.4 and the PHD/MDD ration is 1.0.

SID has less data on maximum flows in Tolenas but believes the peak to average ratios in Tolenas are lower than those estimated for urban irrigation. This is in part true because irrigation with reclaimed water in agricultural areas would not be limited to night time, but could occur 24 hours per day. Based on this input a MDD/AAD of 3.0 and a PHD/MDD of 1.6 were used in Tolenas. The peaking factor for White Wing is taken from the draft Environmental Impact Report for that project.

Industrial process and cooling water demand peaking factors have been developed on a case-by-case basis. Industrial peaking factors are usually substantially lower than irrigation peaking factors because the usage is generally year round.

DESCRIPTION OF ALTERNATIVES

This section presents brief descriptions of the alternatives modeled for the Central Solano Dual Water Systems Master Plan. The alternatives are all based on subdivision of the study area into five separate service areas:

- Central Fairfield
- Suisun Valley
- Lower Suisun Valley
- Cordelia
- Suisun City

Due to the local geography, it works out best to provide a separate non-potable water distribution system for each of these service areas. These service areas correspond to five of the eleven geographic sub-areas defined in Section 3 of this report. Alternatives for service to five of the other sub-areas - Paradise Valley, Rancho Solano, Lower Green Valley, Tolenas, and White Wing - consist of extensions of the distribution systems serving the five service areas.

No alternatives have been defined for service to Northeast Fairfield. The area is too far from the Fairfield-Suisun WWTP for cost-effective service of reclaimed water.

Subsequent to publication of the draft of this report, representatives of the staffs and elected officials from the City of Fairfield, Suisun City, FSSD, and SID held a series of meetings to discuss what non-potable water projects could be constructed in the near term (5 to 10 years). The alternatives described here have been revised to reflect the new alternatives that came out of those discussions.

Service Area 1 - Central Fairfield

Service to this area includes the transmission pipeline, distribution system pipelines (excluding those identified as future pipelines), and reservoir identified in the 1987 Water Reclamation Study (JMM, September, 1987) to serve Central Fairfield. Additionally, pipelines serving Rancho Solano, and a connection to serve Lagoon Valley and Paradise Valley, are considered. A proposed storage reservoir is considered at Dickson Hill. The distribution system for Service Area 1 was modeled as a high pressure system, i.e., a minimum pressure of 45 psi must be provided at each use point. The area could be readily served by five different water sources. Reclaimed water could be pumped into the distribution system from a pump station near the Fairfield-Suisun WWTP. Water could be taken from the Cache Slough Pipeline and routed to the pump station at the WWTP. Potable water could also be discharged into the pump station at the WWTP and pumped into the non-potable water distribution system. Potable water could also be fed into the Dickson Hill non-potable water reservoir. Water from the Putah South Canal could be pumped into the Dickson Hill Reservoir by a pump station at the site of the Dickson Hill Water Treatment Plant. North Bay Aqueduct (NBA) water could be fed into the system from a pump station at an existing NBA turnout near Beck Avenue. The following alternatives were evaluated for Service Area 1.

Alternative 1. This alternative distribution system would be based around a transmission main that would stretch northeastward through Central Fairfield from the Fairfield-Suisun WWTP to a reservoir on Dickson Hill. The transmission main would run north on Chadbourne Road, east on Courage Drive, north on Beck Avenue, northeast through Linear Park, and north on Dover Avenue to Dickson Hill. This transmission main would include the 24-inch reclaimed water transmission main already constructed in Linear Park between Beck Avenue and Travis Boulevard, but the roughly $500,000 Fairfield spent to build that pipeline are not included in the capital cost estimates in this report.. Several smaller lines would branch off this transmission main to serve the area.

A major branch would bring reclaimed water to the Solano Irrigation District pump station serving raw water to Paradise and Lagoon Valleys, thus allowing reclaimed water to be distributed to these two valleys via the existing raw water system. These two valleys represent a substantial non-potable water demand, given that a golf course is under construction in Paradise Valley and another is planned in Lagoon Valley. The potential customers in Lagoon Valley are in the City of Vacaville. Implementation of this alternative would require agreements among SID, the City of Fairfield, and the City of Vacaville. Several customers take water from the Paradise Valley raw water system and treat it at the point of entry into the home for use as potable water. Before reclaimed water could be introduced into the raw water system, alternative potable water service would be needed for these customers. These customers are not far from the existing City of Fairfield potable water system. It would not be technically difficult to extend the Fairfield potable water system to serve them, but this would involve negotiations between the customers, Fairfield and SID.

Another major branch would serve reclaimed water to the Tolenas area. It would connect to the existing irrigation system piping near East Tabor Avenue and Railroad Avenue.

This alternative would serve most of Central Fairfield other than those areas above elevation 80 feet mean sea level plus Paradise Valley and Lagoon Valley. It would not provide service to any of the area west of Interstate 80. It would serve Solano Mall, the Gateway area, Solano and Low Business Parks, the Suisun-Fairfield cemetery, the County and City offices, and the vast majority of Fairfield's parks and schools.

Alternative 2. This alternative would serve exactly the same area as Alternative 1. It would utilize a different transmission main layout between the Fairfield-Suisun WWTP and Linear Park. Alternative 2 would utilize one of the existing dual sewage force mains to convey reclaimed water to the Fairfield-Suisun Sewer District's central pump station near Illinois Avenue and Pennsylvania Avenue. A new force main would carry the water from the Central Pump Station along Woolner Avenue to Beck Avenue and north to Linear Park. From that point northward the transmission alignment would be identical to Alternative 1. Alternative 2 would also include a small pump station and a small force main from the Fairfield-Suisun WWTP north along Chadbourne Road to serve the Solano and Low Business Parks.

Alternative 3. This alternative would be similar to Alternative 1 except that the pipeline branch feeding reclaimed water to Paradise Valley and Lagoon Valley would not be included.

Alternative 4. This alternative would be similar to the southern portion of Alternative 1. The transmission main would end at the north side of Travis Boulevard. None of the area north of Travis Boulevard other than the Solano Mall would be served in this alternative. The transmission main would end at the northern end of the existing reclaimed water transmission main in Linear Park. In this alternative, non-potable water service would be provided to Solano and Low Business Parks, Allan Witt Park, Linear Park, Armijo High School, the County and City offices, and Solano Mall. Most of the remaining parks and schools in Fairfield would not be served. This alternative would not include a reservoir and it would have no potential of receiving raw water from the Putah South Canal as an alternate water source. It also would not serve the Suisun-Fairfield Cemetery, which the City of Fairfield has contracted to serve with reclaimed water.

Alternative 5. This alternative would be similar to Alternative 4, but it would add a pipeline along Oliver Road to serve the area west of Interstate 80 and the Rancho Solano Golf Course.

Alternative 6. This alternative would be similar to Alternative 1, but it would add a pipeline along Oliver Road to serve the area west of Interstate 80 and the Rancho Solano Golf Course. If at some future date Fairfield and Suisun/Solano Water Authority agree to share service areas, the

existing Suisun/Solano Water Authority potable water pipeline could substitute for their additional non-potable pipeline along Oliver Road.

Alternative 7. This alternative would be similar to Alternative 1 except it would not include service to Tolenas.

Service Area 2 - Suisun Valley

Suisun Valley is currently served by an extensive system of raw water ditches, pipes, and pump stations that bring irrigation water to farms throughout the valley. The raw water system in Suisun Valley is used exclusively for irrigation. No customer in Suisun Valley uses the irrigation water as a source of drinking water, according to SID records. To complete a non-potable water system in this area, provision must only be made to make reclaimed water an alternate source for the existing raw water system. The raw water pipes and ditches, called laterals, all originate at the Putah South Canal. These laterals can double as a reclaimed water distribution system, if reclaimed water can be brought to the heads of the various laterals. Each connection between the Putah South Canal and a lateral would be modified by adding an air gap to prevent any possible backfeed of reclaimed water into the Canal.

This service area does not include the lower portion of Suisun Valley, i.e., land south of Interstate 80 and Solano Community College grounds. The reclaimed water pipe system serving lower Suisun Valley would be separate from that serving Service Area 2, middle and upper Suisun Valley.

The piping system in this service area was modeled as a low pressure system. Pressures must only be greater than 0 psi at each delivery point. Each user would handle onsite distribution and pumping.

As noted in Section 3 of this report, several farmers in Suisun Valley have expressed reluctance to utilize reclaimed water. One of their fears is that the quality of the water would harm their crops. This concern can be addressed, at least in part, by blending the reclaimed water with raw water from the Putah South Canal. Blending the reclaimed water with raw water can also reduce the peak reclaimed water flow requirement and thus reduce the sizes of the pumps and pipes needed to transmit reclaimed water to the heads of the existing raw water laterals where the two waters would be blended. The alternatives considered here include the assumption that raw water and reclaimed water would be blended for use in Suisun Valley. Two different blending ratios are assumed for purposes of sizing the pumps and pipes: 50 percent reclaimed water and 25 percent reclaimed water.

The following alternatives were evaluated for this service area.

Alternative 1. This alternative would include construction of a booster pump station and transmission mains. It would utilize the existing SID reclaimed water pump station and transmission main. The booster pump station would be built at the north end of the existing reclaimed water transmission main along Chadbourne Road. The new transmission main would run north from the booster pump station along Abernathy Road to the Putah South Canal where it would discharge into the upper end of the existing Chadbourne Lateral operated by SID. A branch off the transmission main would serve the Rancho Solano Golf Course. Another branch would run westward, generally along Mankas Corner Road. This pipe would serve reclaimed water to the remaining irrigation laterals operated by SID in middle and upper Suisun Valley, including the Pierce Lateral, the Lambert Lateral, and Lateral A. This alternative would provide reclaimed water to essentially every farm in middle and upper Suisun Valley. This alternative assumes that, at peak flow, 50 percent of the irrigation demand would be met with reclaimed water and the remainder would be met with raw water.

Alternative 2. This alternative, like Alternative 1, would include the booster pump station and the transmission main along Abernathy Road. It also includes service to the Rancho Solano Golf Course. Unlike Alternative 1, this alternative only distributes reclaimed water to the Chadbourne and Pierce Laterals. The laterals north of the Putah South Canal (the Lambert Lateral and Lateral A) would not receive reclaimed water. The bulk of the irrigation water use in the valley is south of the Putah South Canal, so this alternative would still serve the bulk of the irrigation customers while reducing the length of transmission main required. This alternative assumes that, at peak flow, 50 percent of the irrigation demand would be met with reclaimed water.

Alternative 3. This alternative is identical to Alternative 1 with the exception that only 25 percent of the peak flow demand would be met with reclaimed water.

Alternative 4. This alternative is identical to Alternative 2 with the exception that only 25 percent of the peak flow demand would be met with reclaimed water.

Service Area 3 - Lower Suisun Valley

Lower Suisun Valley is defined for purposes of this report to be the area of Suisun Valley served by SID's Young Lateral, which is mostly south of Interstate 80, plus Solano Community College and Fairfield Corporate Commons. These areas presently receive raw water for irrigation from SID. The existing raw water distribution system could also be used to distribute reclaimed water if reclaimed water could be transmitted to appropriate points in the existing distribution system. Air gaps between the reclaimed water system and the existing raw water service would be needed if the raw water services are to be maintained. The proposed alternatives would all provide access to reclaimed water, Putah South Canal water, Cache Slough pipeline water, and potable water as alternative water sources.

Also, possibly included in this service area would be a proposed golf course in an area west of Suisun Valley known as White Wing. There are few alternative sources of irrigation water for this proposed golf course and associated development. The developers may be a primary impetus for construction of a reclaimed water system in this service area, and may pay a significant portion of the construction cost.

Unlike the systems in middle and upper Suisun Valley, the reclaimed water systems in this service area would be sized to handle the full irrigation demand without blending. In sizing the pipes and pumps for this area, it was assumed that operational storage in the form of ponds would be constructed along with the White Wing development. Costs for the ponds were not included in the cost estimates. All the alternatives would also include a storage reservoir near Solano Community College. Costs for that reservoir are included in the estimates. The storage reservoirs would make it possible to size the system for maximum day demand, not peak hour demand. The proposed alternatives would provide low pressure service to the area.

Alternative 1. This alternative would include the existing SID reclaimed water pump station and a transmission main running generally westward across the valley. The transmission main would cross under Interstate 80 at Suisun Creek. The transmission main would follow a route initially proposed by SID. The system would include a booster pump station near Solano Community College and a transmission main from there along Rockville Road to the proposed White Wing development. It is assumed that a third pump station, one to distribute irrigation water within the White Wing development, would be built by the White Wing developer. Thus, that third pump station is not included in this analysis. This alternative would utilize the existing reclaimed water piping along Chadbourne Road and Cordelia Road near the Fairfield-Suisun WWTP and about 2,000 feet of unused irrigation pipe along I-80. The existing piping belongs to SID.

Alternative 2. This alternative would include all the elements described for Alternative 1 plus it would serve reclaimed water to the streetscapes in lower Green Valley. Green Valley service would be provided using a branch pipe from the reclaimed water transmission main to the non-potable water pipe recently constructed in Mangels Boulevard. There is an existing non-potable water system in Lower Green Valley, making this an attractive area to serve. The landscape architect for the streetscapes has said the plants would not tolerate reclaimed water so it may not be acceptable to attach this system to the reclaimed water system.

Alternative 3. This alternative would be similar to Alternative 2 except it would not have service to White Wing. This alternative is included because White Wing is only a proposed development. There is a real chance that the White Wing development as new proposed will not be completed and that whatever development occurs would not utilize reclaimed water.

Alternative 4. This alternative would serve the same areas as Alternative 1, but via a different route. The route would be via one of the two existing wastewater force mains from the Fairfield-Suisun WWTP to near Pittman Road and Cordelia Road. The second force main was built to convey peak wet weather wastewater flows. During the irrigation season, the force main is not needed for wastewater purposes and could be available for transporting reclaimed water in the reverse direction. The regulatory implications of utilizing a wastewater force main for reclaimed water were discussed in Section 5 of this report. A new pipeline would be built along Pittman Road and Suisun Valley Road ending at the reservoir to be built at Solano Community College. A booster pump station and pipeline along Rockville Road to White Wing would also be included. This alternative would utilize the existing utility water pump station at the Fairfield-Suisun WWTP and existing in-plant piping with improvements as needed to give them the capacity needed. Alternative 4 would include service to the same area as Alternative 1, the Young Lateral, Solano Community College, Fairfield Corporate Commons and White Wing.

Alternative 5. This alternative would utilize the same piping route as Alternative 4, but it would add service to Lower Green Valley. This alternative would serve the same areas as Alternative 2.

Alternative 6. This alternative would be similar to Alternative 5, but it would not include service to White Wing. It would serve the same area as Alternative 3.

Service Area 4 - Cordelia

Three alternatives were considered for the Cordelia Service Area. All include pumping reclaimed water through the second of the two existing wastewater force mains from Cordelia to the Fairfield-Suisun WWTP.

Separate non-potable water systems have been installed for streetscape and park irrigation in the portions of Cordelia Villages developed in the past two years. These existing non-potable water systems were considered as part of the non-potable water distribution system alternatives analyzed in this plan. The roughly $200,000 already spent on dual water systems in the area is not included in the cost estimates.

The alternatives for this service area are all high pressure distribution systems. Alternatives 1, 1R, and 2 would all have access to reclaimed water, water from the Cache Slough pipeline, and potable water. The following three alternatives were analyzed.

Alternative 1. This alternative would include a pump station at the Fairfield-Suisun WWTP, the existing wastewater force main, and a transmission main along Lopes Road. Pipes branching off this transmission main would serve the area.

Alternative 1R. This alternative would be similar to Alternative 1, except that it would include a reservoir in the hills west of Cordelia for operational storage.

Alternative 2. This alternative includes all of the system described for Alternative 1 plus a connection to the existing non-potable water pipe in Green Valley Road. This would allow service to the Lower Green Valley area as well as to Cordelia. The connection to Lower Green Valley in Alternative 2 would make it possible to deliver water from the Putah South Canal into this distribution system, an option that does not exist in Alternatives 1 or 1R.

Service Area 5 - Suisun City

Existing dual wastewater force mains run from the western edge of Suisun City to the Fairfield-Suisun WWTP. This presents the opportunity to utilize one of these force mains in the reverse direction to bring reclaimed or raw water to Suisun City. Both of the alternatives considered for Suisun City incorporate this concept. Water sources for the Suisun City non-potable water distribution system alternatives are limited to reclaimed water, water from the Cache Slough pipeline, and potable water.

Alternative 1. This alternative would include improvements to the utility water pump station at the Fairfield-Suisun WWTP, the existing wastewater force main, and a transmission main along Highway 12. It would also include a transmission main along Emperor Drive and Olive Road that would serve non-potable water to the Tolenas area.

At the upper end of the wastewater force mains is the central pump station near the intersection of Illinois and Pennsylvania Avenues. From that point non-potable water would be piped along an existing Fairfield-Suisun Sewer District right-of-way to near the intersection of Highway 12 and Marina Boulevard. The non-potable transmission main would follow Highway 12 from Marina Boulevard to Scandia Road. This section of Highway 12 is scheduled for improvement in the next two years. Should a non-potable water system be built in this area, it would save money to construct the pipeline when Highway 12 is improved. Current State law requires CalTrans to allow reclaimed water transmission pipes to parallel state highways in the highway right-of-way.

Tolenas currently has dual water systems, one providing irrigation water to the area and the other providing potable water. The irrigation water now comes from the Cache Slough pipeline. In this alternative, the current connection to the Cache Slough pipeline would be replaced by a new reclaimed and raw water service from the Fairfield-Suisun WWTP.

This alternative would also serve water to the landscaping along Highway 12 and to several streetscapes and parks in Suisun City including the planned sports complex along Scandia Road. The vast majority of the demand would be in the Tolenas area. The only demand of any significance in Suisun City would be the sports complex. A reservoir at the sports complex would provide operational storage.

There would be a small amount of demand on this system in the winter when the wastewater force main would be unavailable. To supply this winter demand, this alternative would include a connection from a Suisun-Solano Water Authority potable water pipeline or the Cache Slough pipeline to the reclaimed water system through an air gap and pump station.

Alternative 2. This alternative would utilize the existing utility water pump station at the Fairfield-Suisun WWTP and the existing wastewater force main. The new transmission main would only run along Highway 12. This alternative would serve only the demands in Suisun City including the planned sports complex. It would not include service to Tolenas. Winter service would be similar to Alternative 1.

Alternative 3. Alternative 3 would serve the same area as Alternative 1, Suisun City and Tolenas, but via a different distribution system. The new transmissions main would start at the FSSD central pump station and follow the same route as in Alternative 1 to near the intersection of Highway 12 and Marina Boulevard. The transmission main would then roughly follow Railroad Avenue to East Tabor Avenue, where it would discharge into a storage reservoir. A pump station would then pump from the reservoir into the Tolenas irrigation system. Several connections would be made to the southern ends of the Tolenas irrigation piping to serve demands in Suisun City, including schools, parks, Highway 12 landscaping and the planned sports complex. A reservoir would be built at the sports complex for operational storage.

ANALYSIS OF SYSTEM COMPONENTS

Table 6-2 presents a summary listing of the alternatives analyzed.

TABLE 6-2
SUMMARY LISTING OF NON-POTABLE WATER SYSTEM ALTERNATIVES

Service Area 1 - Central Fairfield	
Alternative 1	Service to almost all Central Fairfield plus Paradise Valley, Lagoon Valley, and Tolenas
Alternative 2	Service to the same area as 1, but via an alternate transmission main route.
Alternative 3	Similar to 1, but excluding Paradise Valley and Lagoon Valley.
Alternative 4	Similar to 1, but serving only the area north of Travis Boulevard.
Alternative 5	Similar to 4, but adds service to Rancho Solano Golf Course.
Alternative 6	Similar to 1, but adds service to Rancho Solano Golf Course.
Alternative 7	Similar to 1, but excluding Tolenas.
Service Area 2 - Suisun Valley	
Alternative 1	Service to the entire middle and upper Suisun Valley plus Rancho Solano with 50% reclaimed water to agriculture.
Alternative 2	Service only to middle Suisun Valley (Chadbourne and Pierce Laterals) plus Rancho Solano with 50% reclaimed water to agriculture.

Alternative 3	Same as 1 except only 25% reclaimed water to agriculture.
Alternative 4	Same as 2 except only 25% reclaimed water to agriculture.

Service Area 3 - Lower Suisun Valley

Alternative 1	Service to Lower Suisun Valley and White Wing but not Green Valley via new transmission main.
Alternative 2	Same as 1 plus service to lower Green Valley.
Alternative 3	Same as 2 but without service to White Wing.
Alternative 4	Same service area as 1, but via FSSD force main.
Alternative 5	Same as 4 plus service to Lower Green Valley.
Alternative 6	Same as 5, but without service to White Wing.

Service Area 4 - Cordelia

Alternative 1	Service to Cordelia via FSSD force main.
Alternative 1R	Same as 1, but with a reservoir.
Alternative 2	Same as 1 plus service to Lower Green Valley.

Service Area 5 - Suisun City

Alternative 1	Suisun City and Tolenas service via transmission main in Highway 12.
Alternative 2	Service to Suisun City, only via transmission main in Highway 12.
Alternative 3	Suisun City and Tolenas service via transmission main along Railroad Avenue.

Tables 6-3 through 6-7 present a reconnaissance level project cost estimate for each of the alternative distribution systems. The unit costs in Tables 6-3 through 6-7 for capital costs are based on JMM's experience and database of recent pipeline projects in northern California. The projects in the database are primarily water pipelines. They include a wide variety of pipe materials. Thus the costs can be considered average costs for pipeline construction rather than costs for any specific type of pipe.

The pump station capital costs are taken from curves for a moderately complex pump station in JMM's cost estimating manual. The curves give cost as a function of station horsepower.

TABLE 6-3
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
NEW FACILITY COST ESTIMATES FOR SERVICE AREA 1 - CENTRAL FAIRFIELD
ALTERNATIVE 1 - BECK AVENUE TRANSMISSION MAIN
ALTERNATIVE 2 - WOOLNER AVENUE TRANSMISSION MAIN & FSSD FORCE MAIN

ELEMENT	UNIT COST ($/lf)(a)	ALTERNATIVE 1 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 2 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST
6 -inch	41	31,600	$1,295,600	$34,444			29,900	$1,225,900	$32,591		
8 -inch	56	19,700	$1,103,200	$21,473			19,700	$1,103,200	$21,473		
10 -inch	70	2,300	$161,000	$2,507			2,300	$161,000	$2,507		
12 -inch	83	5,900	$489,700	$6,431			5,900	$489,700	$6,431		
14-inch	98	2,300	$225,400	$2,507			2,300	$225,400	$2,507		
16 -inch	111						1,400	$155,400	$1,526		
18 -inch	126						3,900	$491,400	$4,251		
20-inch	140	1,500	$210,000	$1,635			6,100	$854,000	$6,649		
24 -inch	167						8,500	$1,419,500	$9,265		
30 -inch	209	28,000	$5,852,000	$30,520			12,800	$2,675,200	$13,952		
36 -inch	251	13,500	$3,388,500	$14,715			13,500	$3,388,500	$14,715		
42 -inch	293										
48 -inch	345										
54 -inch	397										
PIPE SUBTOTAL		104,800	$12,725,400	$114,232	$936,335		106,300	$12,189,200	$115,867	$896,881	
PUMP STATION (a,b,c)(gpm) (TDH, ft) (hp)		8,000 249 900	$1,800,000		$132,444		6,500 256 850	$1,785,000		$131,340	
PUMP STATION (a,b,c)(gpm) (TDH, ft) (hp)							3,947 185 500	$1,250,000		$91,975	
RAW WTR P.S.(a,b,c)(gpm) (TDH, ft) (hp)		8,000 209 750	$1,650,000		$121,407		8,000 209 750	$1,650,000		$121,407	
RESERVOIR (a) (volume, mil. gal)		6.30	$5,670,000		$417,199		4.80	$4,800,000		$353,184	
PUMP STATIONS (d) maintenance				$69,000					$93,700		
PUMP STATIONS (e) operation				$5,000					$10,000		
ENERGY COSTS (g)				$177,929					$173,418		
PIPE + PUMP SUBTOTAL			$21,845,400	$366,161	$1,607,385			$21,674,200	$392,985	$1,594,788	
ENGINEERING, ADMIN & CONTINGENCIES @45%			$9,830,430		$723,323			$9,753,390			
TOTAL			$31,675,830	$366,161	$2,330,708	$2,696,868		$31,427,590	$392,985	$2,312,442	$2,705,427
AAD (acre-ft/year)			4,880	4,880	4,880	4,880		4,880	4,880	4,880	4,880
$ per acre-ft				$75	$478	$553			$81	$474	$554

(a) Assumptions: (1) In street; (2) 10-15 ft depth; (3) Includes MOB, OH, & profit; (4) Costs in 1991 dollars; (5) Fairfield ENR=6100.
(b) Costs from Figure 3-1, Curve B, JMM Cost Estimating Manual,1982.
(c) Pump efficiency assumed to be 80%. Wire to water efficiency assumed to be 70%. Used standard sized pumps including one standby.
(d) Annual maintenance cost for pump station is 2% of the initial capital cost for the pump station.
(e) Pump station operations costs equal 15% of one persons time for half a year.
(f) Pipeline maintenance = $1.09 per linear foot/year
(g) Energy cost = $ 0.10 per kwh.
(h) Annual equivalent cost calculated using a discount rate, i=4%, and a time period of 20 years.

TABLE 6-3 (continued)
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
NEW FACILITY COST ESTIMATES FOR SERVICE AREA 1 - CENTRAL FAIRFIELD
ALTERNATIVE 3 - ALTERNATIVE 1, WITHOUT SERVICE TO LAGOON AND PARADISE VALLEYS
ALTERNATIVE 4 - ALTERNATIVE 1, SERVING ONLY TO EXISTING PIPELINE IN LINEAR PARK

ELEMENT	UNIT COST ($/lf)(a)	ALTERNATIVE 3 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 4 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST
6 -inch	41	32,600	$1,336,600	$35,534			20,600	$844,600	$22,454		
8 -inch	56	18,700	$1,047,200	$20,383			5,400	$302,400	$5,886		
10 -inch	70	2,300	$161,000	$2,507			7,000	$490,000	$7,630		
12 -inch	83	5,900	$489,700	$6,431							
14-inch	98	2,300	$225,400	$2,507							
16 -inch	111										
18 -inch	126						3,900	$491,400	$4,251		
20-inch	140						5,900	$826,000	$6,431		
24 -inch	167	15,200	$2,538,400	$16,568			5,400	$901,800	$5,886		
30 -inch	209	12,800	$2,675,200	$13,952							
36 -inch	251	13,500	$3,388,500	$14,715							
42 -inch	293										
48 -inch	345										
54 -inch	397										
PIPE SUBTOTAL		103,300	$11,862,000	$112,597	$872,806		48,200	$3,856,200	$52,538	$283,739	
PUMP STATION (b,c)(gpm) (TDH, ft) (hp)		6,500 277 900	$1,800,000		$132,444		6,783 215 750	$1,650,000		$121,407	
PUMP STATION (b,c)(gpm) (TDH, ft) (hp)											
RAW WTR P.S.(b,c)(gpm) (TDH, ft) (hp)		6,500 209 700	$1,540,000		$113,313		6,783 209 750	$1,650,000		$121,407	
RESERVOIR (volume, mil. gal)		6.30	$5,670,000		$417,199						
PUMP STATIONS (d) maintenance				$66,800					$66,000		
PUMP STATIONS (e) operation				$5,000					$5,000		
ENERGY COSTS (g)				$111,137					$44,075		
PIPE + PUMP SUBTOTAL			$20,872,000	$295,534	$1,535,762			$7,156,200	$167,613	$526,553	
ENGINEERING, ADMIN & CONTINGENCIES @45%			$9,392,400					$3,220,290		$236,949	
TOTAL			$30,264,400	$295,534	$2,226,855	$2,522,388		$10,376,490	$167,613	$763,502	$931,115
AAD (acre-ft/year)			2,740	2,740	2,740	2,740		1,400	1,400	1,400	1,400
$ per acre-ft				$108	$813	$921			$120	$545	$665

(a) Assumptions: (1) In street
(2) 10-15 ft depth
(3) Includes MOB, OH, & profit
(4) Costs in 1991 dollars.
(5) Fairfield ENR=6100.

(b) Costs from Figure 3-1, Curve B, JMM Cost Estimating Manual,1982.
(c) Pump efficiency assumed to be 80%. Wire to water efficiency assumed to be 70%. Used standard sized pumps including one standby.
(d) Annual maintenance cost for pump station is 2% of the initial capital cost for the pump station.
(e) Pump station operations costs equal 15% of one persons time for half a year.
(f) Pipeline maintenance = $1.09 per linear foot/year
(g) Energy cost = $ 0.10 per kwh.
(h) Annual equivalent cost calculated using a discount rate, i=4%, and a time period of 20 years.

TABLE 6-3 (continued)
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
NEW FACILITY COST ESTIMATES FOR SERVICE AREA 1 - CENTRAL FAIRFIELD
ALTERNATIVE 5 - ALTERNATIVE 4, WITH SERVICE TO RANCHO SOLANO
ALTERNATIVE 6 - ALETRNATIVE 1, WITH SERVICE TO RANCHO SOLANO
ALTERNATIVE 7 - ALTERNATIVE 1 WITHOUT SERVICE TO TOLENAS

ELEMENT	UNIT COST ($/lf)(a)	ALTERNATIVE 5 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 6 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 7 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST
6 -inch	41	24,100	$988,100	$26,269			32,400	$1,328,400	$35,316			28,600	$1,172,600	$31,174		
8 -inch	56	10,600	$593,600	$11,554			18,300	$1,024,800	$19,947			24,900	$1,394,400	$27,141		
10 -inch	70	3,500	$245,000	$3,815			6,400	$448,000	$6,976			3,800	$266,000	$4,142		
12 -inch	83						7,600	$630,800	$8,284			4,400	$365,200	$4,796		
14-inch	98															
16 -inch	111						2,300	$255,300	$2,507							
18 -inch	126															
20-inch	140						1,500	$210,000	$1,635			1,500	$210,000	$1,635		
24 -inch	167	25,400	$4,241,800	$27,686			6,150	$1,027,050	$6,704			29,300	$4,893,100	$31,937		
30 -inch	209						13,600	$2,842,400	$14,824			1,100	$229,900	$1,199		
36 -inch	251						27,200	$6,827,200	$29,648							
42 -inch	293						5,700	$1,670,100	$6,213							
48 -inch	345															
54 -inch	397															
PIPE SUBTOTAL		63,600	$6,068,500	$69,324	$446,520		121,150	$16,264,050	$132,054	$1,196,709		93,600	$8,531,200	$102,024	$627,726	
PUMP STATION (a,b,c) (gpm)		8,570	$1,720,000		$126,558		9,900	$2,160,000		$158,933		5,000	$1,380,000		$101,540	
(TDH, ft)		215					259					251				
(Hp)		800					1,200					600				
RAW WTR P.S.(a,b,c)(gpm)		8,000	$1,650,000		$121,407		8000	$1,650,000		$121,407		5,000	$1,380,000		$101,540	
(TDH, ft)		209					209					209				
(hp)		750					750					600				
RESERVOIR (a)								$5,670,000		$417,199			$3,000,000		$220,740	
(volume, mil. gal.)							6.30					3.00				
PUMP STATION (d)				$67,400					$76,200					$55,200		
maintenance																
PUMP STATION (e)				$5,000					$5,000					$5,000		
operation																
ENERGY COSTS (g)				$75,243					$222,620					$148,117		
PIPE + PUMP SUBTOTAL			$9,438,500	$216,967	$694,485			$25,744,050	$435,874	$1,894,247			$14,291,200	$310,341	$1,051,546	
ENGINEERING, ADMIN &			$4,247,325		$312,518			$11,584,823		$852,411			$6,431,040		$473,196	
CONTINGENCIES @45%																
TOTAL			$13,685,825	$216,967	$1,007,003	$1,223,970		$37,328,873	$435,874	$2,746,658	$3,182,532		$20,722,240	$310,341	$1,524,742	$1,835,084
AAD (acre-ft/year)			2,390	2,390	2,390	2,390		5,870	5,870	5,870	5,870		4,030	4,030	4,030	4,030
$ per acre-ft				$91	$421	$512			$74	$468	$542			$77	$378	$455

(a) Assumptions: (1) In street
(2) 10-15 ft depth
(3) Includes MOB, OH, & profit
(4) Costs in 1991 dollars.
(5) Fairfield ENR=6100.

(b) Costs from Figure 3-1, Curve B, JMM Cost Estimating Manual,1982.

(c) Horsepower requirement assumes 80% pump efficiency, 70% wire-to-water efficiency. Cost estimate uses standard sized pumps including one standby pump.

(d) Annual maintenance cost for pump station is 2% of the initial capital cost for the pump station.

(e) Pump station operations costs equal 15% of one persons time for half a year.

(f) Pipeline maintenance = $1.09 per linear foot per year

(g) Energy cost = $ 0.10 per kwh.

(h) Equivalent annual cost calculated using a discount rate, i=4%, and a time period of 20 years.

TABLE 6-4

CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

NEW FACILITY COST ESTIMATES FOR SERVICE AREA 2 - SUISUN VALLEY

ALTERNATIVE 1 - INCLUDING RANCHO SOLANO, 50% PEAK HOUR

ALTERNATIVE 2 - SERVICE ONLY TO PUTAH SOUTH CANAL INCLUDING RANCHO SOLANO, 50% PEAK HOUR

ELEMENT	UNIT COST ($/lf)(a)	ALTERNATIVE 1 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 2 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST
6 -inch	41										
8 -inch	56	3,960	$221,760	$4,316							
10 -inch	70										
12 -inch	83	4,800	$398,400	$5,232			7,970	$661,510	$8,687		
14-inch	98	5,940	$582,120	$6,475							
16 -inch	111						1,600	$177,600	$1,744		
18 -inch	126	3,170	$399,420	$3,455							
20-inch	140						13,300	$1,862,000	$14,497		
24 -inch	167	21,400	$3,573,800	$23,326							
30 -inch	209										
36 -inch	251										
42 -inch	293										
48 -inch	345										
54 -inch	397										
PIPE SUBTOTAL		39,270	$5,175,500	$42,804	$380,813		22,870	$2,701,110	$24,928	$198,748	
PUMP STATION (a,b,c)(gpm)		7,000	$1,760,000		$129,501		4,720	$1,080,000		$79,466	
(TDH, ft)		252					158				
(hp)		800					400				
RESERVOIR (a) capital cost											
PUMP STATIONS (d) maintenance				$35,200					$25,600		
PUMP STATIONS (e) operation				$5,000					$8,000		
ENERGY COSTS (g)				$164,907					$92,828		
PIPE + PUMP SUBTOTAL			$6,935,500	$247,911	$510,314			$3,781,110	$151,356	$278,214	
ENGINEERING, ADMIN & CONTINGENCIES @45%			$3,120,975		$229,641			$1,701,500		$125,196	
TOTAL			$10,056,475	$247,911	$739,955	$987,866		$5,482,610	$151,356	$403,410	$554,766
AAD (acre-ft/year)			4,469	4,469	4,469	4,469		2,908	2,908	2,908	2,908
$ per acre-ft				$55	$166	$221			$52	$139	$191

(a) Assumptions: (1) In street
(2) 10-15 ft depth
(3) Includes MOB, OH, & profit
(4) Costs in 1991 dollars.
(5) Fairfield ENR=6100.

(b) Costs from Figure 3-1, Curve B, JMM Cost Estimating Manual,1982.

(c) Horsepower requirement assumes 80% pump efficiency. Cost estimate uses standard sized pumps including one standby pump.

(d) Annual maintenance cost for pump station is 2% of the initial capital cost for the pump station.

(e) Pump station operations costs equal 15% of one persons time for half a year.

(f) Pipeline maintenance = $1.09 per linear foot per year

(g) Energy cost = $ 0.10 per kwh. Assumed wire-to-water efficiency is 70%.

(h) Equivalent annual cost calculated using a discount rate, i=4%, and a time period of 20 years.

TABLE 6-4 (continued)
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
NEW FACILITY COST ESTIMATES FOR SYSTEM 2 - SUISUN VALLEY
ALTERNATIVE 3 - INCLUDING RANCHO SOLANO, 25% PEAK HOUR
ALTERNATIVE 4 - SERVICE ONLY TO PUTAH SOUTH CANAL INCLUDING RANCHO SOLANO, 25% PEAK HOUR

ELEMENT	ALTERNATIVE 3 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 4 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST
6 -inch	3,960	$162,360	$4,316							
8 -inch						3,170	$177,520	$3,455		
10 -inch	5,940	$415,800	$6,475							
12 -inch	4,800	$398,400	$5,232			6,400	$531,200	$6,976		
14-inch	3,170	$310,660	$3,455			13,300	$1,303,400	$14,497		
16 -inch	1,600	$177,600	$1,744							
18 -inch										
20-inch	13,300	$1,862,000	$14,497							
24 -inch										
30 -inch										
36 -inch										
42 -inch										
48 -inch										
54 -inch										
PIPE SUBTOTAL	32,770	$3,326,820	$35,719	$244,787		22,870	$2,012,120	$24,928	$148,052	
PUMP STATION (b,c) @ MDD (TDH, ft)	4,320 238 475	$1,235,000		$90,871		2,340 208 225	$675,000		$49,667	
RESERVOIR capital cost										
PUMP STATIONS (d) maintenance			$28,700					$17,500		
PUMP STATIONS (e) operation			$8,000					$8,000		
ENERGY COSTS (g)			$125,671					$73,777		
PIPE + PUMP SUBTOTAL		$4,561,820	$198,090	$335,659			$2,687,120	$124,205	$197,718	
ENGINEERING, ADMIN & CONTINGENCIES @45%		$2,052,819		$151,046			$1,209,204		$88,973	
TOTAL		$6,614,639	$198,090	$486,705	$684,796		$3,896,324	$124,205	$286,692	$410,897
AAD (acre-ft/year)		2,880	2,663	2,880	2,880		1,880	1,880	1,880	1,880
$ per acre-ft/year			$74	$169	$238			$66	$152	$219

(a) Assumptions: (1) In street
(2) 10-15 ft depth
(3) Includes MOB, OH, & profit
(4) Costs in 1991 dollars.
(5) Fairfield ENR=6100.

(b) Costs from Figure 3-1, Curve B, JMM Cost Estimating Manual,1982.

(c) Assumes 70% wire-to-water efficiency, 80% pump efficiency, standard sized pumps including one standby pump.

(d) Annual maintenance cost for pump station is 2% of the initial capital cost for the pump station.

(e) Pump station operations costs equal 15% of one persons time for half a year.

(f) Pipeline maintenance = $1.09 per linear foot per year

(g) Energy cost = $ 0.10 per kwh.

(h) Present worth calculated using a discount rate, i=4%, and a time period of 20 years.

TABLE 6-5
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
NEW FACILITY COST ESTIMATES FOR SERVICE AREA 3 - LOWER SUISUN VALLEY
ALTERNATIVE 1 - EXCLUDING GREEN VALLEY, INCLUDING WHITE WING, SID ROUTE
ALTERNATIVE 2 - INCLUDING GREEN VALLEY AND WHITE WING, SID ROUTE
ALTERNATIVE 3 - INCLUDING GREEN VALLEY, EXCLUDING WHITE WING, SID ROUTE

ELEMENT	UNIT COST ($/lf)(a)	ALTERNATIVE 1 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 2 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 3 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST
6 -inch	41															
8 -inch	56	4,090	$229,040	$4,458			1,580	$88,480	$1,722			1,580	$88,480	$1,722		
10 -inch	70	11,900	$833,000	$12,971			11,900	$833,000	$12,971							
12 -inch	83						4,090	$339,470	$4,458			8,710	$722,930	$9,494		
14-inch	98	4,620	$452,760	$5,036								9,500	$931,000	$10,355		
16 -inch	111	9,500	$1,054,500	$10,355			14,100	$1,565,100	$15,369							
18 -inch	126															
20-inch	140															
24 -inch	167															
30 -inch	209															
36 -inch	251															
42 -inch	293															
48 -inch	345															
54 -inch	397															
PIPE SUBTOTAL		30,110	$2,569,300	$32,820	$189,049		31,670	$2,826,050	$34,520	$207,941		19,790	$1,742,410	$21,571	$128,207	
PUMP STATION (b,c)(gpm) (TDH, ft) (hp)			$0		$0		1,330 47 40	$250,000		$18,395		1,330 47 40	$250,000		$18,395	
PUMP STATION (b,c)(gpm) (TDH, ft) (hp)		891 200 150	$570,000		$41,941		891 200 150	$570,000		$41,941						
RESERVOIR (volume, mil.gal.)		0.452	$339,000				0.74	$552,750		$40,671		0.74	$552,750		$40,671	
PUMP STATIONS (d) maintenance				$11,800					$16,800					$5,400		
PUMP STATIONS (e) operation				$5,000					$8,000					$5,000		
ENERGY COSTS (g)				$26,721					$33,288					$8,620		
PIPE + PUMP SUBTOTAL			$3,478,300	$76,340	$230,990			$4,198,800	$92,608	$308,948			$2,545,160	$40,592	$187,273	
ENGINEERING, ADMIN & CONTINGENCIES @45%			$1,565,235		$115,170			$1,889,460		$139,026			$1,145,322		$84,273	
TOTAL			$5,043,535	$76,340	$346,160	$422,500		$6,088,260	$92,608	$447,974	$540,582		$3,690,482	$40,592	$271,546	$312,137
AAD (acre-ft/year)			1,240	1240	1,240	1,240		1,380	1380	1,380	1,380		662	662	662	662
$ per acre-ft				$62	$279	$341			$67	$325	$392			$61	$410	$472

(a) Assumptions:
(1) In street
(2) 5-15 ft depth
(3) Includes MOB, OH, & profit
(4) Costs in 1991 dollars.
(5) Fairfield ENR=6100.

(b) Costs from Figure 3-1, Curve B, JMM Cost Estimating Manual,1982.
(c) Horsepower requirement assumes 80% pump efficiency.
Cost estimate uses standard sized pumps including one standby pump.
(d) Annual maintenance cost for pump station is 2% of the initial capital cost for the pump station.

(e) Pump station operations costs equal 15% of one persons time for half a year.
(f) Pipeline maintenance = $1.09 per linear foot per year
(g) Energy cost = $ 0.10 per kwh. Wire-to-water efficiency = 70%.
(h) Present worth calculated using a discount rate, i=4%, and a time period of 20 years.

TABLE 6-5 (continued)
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
NEW FACILITY COST ESTIMATES FOR SERVICE AREA 3 - LOWER SUISUN VALLEY
ALTERNATIVE 4 - EXCLUDING GREEN VALLEY, INCLUDING WHITE WING, FSSD ROUTE
ALTERNATIVE 5 - INCLUDING GREEN VALLEY AND WHITE WING, FSSD ROUTE
ALTERNATIVE 6 - INCLUDING GREEN VALLEY, EXCLUDING WHITE WING, FSSD ROUTE

ELEMENT	UNIT COST ($/lf)(a)	ALTERNATIVE 4 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 5 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 6 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST
6-inch	41															
8-inch	56	1,500	$84,000	$1,635			1,500	$84,000	$1,635			1,500	$84,000	$1,635		
10-inch	70															
12-inch	83	1,710	$141,930	$1,864			1,710	$141,930	$1,864			11,740	$974,420	$12,797		
14-inch	98	10,030	$982,940	$10,933			3,960	$388,080	$4,316							
16-inch	111						6,070	$673,770	$6,616							
18-inch	126															
20-inch	140															
24-inch	167															
30-inch	209															
36-inch	251															
42-inch	293															
48-inch	345															
54-inch	397															
PIPE SUBTOTAL		13,240	$1,208,870	$14,432	$88,949		13,240	$1,287,780	$14,432	$94,755		13,240	$1,058,420	$14,432	$77,879	
PUMP STATION (a,b,c)(gpm)		891	$570,000		$41,941		891	$570,000		$41,941						
(TDH, ft)		200					200									
(hp)		150					150									
RESERVOIR (a)			$504,000					$504,000		$37,084			$504,000		$37,084	
(volume, mil.gal.)		0.672					0.67					0.67				
PUMP STATIONS (d) maintenance				$11,800					$11,800					$400		
PUMP STATIONS (e) operation				$5,000					$5,000					$2,000		
ENERGY COSTS (g)				$36,473					$37,250					$6,827		
PIPE + PUMP SUBTOTAL			$2,282,870	$67,705	$130,889			$2,361,780	$68,481	$173,780			$1,562,420	$23,658	$114,963	
ENGINEERING, ADMIN & CONTINGENCIES @45%			$1,027,292		$75,588			$1,062,801		$78,201			$703,089		$51,733	
TOTAL			$3,310,162	$67,705	$206,477	$274,182		$3,424,581	$68,481	$251,981	$320,462		$2,265,509	$23,658	$166,696	$190,354
AAD (acre-ft/year)			1,240	1240	1,240	1,240		1,350	1350	1,350	1,350		630	630	630	630
$ per acre-ft				$55	$167	$221			$51	$187	$237			$38	$265	$302

(a) Assumptions:
(1) In street
(2) 5-15 ft depth
(3) Includes MOB, OH, & profit
(4) Costs in 1991 dollars.
(5) Fairfield ENR=6100.

(b) Costs from Figure 3-1, Curve B, JMM Cost Estimating Manual,1982.
(c) Horsepower requirement assumes 80% pump efficiency.
Cost estimate uses standard sized pumps including one standby pump.
(d) Annual maintenance cost for pump station is 2% of the initial capital cost for the pump station.

(e) Pump station operations costs equal 15% of one persons time for half a year.
(f) Pipeline maintenance = $1.09 per linear foot per year
(g) Energy cost = $ 0.10 per kwh. Wire-to-water efficiency = 70%.
(h) Present worth calculated using a discount rate, i=4%, and a time period of 20 years.

TABLE 6-6
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
NEW FACILITY COST ESTIMATES FOR SERVICE AREA 4 - CORDELIA
ALTERNATIVE 1 - EXCLUDING GREEN VALLEY
ALTERNATIVE 1R - EXCLUDING GREEN VALLEY, WITH RESERVOIR
ALTERNATIVE 2 - INCLUDING GREEN VALLEY

ELEMENT	UNIT COST ($/lf)(a)	ALTERNATIVE 1 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 1R PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 2 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST
6 -inch	41	21,900	$897,900	$23,871			19,500	$799,500	$21,255			21,900	$897,900	$23,871		
8 -inch	56	3,900	$218,400	$4,251			9,100	$509,600	$9,919			3,900	$218,400	$4,251		
10 -inch	70						4,100	$287,000	$4,469							
12 -inch	83	6,900	$572,700	$7,521			5,200	$431,600	$5,668			3,900	$323,700	$4,251		
14-inch	98											5,400	$529,200	$5,886		
16 -inch	111															
18 -inch	126															
20-inch	140															
24 -inch	167															
27-inch	189															
30 -inch	209															
36 -inch	251															
42 -inch	293															
48 -inch	345															
54 -inch	397															
PIPE SUBTOTAL		32,700	$1,689,000	$35,643	$124,277		37,900	$2,027,700	$41,311	$149,198		35,100	$1,969,200	$38,259	$144,894	
PUMP STATION (a,b,c)(gpm)		1151	$700,000		$51,506		384	$285,000		$20,970		2,446	$900,000		$66,222	
(TDH, ft)		230					267					245				
(hp)		200					50					300				
RAW WTR P.S.(a,b,c)(gpm)												2446	$900,000		$66,222	
(TDH, ft)												260				
(hp)												300				
RESERVOIR (a)								$200,000		$14,716						
(volume, mil. gal.)							0.2									
PUMP STATION (d)				$14,000					$5,700					$18,000		
maintenance																
PUMP STATION (e)				$5,000					$5,000					$5,000		
operation																
ENERGY COSTS (g)				$5,330					$1,333					$17,000		
PIPE + PUMP SUBTOTAL			$2,389,000	$59,973	$175,783			$2,512,700	$53,344	$184,884			$3,769,200	$78,259	$277,338	
ENGINEERING, ADMIN &			$1,075,050		$79,102			$1,130,715		$83,198			$1,696,140		$124,802	
CONTINGENCIES @45%																
TOTAL			$3,464,050	$59,973	$254,885	$314,858		$3,643,415	$53,344	$268,082	$321,426		$5,465,340	$78,259	$402,140	$480,399
AAD (acre-ft/year)			182	182	182	182		182	182	182	182		387	387	387	387
$ per acre-ft				$330	$1,400	$1,730			$293	$1,473	$1,766			$202	$1,039	$1,241

(a) Assumptions: (1) In street (4) Costs in 1991 dollars.
(2) 10-15 ft depth (5) Fairfield ENR=6100.
(3) Includes MOB, OH, & profit

(b) Costs from Figure 3-1, Curve B, JMM Cost Estimating Manual,1982.

(c) Horsepower requirement assumes 80% pump efficiency. Cost estimate uses standard sized pumps including one standby pump.

(d) Annual maintenance cost for pump station is 2% of the initial capital cost for the pump station.

(e) Pump station operations costs equal 15% of one persons time for half a year.

(f) Pipeline maintenance = $1.09 per linear foot/year

(g) Energy cost = $ 0.10 per kwh. Assumed wire-to-water efficiency is 70%.

(h) Equivalent annual cost calculated using a discount rate, i=4%, and a time period of 20 years.

TABLE 6-7
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
NEW FACILITY COST ESTIMATES FOR SERVICE AREA 5 - SUISUN CITY
ALTERNATIVE 1 - SUISUN CITY AND TOLENAS VIA TRANSMISSION MAIN IN HIGHWAY 12
ALTERNATIVE 2 - SUISUN CITY ONLY (EXCLUDING TOLENAS)
ALTERNATIVE 3 - SUISUN CITY AND TOLENAS VIA TRANSMISSION MAIN ALONG RAILROAD AVENUE

ELEMENT	UNIT COST ($/lf)(a)	ALTERNATIVE 1 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 2 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST	ALTERNATIVE 3 PIPE LENGTH (ft)	CAPITAL COST	OPERATIONS & MAINTENANCE COSTS PER YEAR (f)	AMMORTIZED ANNUAL CAPITAL COSTS (h)	TOTAL ANNUAL COST
6 -inch	41	4,800	$196,800	$5,232			6,450	$264,450	$7,031			21,640	$887,240	$23,588		
8 -inch	56	9,100	$509,600	$9,919			14,050	$786,800	$15,315			8,100	$453,600	$8,829		
10 -inch	70															
12 -inch	83	8,250	$684,750	$8,993			14,200	$1,178,600	$15,478							
14-inch	98															
16 -inch	111	14,200	$1,576,200	$15,478								15,000	$1,665,000	$16,350		
18 -inch	126															
20-inch	140															
24 -inch	167															
30 -inch	209															
36 -inch	251															
42 -inch	293															
48 -inch	345															
54 -inch	397															
PIPE SUBTOTAL		36,350	$2,967,350	$39,622	$218,338		34,700	$2,229,850	$37,823	$164,072		44,740	$3,005,840	$48,767	$221,170	
PUMP STATION (a,b,c)(gpm)		2,120	$420,000		$30,904							3,440	$570,000		$41,941	
(TDH, ft)		100										90				
(hp)		105										150				
RESERVOIR (a)			$519,000		$38,188			$305,250		$22,460			$735,000		$54,081	
(volume, mil.gal.)		0.692					0.41					0.98				
PUMP STATIONS (d) maintenance				$8,800					$400					$11,800		
PUMP STATIONS (e) operation				$7,000					$2,000					$7,000		
ENERGY COSTS (g)				$34,007					$7,540					$36,853		
PIPE + PUMP SUBTOTAL			$3,906,350	$89,428	$287,429			$2,535,100	$47,763	$186,533			$4,310,840	$104,420	$317,192	
ENGINEERING, ADMIN & CONTINGENCIES @45%			$1,757,858		$129,343			$1,140,795		$83,940			$1,939,878		$142,736	
TOTAL			$5,664,208	$89,428	$416,772	$506,201		$3,675,895	$47,763	$270,472	$318,235		$6,250,718	$104,420	$459,928	$564,348
AAD (acre-ft/year)			1,040	1040	1,040	1,040		341	341	341	341		1,040	1040	1,040	1,040
$ per acre-ft				$86	$401	$487			$140	$793	$933			$100	$442	$543

(a) Assumptions: (1) In street
(2) 5-15 ft depth
(3) Includes MOB, OH, & profit
(4) Costs in 1991 dollars.
(5) Fairfield ENR=6100.

(b) Costs from Figure 3-1, Curve B, JMM Cost Estimating Manual,1982.
(c) Horsepower requirement assumes 80% pump efficiency.
Cost estimate uses standard sized pumps including one standby pump.
(d) Annual maintenance cost for pump station is 2% of the initial capital cost for the pump station.

(e) Pump station operations costs equal 15% of one persons time for half a year.
(f) Pipeline maintenance = $1.09 per linear foot per year
(g) Energy cost = $ 0.10 per kwh. Wire-to-water efficiency = 70%.
(h) Present worth calculated using a discount rate of 4%, and a time period of 20 years.

Construction costs undergo long-term changes in keeping with corresponding changes in the national economy. The best available measure of these changes is the Engineering News Record Construction Cost Index (ENR CCI). The cost estimates in this report reflect an ENR CCI of 6,100, the ENR CCI for San Francisco as of November 1991.

The operations and maintenance costs for pump stations and pipelines reflect information provided by the City of Fairfield Public Works Department staff. The costs used are comparable to Fairfield's past costs for operation and maintenance of water system pump stations and pipelines.

Sizes of the various distribution system components were determined using the FAAST computer model. These analyses utilized the potential non-potable water demands described in Section 3, the planning criteria described in this Section, and the alternative piping configurations described in this Section.

Tables 6-3 through 6-7 also include an estimate of the unit cost for distribution of reclaimed water. This is how much it would cost to construct and operate the proposed system per acre-foot of water delivered. These unit costs range from a low of $191/acre-ft for alternative 2 in Suisun Valley to a high of $1,766/acre-ft for alternative 1R in Cordelia. Most of the unit costs fall between $300 and $600 per acre-foot.

Section 7

SECTION 7

SELECTION OF RECOMMENDED SYSTEMS

In this Section the recommended non-potable water distribution systems for central Solano County are described. The process used to select the recommended systems and the reasons for their selection are presented.

SELECTION PROCESS

This Dual Water Systems Master Plan recommends a non-potable water distribution system in each of the five service areas. Whether a non-potable water system will be built in any given service area depends as much on institutional considerations as it does on technical merit. In the Central Fairfield and Cordelia service areas, the City of Fairfield would be the likely agency to spearhead implementation of this plan. In the Suisun City service area, the City of Suisun City would be the likely implementing agency. In Suisun Valley and lower Suisun Valley, the Solano Irrigation District would be the likely agency to implement this plan. Given that the implementing agency differs by service area, it is not appropriate to compare non-potable water systems in different service areas; one agency may be willing to spend more than another to implement this plan. No attempt is made to priortize the five service areas. Rather, the options within each service area are compared and a recommended nonpotable water distribution system recommended for each service area.

Evaluation Criteria

Within each service area the alternatives were first ranked based on unit cost. Unit costs were determined by adding the annual operation and maintenance cost to the annualized equivalent capital cost and dividing the sum by the potential annual demand. The unit costs are useful for comparisons between alternatives that serve different potential demands. Table 7-1 presents the results of that ranking based strictly on unit cost. A series of non-cost related criteria were utilized to supplement the cost based ranking. The non-cost related criteria that were considered included the following.

- **System Reliability**

  The reliability of each alternative was assessed based on the system's ability to meet peak hour demands (hydraulic capacity), the risks associated with power failures or outages, and the availability of alternative sources of water to serve the system.

- **Water Quality Considerations**

  Water quality requirements vary for landscape irrigation and agricultural irrigation, but the common primary factor in evaluating water quality for irrigation is the quantity and kind of salt present in the proposed non-potable water supplies. Higher salt content requires a greater level of management to successfully deal with problems related to use of such water. Water quality must also meet federal, state, and local regulatory requirements. Water quality regulatory requirements and soil and water quality are discussed in Section 2 and Section 4, respectively.

TABLE 7-1

RANKING OF NON-POTABLE WATER DISTRIBUTION SYSTEM ALTERNATIVES BASED ON UNIT COST

Ranking	Service Area/Alternative	Unit Cost ($/acre-ft)
	Central Fairfield	
1	7. Alt 1 w/o Tolenas*	$455
2	5. Alt 4 plus Rancho Solano	$512
3	6. Alt 1 plus Rancho Solano	$542
4	1. Beck Avenue Trans. Main	$553
5	2. Woolner Avenue Trans. Main	$554
6	4. Trans. Main to Travis Blvd only	$665
7	3. Alt 1 w/o Lagoon & Paradise Valleys	$921
	Suisun Valley	
1	2. Valley S. of PSC, 50% Blend*	$191
2	4. Valley S. of PSC, 25% Blend	$219
3	1. Entire Valley, 50% Blend	$221
4	3. Entire Valley, 25% Blend	$238
	Lower Suisun Valley	
1	4. Excluding Green Valley, Including White Wing, FSSD Route	$221
2	5. Including Green Valley and White Wing, FSSD Route	$237
3	6. Including Green Valley, Excluding White Wing, FSSD Route*	$302
4	1. Excluding Green Valley, Including White Wing, SID Route	$341
5	2. Including Green Valley and White Wing, SID Route	$392
6	3. Including Green Valley, Excluding White Wing, SID Route	$473
	Cordelia	
1	2. Cordelia plus Green Valley	$1,241
2	1. Cordelia Only*	$1,730
3	1R. Alt. 1 with Reservoir	$1,766
	Suisun City	
1	1. Suisun City plus Tolenas via Hwy 12 Transmission Main*	$487
2	2. Suisun City Only	$933
3	3. Suisun City plus Tolenas via Railroad Ave. Transmission Main	$543

* Denotes Recommended Alternative

- **Environmental Considerations**

  Environmental considerations include the impacts of alternatives on the physical, biological, and human environment. Short-term impacts associated with construction activities include air quality impacts, traffic disturbances, increased noise levels near urban areas, and biological impacts upon vegetation and wildlife. Long-term impacts would be associated with the noise and visual aspects of the facilities and with the decrease in wastewater discharge to the Suisun Marsh.

- **Institutional Considerations**

  To implement the Central Solano Dual Water Systems Master Plan, suitable institutional arrangements must be established. Institutional considerations include serving both Fairfield and Suisun City. Additional institutional considerations are identified in Section 8.

- **User Acceptance Considerations**

  Public acceptance of reclaimed water use has been increasingly positive in the past 5 to 10 years due to implementation of on-going reclamation programs and public education efforts. Public education programs must continue to target a variety of groups including public agency customers, agricultural customers, public facility users, and more. The user acceptance considerations addressed here include public acceptance of several aspects of a reclamation project including application of reclaimed water, water quality for specific users, and pricing policy impacts.

- **Miscellaneous Planning Concerns**

  Miscellaneous planning concerns include the potential impacts to operation of the Fairfield-Suisun WWTP, whether the demand is year-round or seasonal, flexibility of the dual water systems to serve future demands, and evaluation of the potential for cross-connections and misuse of non-potable water.

The following paragraphs discuss the selection of a recommended alternative in each service area. In many cases, cost is the only evaluation criteria for which the alternatives differed. Where the alternatives differed in one of the non-cost related criteria, that is pointed out in the following discussion.

Central Fairfield Service Area

The nature of the alternatives defined for the Central Fairfield Service Area required that a choice first be made between Alternatives 1 and 2. These two alternatives would serve the same area but would utilize different transmission mains in the southern part of the service area. Alternative 1 would utilize all new transmission mains. Alternative 2 would utilize one of the existing sewage force mains between the Fairfield-Suisun WWTP and the Fairfield-Suisun Sewer District Central Pump Station. Alternative 1 would require construction of more new transmission mains but Alternative 2 would require construction of two pump stations - one to serve most of the area and a second one to serve the Solano Business Park, thus capital costs are approximately equal. The transmission main route in Alternative 2 is less direct, making it a longer pipeline with higher head losses. Thus, pumping costs are higher in Alternative 2. If Alternative 2 were implemented, cleaning the sewage force main would be necessary every spring. With Alternative 1, that cleaning is not required. In all other respects the two alternatives are equal. Alternative 1 was selected over Alternative 2 based on the lower operating costs,.

The remaining alternatives considered for the Central Fairfield Service Area are based on the transmission mains defined for Alternative 1. The remaining alternatives are either extensions of that system to serve additional area (Rancho Solano in Alternatives 5 and 6) or reductions in the area served (Alternatives 3, 4, 5 and 7). Alternatives 5 and 6 each include service to the Rancho Solano Golf Course. Serving Rancho Solano from the proposed system in Suisun Valley would be considerably less expensive than serving it from the Central Fairfield system. Thus, neither Alternative 5 nor 6 is recommended, provided Rancho Solano service is possible through Suisun Valley. If the Suisun Valley system is not built, then Alternatives 5 and 6 warrant further consideration.

Alternative 1 would serve the largest area, including Central Fairfield, Paradise and Lagoon Valleys, and Tolenas. Alternative 3 would delete Lagoon Valley and Paradise Valley from the service area. Alternative 7 would delete Tolenas from the Alternative 1 service area. With Alternative 4, the service area would be reduced to central Fairfield south of Travis Boulevard.

Alternative 3 can be rejected based on cost considerations. Its unit cost is substantially more than the unit cost of the other alternatives. The only difference between alternatives 1 and 3 is that service to Paradise Valley and Lagoon Valley is not included in alternative 3. The golf courses in these two valleys (one is built, the other is planned) constitute a significant part of the demand in Alternative 1. The fact that Alternative 3 is not cost effective demonstrates how important the two golf courses are to the cost effectiveness of Alternative 1. The recommended alternative should be reconsidered if for some reason reclaimed water cannot be delivered to the Paradise Valley and Lagoon Valley golf courses.

Alternative 1 includes service to Tolenas. Tolenas could also be served from the Suisun City system. The Suisun City system is not feasible unless it includes service to Tolenas. For non-cost related reasons, it would be beneficial to build reclaimed water systems in Suisun City and Fairfield not just in Fairfield. This plan recommends that Tolenas be served from the Suisun City system.

That leaves Alternatives 4 and 7. Either would be acceptable. Alternative 4 has a higher unit cost, and it would utilize substantially less reclaimed water. This plan recommends Alternative 7, assuming 1) Rancho Solano service will be through Suisun Valley, 2) Lagoon Valley will be served, and 3) Tolenas service will be along with Suisun City.

Suisun Valley Service Area

Two characteristics differ among the alternatives considered for the Suisun Valley:

- Some alternatives serve the entire middle and upper valley and some exclude the area north of the Putah South Canal.
- The peak reclaimed water delivery capacity of the system is equal to 25 percent of the peak demand in some alternatives and 50 percent in others.

The cost analysis shows the following:

- Unit costs would be lower for alternatives that exclude the area north of the Putah South Canal from the service area, but the amount of reclaimed water utilized would be substantially more for alternatives that serve the entire valley.
- Total costs would be markedly less for systems with a reclaimed water capacity equal to 25% of peak demand, but unit costs would be less for systems with a reclaimed water capacity equal to 50% of peak demand.

cost. It costs more to extend the system to Tolenas, but the potential demand in Tolenas is so great that the unit cost is markedly lower if Tolenas is included. The alternatives do not differ significantly with respect to any of the non-cost related criteria. Therefore, including the Tolenas area is recommended.

Alternatives 1 and 3 both serve Tolenas and Suisun City. They utilize different pipeline routes. Much of the pipeline route for Alternative 1 follows Highway 12. Constructing this pipeline when Highway 12 is improved could be expected to reduce construction costs for the pipeline in Highway 12 about 15 percent below the values estimated in this analysis. However, the pipeline route in Alternative 3 has a shorter length of large diameter pipe. The net result is that Alternative 1 would be less expensive than Alternative 1. Alternative 1 is recommended.

Tolenas could also be served by extending the Central Fairfield system. The marginal cost to serve Tolenas is similar, whether it is served from the Suisun City system or the Central Fairfield system. If Tolenas were not included in the Suisun City system, the unit costs would be so high that a reclaimed water system in Suisun City would be considered infeasible. From an institutional point of view, it would be beneficial to have reclaimed water systems in both Suisun City and Fairfield. This Master Plan recommends serving Tolenas from the Suisun City system to improve the feasibility of a Suisun City reclaimed water distribution system.

The Suisun City/Tolenas system may be the least favorable system from a soils point of view. The soils analyses conducted for this study suggest that the soils in Suisun City and Tolenas are marginal for irrigation with reclaimed water. Poorly drained clays make up the bulk of the soils in this area. Any agency delivering reclaimed water to this service area should expect to use at least some raw water for blending or leaching and to apply gypsum occasionally. As with all reclaimed water irrigation, the soils and plants in the irrigated area should be monitored carefully for any sign of salt buildup to unacceptable levels.

RECOMMENDED SYSTEMS

The recommended non-potable water distribution systems are presented in Figures 7-2 through 7-6. Each of the figures presents the recommended system in one of the five service areas. Figure 7-1 is an index map for the five service areas.

The recommended systems include networks of pump stations, pipes, and reservoirs. Sizes for the recommended pipes are presented in Figures 7-2 through 7-6. Sizes for the recommended pump stations and reservoirs are presented in Table 7-2.

Pipe and pump station sizes were determined using the FAAST model to determine the distribution system needed to meet the potential non-potable water demands. The detailed outputs from the FAAST model runs are bound separately as an appendix to this report. The nodes and reference numbers shown on Figures 7-2 through 7-6 refer to reference points used in the model runs.

The area served by each recommended system is also shown in Figures 7-2 through 7-6. These service area boundaries differ somewhat from the geographic sub-area boundaries defined in Section 3 of this report. In some cases, two or more sub-areas have been combined to make up the service area for one distribution system. It is often impractical to distribute non-potable water to an entire sub-area. It takes larger pipes and bigger pumps to serve reclaimed and raw water to higher elevations and areas further from the Fairfield-Suisun WWTP. The service areas selected strike a balance between the increased use of raw water that comes with a larger service area and the associated increased cost of distribution.

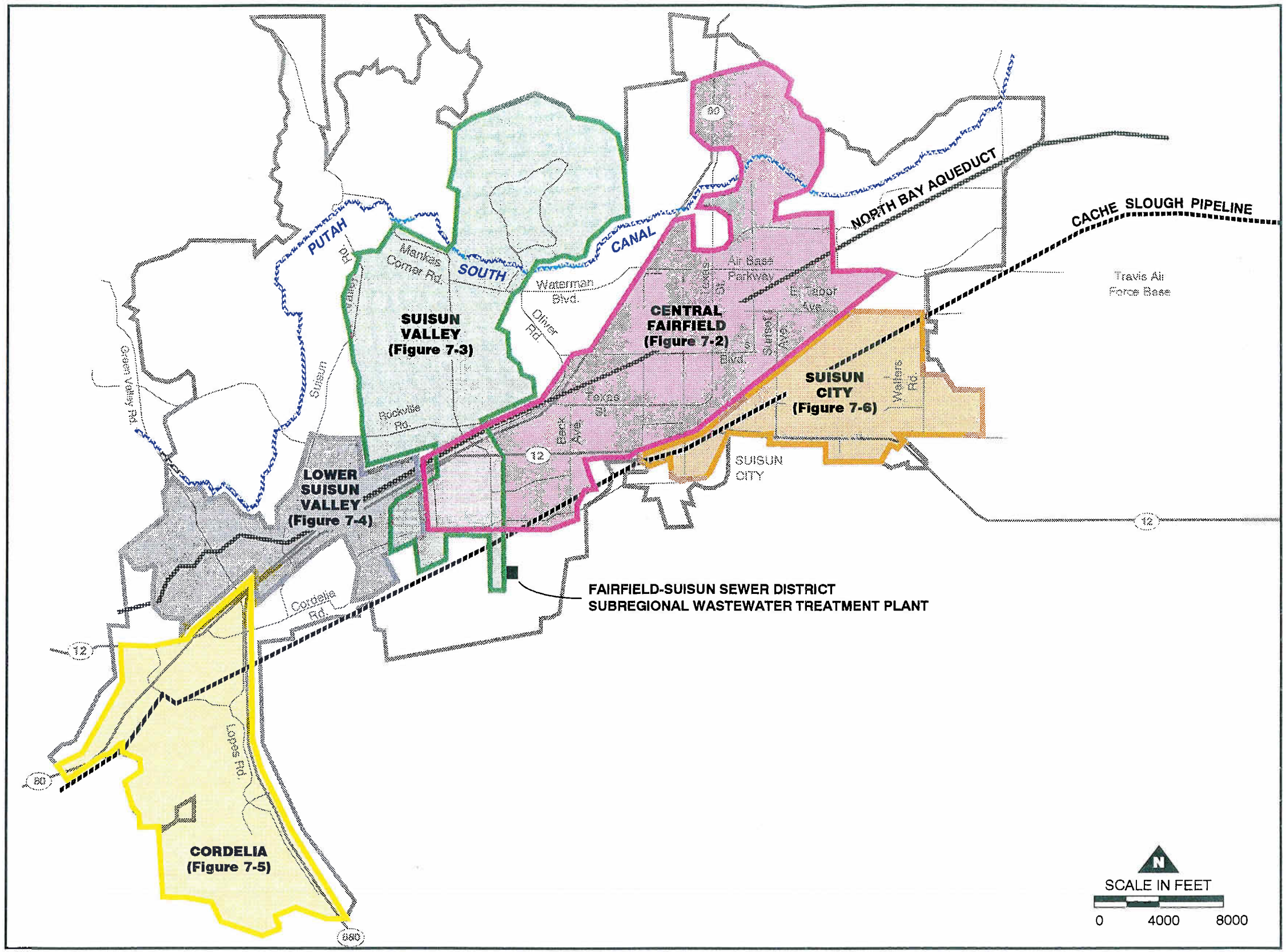
The potential water demands that could be met by the recommended non-potable water systems are listed in Table 7-3. The planning criteria discussion in Section 6 defines each of the measures of water demand.

Table 7-4 presents the estimated costs (capital and operating) for each of the recommended systems. The cost estimates were developed utilizing JMM's experience in Northern California, emphasizing recent construction bids in Solano County and current water system operating costs in Fairfield. These budget-level cost estimates could be expected to be within 10 percent below to 25 percent above the actual cost if the bids were received today. Unit costs for non-potable water distribution are also presented in Table 7-3.

Low cost initial phases of the system to serve Central Fairfield could be constructed by using the existing SID reclaimed water pump station and pipeline and serving reclaimed water at low pressure to only the southern portion of Central Fairfield. Phase 1.1 would involve construction of a transmission main along Courage Drive and Beck Avenue. This transmission main would connect to the existing SID reclaimed water pipeline in Chadbourne Road on one end and to the existing Linear Park reclaimed water pipeline on the other end. In phase 1.2, laterals would be added to the transmission main built in Phase 1.1.

The existing SID reclaimed water pump station does not have enough flow capacity to supply all the potential demand in the service area. The pump station could meet initial demands. The pump station need not be expanded or replaced until some time in the future when the industrial parks are more developed and demands have grown to exceed the existing pump station capacity.

The suggested initial plans are drawn in Figure 7-7. The system could later be expanded to alternative 5,6 or 7 depending on the arrangements worked out for Rancho Solano, Paradise Valley, and Lagoon Valley.



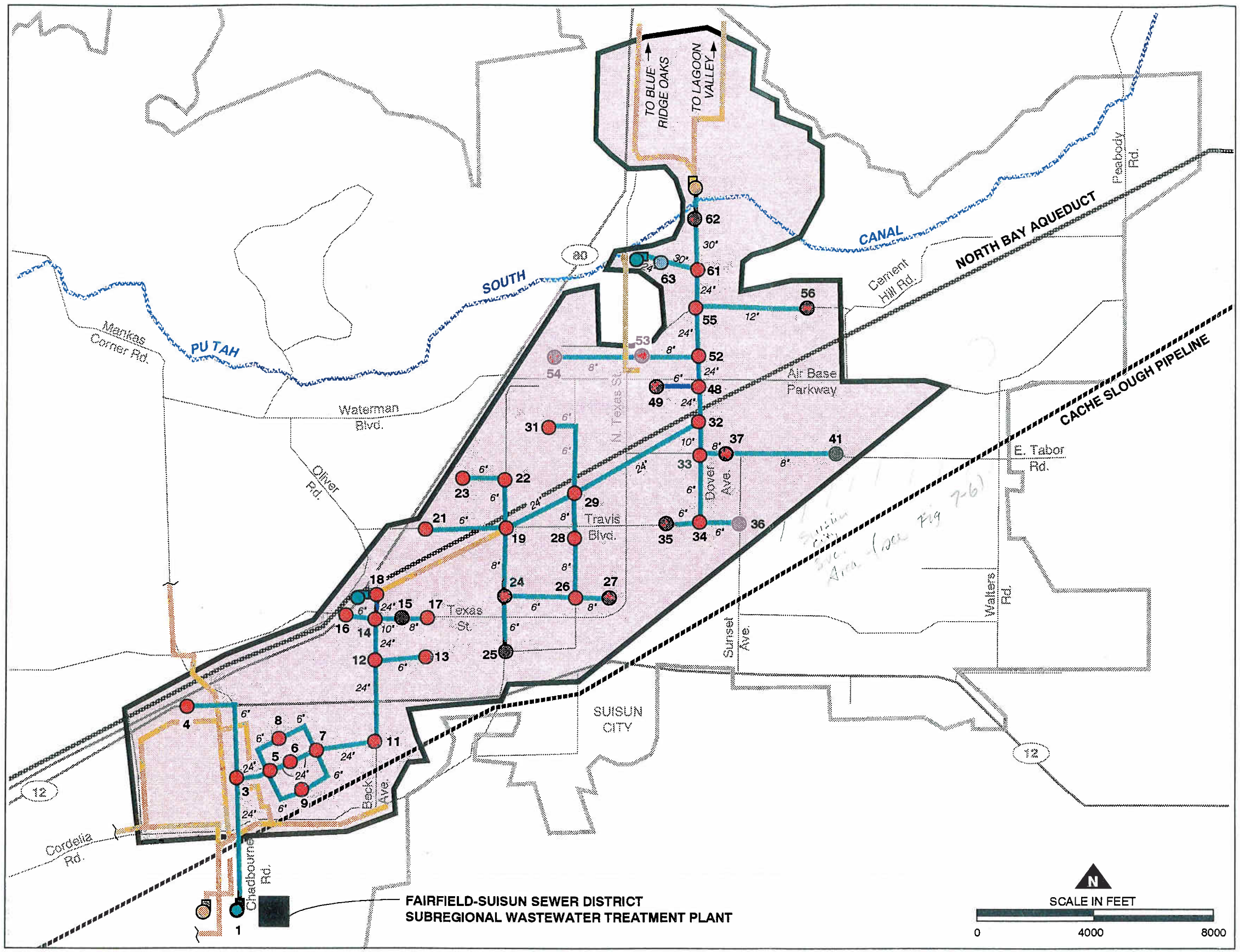
LEGEND

- STUDY AREA
- CENTRAL FAIRFIELD SERVICE AREA
- SUISUN VALLEY SERVICE AREA
- LOWER SUISUN VALLEY SERVICE AREA
- CORDELIA SERVICE AREA
- SUISUN CITY SERVICE AREA

CITY OF FAIRFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

INDEX MAP FOR RECOMMENDED NON-POTABLE WATER FACILITIES MAPS

FIGURE 7-1



LEGEND

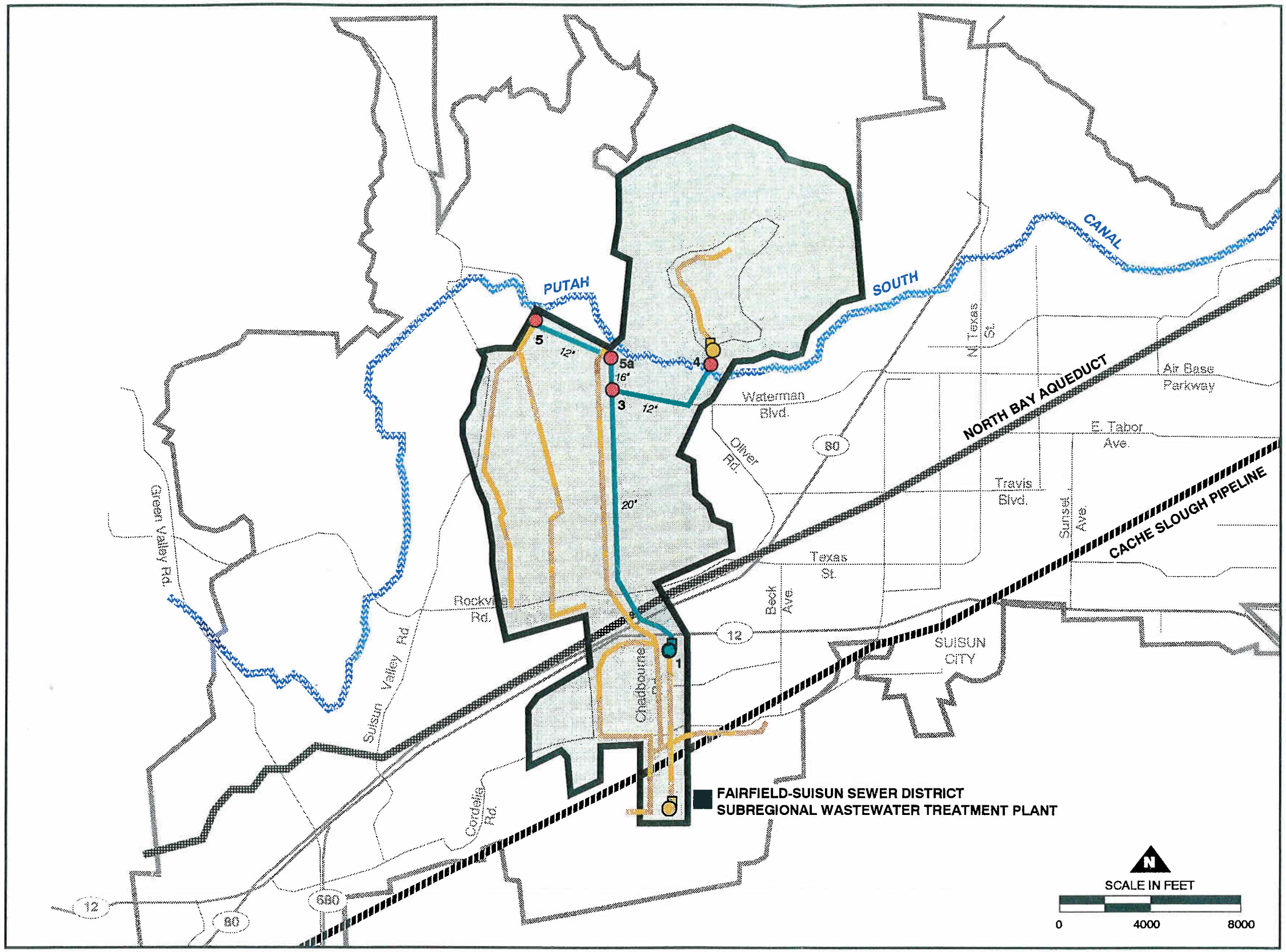
- STUDY AREA
- SERVICE AREA BOUNDARY
- EXISTING PIPE
- EXISTNG PUMP STATION
- 16" RECOMMENDED PIPE WITH SIZE
- 1 RECOMMENDED PUMP STATION AND REFERENCE NUMBER
- 63 RESERVOIR AND REFERENCE NUMBER
- 62 NODE AND REFERENCE NUMBER

CITY OF FAIRFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

RECOMMENDED NON-POTABLE WATER FACILITIES FOR THE CENTRAL FAIRFIELD AREA

FIGURE 7-2

JMM



LEGEND

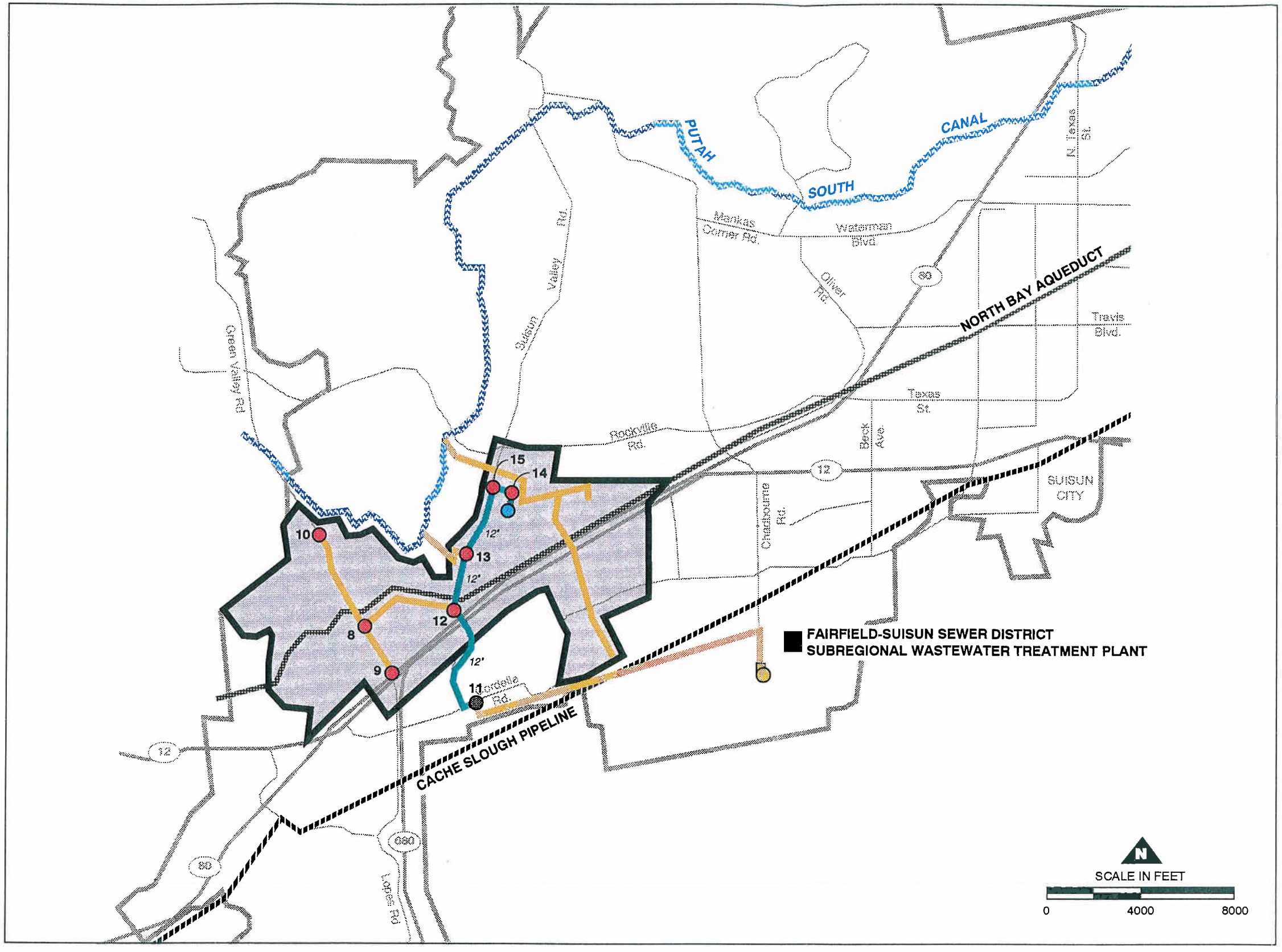
- STUDY AREA
- SERVICE AREA BOUNDARY
- EXISTING PIPE
- EXISTING PUMP STATION
- 16" RECOMMENDED PIPE WITH SIZE
- 1 RECOMMENDED PUMP STATION AND REFERENCE NUMBER
- 62 NODE AND REFERENCE NUMBER

CITY OF FAIRFIELD
CENTRAL SOLANO WATER SYSTEMS MASTER PLAN

RECOMMENDED NON-POTABLE WATER FACILITIES FOR SUISUN VALLEY

FIGURE 7-3

JMM



LEGEND

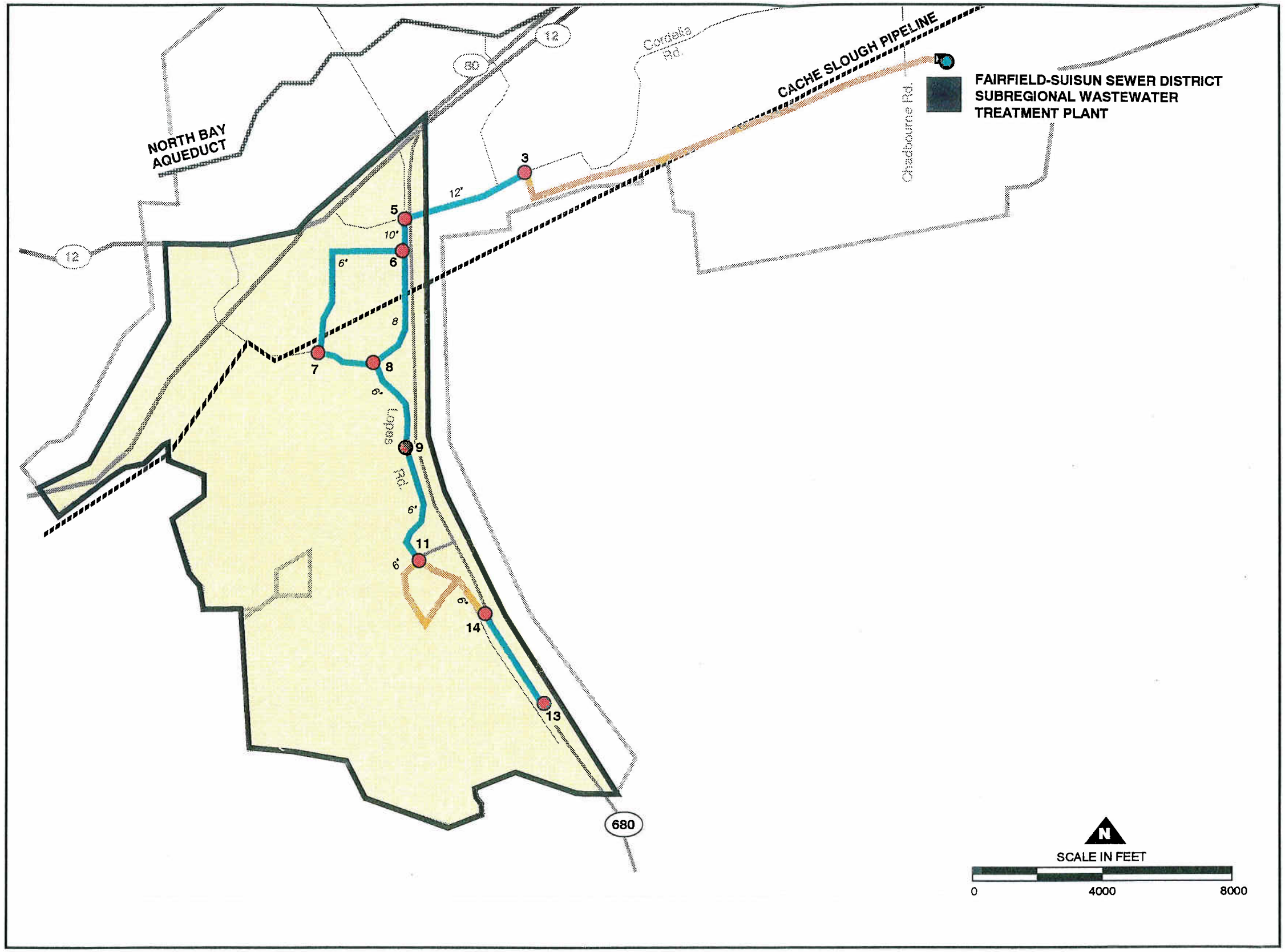
- STUDY AREA
- SERVICE AREA BOUNDARY
- EXISTING PIPE
- 16" RECOMMENDED PIPE WITH SIZE
- RESERVOIR
- 14 NODE AND REFERENCE NUMBER
- EXISTING PUMP STATION

CITY OF FAIRFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

RECOMMENDED NON-POTABLE WATER FACILITIES FOR LOWER SUISUN VALLEY

FIGURE 7-4

JMM



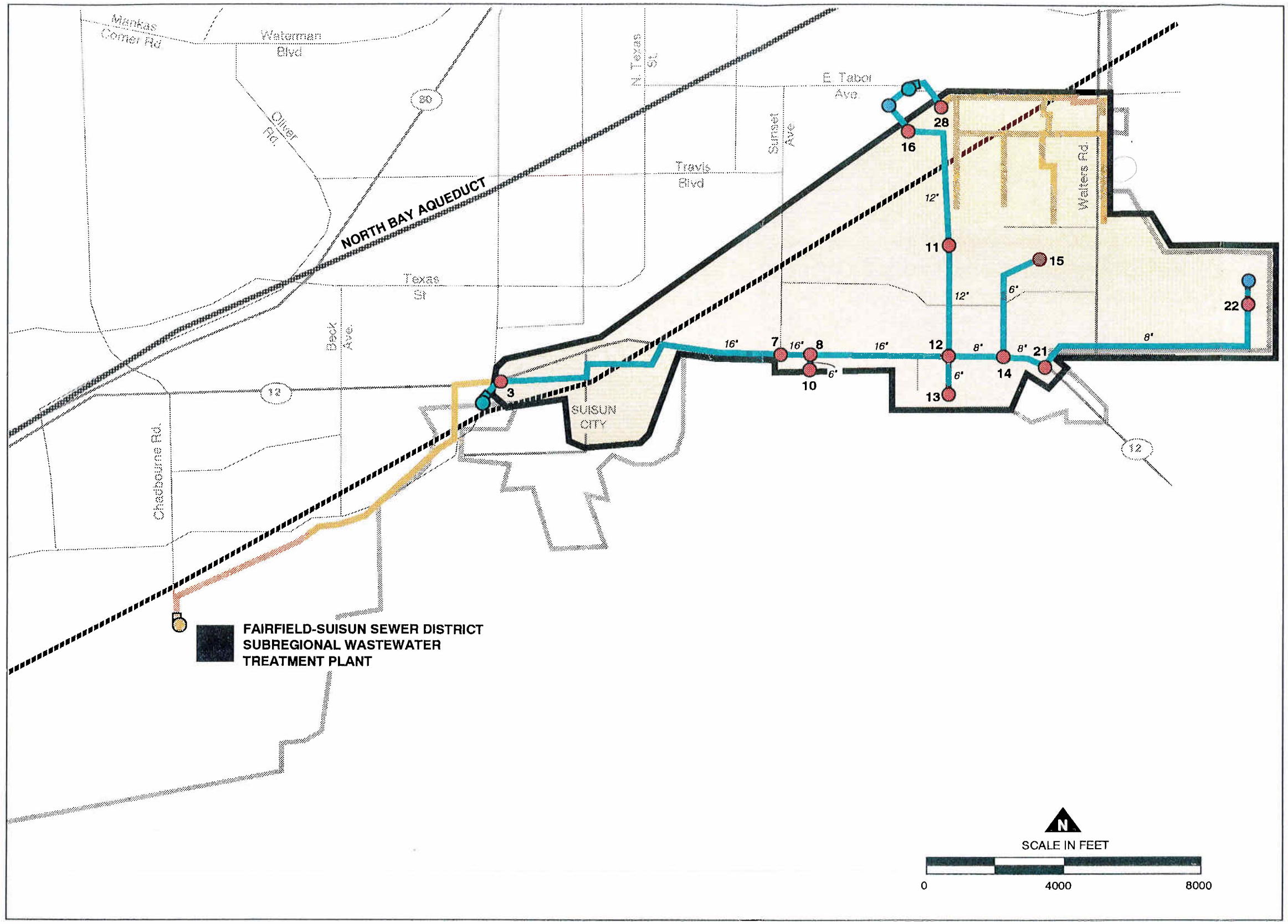
LEGEND

- STUDY AREA
- SERVICE AREA BOUNDARY
- EXISTING PIPE
- 16" RECOMMENDED PIPE WITH SIZE
- RECOMMENDED PUMP STATION
- 62 NODE AND REFERENCE NUMBER

CITY OF FAIRFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

RECOMMENDED NON-POTABLE WATER FACILITIES FOR THE CORDELIA SERVICE AREA

FIGURE 7-5



LEGEND

- STUDY AREA
- SERVICE AREA BOUNDARY
- EXISTING PIPE
- 16" RECOMMENDED PIPE WITH SIZE
- RECOMMENDED PUMP STATION
- RESERVOIR
- 20 NODE AND REFERENCE NUMBER
- EXISTING PUMP STATION

CITY OF FAIRFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

RECOMMENDED NON-POTABLE WATER FACILITIES FOR THE SUISUN CITY SERVICE AREA

FIGURE 7-6

TABLE 7-2

SUMMARY OF RECOMMENDED NON-POTABLE WATER FACILITIES

Facility	Service Areas				
	Central Fairfield	Suisun Valley	Lower Suisun Valley	Cordelia	Suisun City
Pipes					
Maximum Size (in)	30	20	12	12	16
Total Length (ft)	93,600	22,900	13,240	32,700	36,400
Pump Station					
Horsepower	600	existing	existing	200	existing
Flow (gpm)	5,000	4,800	1,150	1,150	2,640
Booster Pump Stations					
Horsepower	-	400	-	-	105
Flow (gpm)	-	4,720	-	-	2,120
Raw Water Pump Station					
Horsepower	600	-	-	-	-
Flow (gpm)	5,000	-	-	-	-
Reservoir					
Size (million gals)	3.00	-	0.67	-	0.69

TABLE 7-3

POTENTIAL NON-POTABLE WATER DEMANDS SERVED BY THE RECOMMENDED DISTRIBUTION SYSTEMS

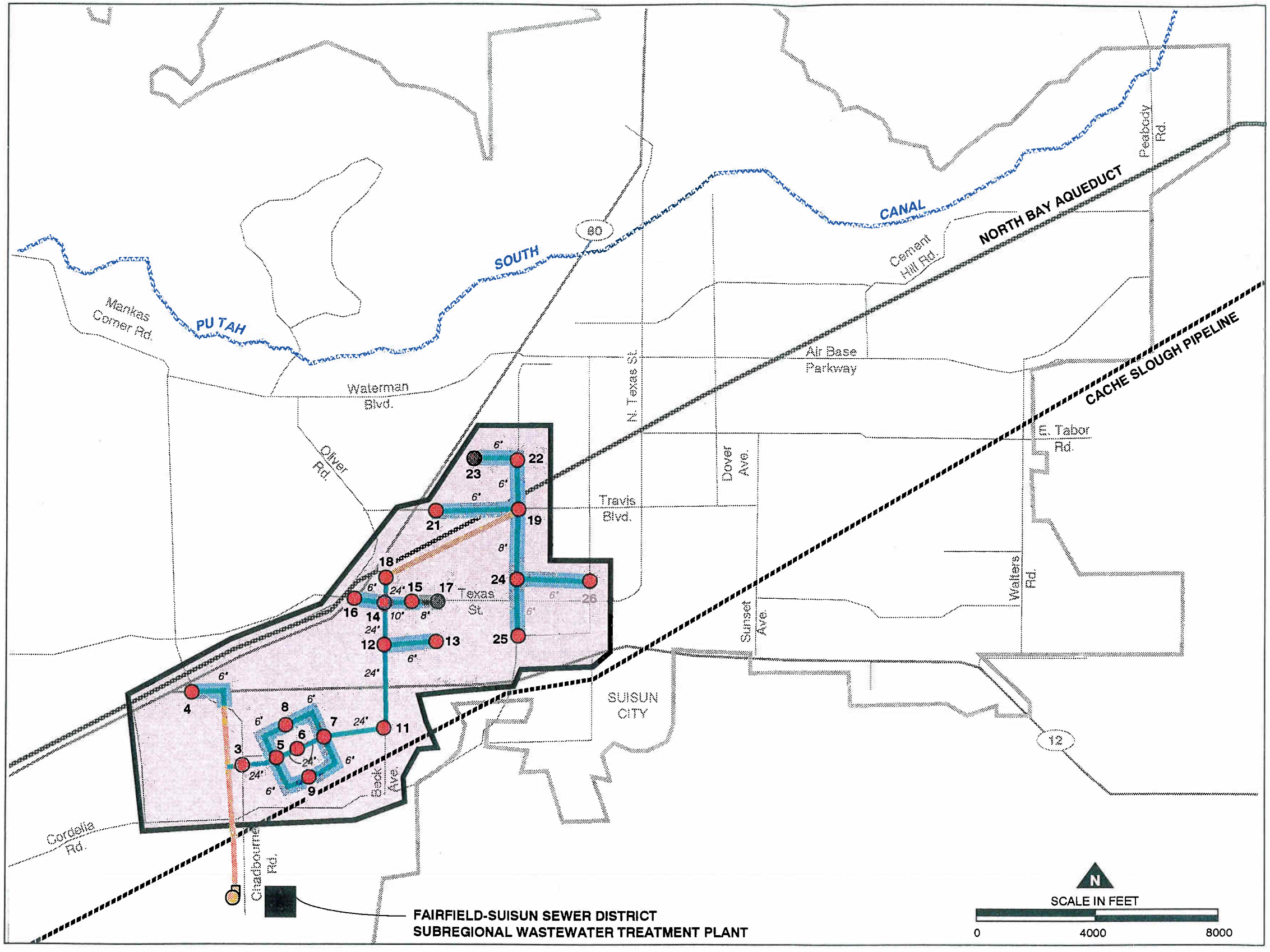
	Service Areas				
Demand Measure	**Central Fairfield**	**Suisun Valley**	**Lower Suisun Valley**	**Cordelia**	**Suisun City**
Average Annual Demand (acre-ft/yr)	4,030	2,910*	630	182	1,040
Maximum Day Demand (mgd)	7.20	8.69	1.65	0.55	2.94
Peak Hour Demand (gpm)	14,400	4,720	2,540	1,150	4,280

* This figure includes only 50% of the agricultural demand to allow for blending of reclaimed water with raw water from the existing source, PSC.

TABLE 7-4

SUMMARY OF ESTIMATED COSTS FOR THE RECOMMENDED NON-POTABLE WATER FACILITIES

Estimated Costs	Service Areas				
	Central Fairfield	Suisun Valley	Lower Suisun Valley	Cordelia	Suisun City
Capital Cost	$20,700,000	$5,480,000	$2,270,000	$3,460,000	$5,660,000
Equivalent Annual Capital Cost	$1,520,000	$403,000	$167,000	$255,000	$417,000
Annual Operations and Maintenance Cost	$310,000	$151,000	$23,700	$60,000	$89,400
Total Equivalent Annual Cost	$1,840,000	$555,000	$190,000	$315,000	$506,000
Average Annual Demand (acre-ft/year)	4,030	2,910	630	182	1,040
Unit Cost ($/acre-ft)	$455	$191	$302	$1,730	$487



LEGEND

- STUDY AREA
- SERVICE AREA BOUNDARY
- EXISTING PIPE
- EXISTNG PUMP STATION
- 16" RECOMMENDED PIPE WITH SIZE PHASE 1.1
- 62 NODE AND REFERENCE NUMBER
- ADDITIONAL PIPES FOR PHASE 1.2

CITY OF FAIRFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

RECOMMENDED INITIAL NON-POTABLE WATER FACILITIES FOR THE CENTRAL FAIRFIELD AREA

FIGURE 7-7

JMM

Section 8

SECTION 8

IMPLEMENTATION

Making the institutional and financial decisions necessary to implement the Dual Water Systems Master Plan is a completed task. Many of the details of the implementation process can only come from discussion and negotiation amongst all the parties involved, including the public, the City of Fairfield, the City of Suisun City, the Fairfield-Suisun Sewer District, and the Solano Irrigation District. This section of the Master Plan seeks only to describe the issues that must be resolved and the options available for implementation of dual water systems. Subjects addressed include possible roles each agency could play, design standards for the new systems, funding possibilities, public information procedures, and the steps needed for implementation.

INSTITUTIONAL CONSIDERATIONS

Distribution of non-potable water is a regional issue. No agency can "go it alone". The final institutional arrangements for distribution of non-potable water must include cooperative agreements among several agencies.

Several different agencies are already involved in wholesale supply of non-potable water. The FSSD produces all the reclaimed water in the region. SID, under contract to SCWA, handles the wholesale distribution of Solano Project water (the Putah South Canal). The City of Vallejo controls the Cache Slough pipeline. The California Department of Water Resources owns and operates the North Bay Aqueduct. Each of these agencies must play a role in implementing dual water systems.

The primary water retailers in the area include the City of Fairfield, SID, the Suisun-Solano Joint Powers Authority (JPA), and the City of Vallejo. The City of Fairfield treats and distributes potable water within the Fairfield city limits. The Suisun-Solano JPA treats and distributes potable water within Suisun City. The City of Vallejo distributes potable water in portions of Suisun Valley and Old Cordelia. SID distributes raw water for irrigation and industrial uses to farmers, large businesses, and institutions throughout the area and treated water in the Tolenas area. Given this complex mix of water wholesalers and retailers, it is unlikely any one agency can take over distribution of non-potable water.

Interagency Agreements

It is likely that dual water systems will be implemented through cooperative agreements amongst two or more of the water suppliers and distributors in the area. These agreements need to address the following subjects.

- **Extent of Responsibility**. The agreements must define what portion of the distribution system is owned and/or operated by which agency. For example, FSSD might treat and pump reclaimed water while the City of Fairfield, the Suisun/Solano JPA, and SID own and operate separate systems of pipes.

- **Construction Responsibility**. Responsibility for system construction may rest with the agency responsible for operation, or two agencies may split those responsibilities. A portion of the system may be constructed by one agency with other agencies sharing in funding that construction.

- **Cost of Reclaimed and Raw Water.** The agreements must set the current price and also define how that price can be adjusted in the future.

- **Water Quantity.** The supplier must know how much the distributor will take during a given period. Conversely, the distributor must know how much water is available and when it will be available. This includes assigning priority for each distributor if reclaimed water is to be supplied to more than one agency.

- **Water Quality.** The minimum acceptable water quality must be defined in the agreements.

- **Reliability Requirements.** The agreements should address what each agency must do to help prevent failure of the system and what the consequences are for each agency when a failure occurs.

- **Water Sources.** The agreements must define what the primary and backup water sources are and who determines which of these sources will be utilized when.

Customer Agreements

There must be similar agreements between the non-potable water distributor and the end use customer. These agreements must cover the following issues:

- **Cost of Reclaimed and Raw Water**

- **Water Quantity.** The agreement should define the maximum and minimum amount to be purchased. This could be in the form of a connection size.

- **Water Quality**

- **Schedule of Deliveries.**

- **Reliability of Deliveries.** The agreement should address the likelihood of delivery interruptions and limit the distributor's liability for damages due to temporary service interruptions.

- **Water Sources.** The agreement should define the primary and backup water sources.

- **On-Site Modifications Required** Modifications the user must make to utilize non-potable water should be addressed in the agreement.

- **Regulatory Requirements.** The agreement must point out that use of non-potable water in violation of the agreement may pose health risks and violate state regulations. The agreement should contain disclaimers limiting the liability of the distributor for misuse of non-potable water by the customer.

Involvement of Vacaville and Vallejo

Both the City of Vacaville and the City of Vallejo would be affected by implementation of the dual water systems recommended in this Master Plan. Agreements may be necessary with each City before the Master Plan can be fully implemented.

The recommended non-potable water system for the Central Fairfield Service Area includes service to Lagoon Valley. Lagoon Valley is inside the Vacaville sphere of influence and much of it is incorporated into the City of Vacaville. SID currently serves raw water to Lagoon Valley. Both the City of Vacaville and SID should be parties to any agreement to serve reclaimed water to Lagoon Valley.

The Cache Slough pipeline is an important part of the existing raw water system in the area and the future dual water systems envisioned in this Master Plan. The Cache Slough pipeline belongs to the City of Vallejo. Permission would be needed from the City of Vallejo before that pipeline could be used to provide raw water to the Central Solano area.

Involvement of the Department of Water Resources

The NBA is the second most important raw water source in the area. (The Solano Project is the most important raw water source.) The Dual Water Systems Master Plan envisions expansion of the current role of the NBA as a raw water source in the area. The NBA is envisioned as a raw water source to the Central Fairfield and Cordelia Service Area. Any change in the current use of the NBA will require the permission of the State Department of Water Resources.

Water Rights

Water rights in the area are well defined. Depending on which agencies implement the various aspects of the Dual Water Systems Master Plan, there may be some need to exchange water amongst the agencies involved.

Rights to the area's reclaimed water present a more complicated situation. In 1974, the City of Fairfield negotiated an arrangement with SID related to reclaimed water. In the arrangement, SID acquired the right to use up to 12 million gallons of reclaimed water each day. The arrangement gave the City of Fairfield the right to purchase additional Solano Project water each year. SID has utilized a portion of the reclaimed water they are entitled to for irrigation of the turf farm near the Fairfield-Suisun WWTP. SID has never used more than half of the reclaimed water to which they are entitled. SID lacks the funds to construct the distribution system needed to expand their use of reclaimed water.

If SID were to expand its use of reclaimed water using its own funds, that use would clearly come out of the 12 mgd reclaimed water right already given SID by Fairfield. Questions arise if the City of Fairfield or Suisun City were to start using reclaimed water or to help SID fund expanded reclaimed water use. Would SID sell any of the reclaimed water to Fairfield or Suisun City? If Fairfield or Suisun City were to use reclaimed water, would their rights be secondary to SID's? If there were inadequate supplies of reclaimed water to meet demand, would SID's demand be met first? If Fairfield or Suisun City were to help fund a reclaimed water system to serve Suisun Valley or Lower Suisun Valley or Tolenas (areas now served by SID), would Fairfield or Suisun City be permitted to purchase all or some of the water offset by that reclaimed water? These questions can only be resolved by negotiations amongst the agencies involved.

Permits

There is no specific permit for establishing a reclaimed water system. The DHS and the RWQCB have rules related to the treatment and use of reclaimed water as described in Section 2 of this Master Plan. Their approval should be sought for any plans for expanded reclaimed water use, but neither agency issues a permit per se.

Permission would be required from several other agencies for construction of the recommended non-potable water distribution systems. Easements must be acquired from each of the Cities, Solano County, the Southern Pacific Railroad Company, CalTrans, the State Department of Water Resources, and SID.

DESIGN STANDARDS

In February of 1989, Bissell & Karn submitted the final draft of Standard Specifications and Details for Nonpotable Water Service Facilities (Standards and Details) for incorporation by addendum to the City Standards. The required or recommended safety precautions identified in the document are summarized below. Some of these may need to be revised when DHS completes the regulation revisions now underway.

- The non-potable water system must be separate and independent of any potable water system. Approved backflow prevention devices are required on remaining potable supplies to premises converted to a non-potable system, and may be required on non-potable systems serving commercial and industrial sites, as determined by the City Engineer.

- Non-potable water mains should be located on the southerly or westerly side of the street, preferably 10 feet, and no less than 3 feet, from the sanitary sewer line or midway between the sanitary sewer and the storm drain where less than 10 feet is available. The non-potable water main should be at least 10 feet from a potable water line unless otherwise approved by the City. When located vertically, the higher quality water line should be located at the top and proceed downward (potable water, non-potable water, sewer). Non-potable water lines should not be installed in the same trench as potable water lines. A minimum 10-foot horizontal and 1-foot vertical clearance must be maintained between non-potable and potable water lines. Whenever a crossing of a non-potable water main and a potable water main or a sewer main must occur in which the non-potable water main passes within 3 feet of the other mains, special construction is required.

- All non-potable water mains and related facilities, including valve boxes, controllers, risers, valves, strainers and filters must be identified with warning signs, labels, identification tape or stenciled pipe.

- Where non-potable water is used for recreational or decorative impoundments, warning signs shall be installed to notify that the impoundment is unsafe for body contact.

- Hose bibbs and fire hydrants are prohibited on non-potable water systems.

- Non-potable water uses shall be limited to approved uses and irrigation of designated areas. Irrigation facilities should be designed to limit or prevent overspray and runoff. Drinking fountains and picnic tables in areas irrigated with non-potable water should be protected from windblown spray in a manner approved by the City Engineer.

- Irrigation systems shall be designed and operated during times when public exposure is at a minimum. A maximum period must be allowed for irrigated areas to dry out before public use.

FINANCIAL CONSIDERATIONS

Funding has often been identified as a significant barrier to developing reclaimed water projects. As the financial, social and environmental costs of developing new fresh water supplies increase, however, the feasibility of reclamation continues to improve.

Funding requirements are generally divided into three categories: construction costs, operations and maintenance costs, and debt retirement costs. To estimate the funding need it is necessary to make assumptions as to what distribution systems are built and operated. An approach that maximizes the use of reclaimed water is to build non-potable water systems whose total average irrigation demand is equal to the amount of reclaimed water available. Raw water can then be used to supplement reclaimed water to meet peak irrigation demands. If the recommended systems were built in all four service areas with the lowest unit costs, the total maximum day demand for reclaimed water would closely match the amount that has been projected to be available. Improvements at the Fairfield-Suisun WWTP beyond those presently planned would be required to allow reclamation of this much water for unrestricted use. The recommended non-potable water distribution systems in the four service areas would cost a total of $34,100,000 to construct. Further assuming that construction is spread over a 13 year period and paid for on a pay-as-you-go basis, the annual need for construction funds would be $2,630,000, ignoring inflation. Annual operation and maintenance costs would be $575,000.

The most likely sources of funds are local. These include increased potable water rates, increased sewer fees, and funds from the sale of non-potable water. Water sales cannot be the only source of funds. Use of reclaimed water is attractive when compared to the marginal cost of obtaining new sources of water, but not when compared to the current average cost of water. For an individual customer, the cheapest water is usually water from the closest existing distribution system. In most cases, that existing distribution system is a potable water system. New reclaimed and raw water systems can be built only if they are subsidized. The most likely sources for a subsidy are potable water rates, sewer fees, and water and sewer connection fees.

There may be some funds available from the federal government. The federal Economic Development Administration (EDA) has expressed an interest in funding construction of reclaimed water projects. The primary requirement for EDA funding is the applicant must show that the funded project makes it possible for the industry to be developed.

Grants from the State of California are also possible. During this project the state legislature considered a bill that would have made grants available for emergency projects related to water conservation and reclamation. This bill was a response to the current drought. The bill did not become law, but its consideration highlighted the interest at the state level in funding of reclaimed water projects. There is always a possibility that similar legislation providing funds for reclaimed water projects could pass at any time.

If there is interest in building the reclaimed water system quickly and then paying for that construction over time, debt financing could be used. The interest rate and debt financing period would depend upon the type of financing. The potential financing alternatives could include tax-free bonds, taxable bonds, or certificates of participation. Debt financing usually increases the overall project costs, but it does get the projects constructed more quickly than the alternative, pay-as-you-go funding.

The State Water Resources Control Board Clean Water and Conservation Bond Act provides low-interest loans for up to $5 million. The interest rate of the loans is 50 percent of the current interest rate at which the state borrows monies, making it very attractive. The loan will require repayment within a 20-year period. The loan funds are dispersed on a "first come-first served" basis. The loan funds are extremely limited and may only fund a portion of the project.

PUBLIC INFORMATION PROGRAM

Successful implementation of dual water systems will require the support of the public. An ongoing public information program can achieve that support. The following are some of the elements that could be included in such a program.

- Develop a "speaker's bureau".
- Prepare a series of short (250 word) articles on water reclamation to be published in local newspapers and special-interest group newsletters.
- Appear on "Fairfield Living" television show.
- Make Public Service Announcements.
- Direct mail to opinion leaders.
- Continue school education programs.
- Develop customer and agency employee education programs which validate the necessity of water reclamation and reuse by stressing the following:
  - need for augmenting water resources
  - economic and environmental benefits of reclamation
  - public health and safety.
- Develop and maintain a demonstration garden.

INITIAL PHASING PLAN

As already noted, institutional considerations will play a major part in determining what non-potable water systems will be built and when. It is not possible to predict what arrangement will eventually be worked out among the agencies involved and how quickly the agencies will want to proceed with construction of the recommended systems. The initial phasing plan presented in Table 8-1 is based on the following assumptions.

- Non-potable water distribution systems will be constructed so that by the year 1998 the amount of reclaimed water available will approximately match the maximum day demand of the areas served.
- Approximately the same amount of system in terms of dollar value will be constructed each year.
- Systems will be built in Fairfield and Suisun City to avoid the appearance of special treatment for one city.
- Service will not be provided to Suisun Valley initially, in part due to the farmers' concerns about water quality.

TABLE 8-1

POSSIBLE PHASING PLAN

Year	Project
1992	Program Adoption
1993	Environmental Documents and Predesign Work
1994	Fairfield Phase 1.1
1995	Suisun City (approximately half of project)
1996	Suisun City (remainer of project)
1997	Central Fairfield Phase 1.2
1998	Lower Suisun Valley

IMPLEMENTATION STEPS

Based on the information presented in this report and the experience gained from similar projects, a series of implementation steps is suggested.

- **Adopt City Policies.** Any development of a commercial, recreational, or public facility in an area where a non-potable water system is planned must install a separate water system for irrigation at no cost to the each of the cities.
- **Develop a Financial Plan.** Include rates and charges, connection fees, sources of construction funds, and debt financing.
- **Develop Incentives to Attract Potential Users.** Fairfield already had adopted lower interim water rates for irrigation who agree to use reclaimed water when available.
- **Negotiate with Potential Users.** Meet with potential users. Facilities which would use reclaimed water need to be visited to determine applicability of using reclaimed water and need for re-plumbing.
- **Receive Letters of Commitment from Users.** These letters should recognize the financial commitment to the project.
- **Settle Contractual Issues Amongst All Agencies Involved.** Ensure a firm supply of reclaimed water.
- **Obtain Approval by Involved Agencies.** Prior to detailed negotiations and facilities design, the directors of each agency should formally approve of the concept.
- **Obtain Conceptual Approval by Regulatory Agencies.** Conceptual approval should be obtained from DHS and the RWQCB prior to final negotiations and facilities design.
- **Refine and Complete a Predesign and Implementation Schedule.**

- **Initiate Design and Obtain Conceptual Approval from All Permitting Agencies.** Following identification of the reclaimed water users, conveyance routes, and required additional treatment facilities, the design can be initiated. During the preliminary design, negotiations with permitting agencies and owners of easements should be initiated. Following approval of the design, final permits will be obtained.

- **Develop an Irrigation Management Plan.**

- **Finalize Sources of Funding.** The method of financing should be finalized prior to obtaining final agreements from the users.

- **Negotiate Final Agreements.** Final agreements between the retailer and the users should be completed prior to commitment of construction funds.

- **Initiate Construction.**

- **Obtain Final Operating Approval.** Prior to the end of construction, final DHS approvals should be obtained.

Appendix A

APPENDIX A

DATA REVIEW

APPENDIX A

DATA REVIEW

Land use information, historical water usage data, water duties, water quality data, raw water supply information, and information regarding existing and planned non-potable water distribution systems were collected and reviewed. A summary of the information gathered is presented below.

LAND USE

Land use information was obtained from the City of Fairfield General Plan Land Use Diagram and Policy Summary, 1988-2000. Within the planning area boundary, the majority of land is used for agricultural purposes. Low density housing comprises a large portion of the land within the urban limit line. Industrial land use is concentrated in a few areas within the urban limit line: approximately 1,200 acres primarily north-northeast of the Fairfield-Suisun WWTP; another approximate 1,900 acres west-northwest of Travis Air Force Base; and about 600 acres located in the far western area of the urban limit. Refer to the above-referenced document for more detailed information.

The land use information discussed above was being revised and updated at the time this information was compiled. Therefore, based on discussions with City staff indicating that the changes being discussed are expected to have minimal effect on this project, the information presented in the 1988-2000 General Plan was utilized for this study.

WATER USAGE

Several documents were reviewed for information on both historical and projected water usage, including:

- Memorandum to Eve Somjen from Rick Wood re: Vision 2020 Estimated Water Needs, July 13, 1990;
- Industrial water usage records, City of Fairfield;
- Suisun commercial sewer billing, FSSD;
- Solano County Water Requirement Projections from 1990 to Ultimate Development, Solano County Water Policy Advisory Committee, September, 1987 and August, 1992; and
- City of Fairfield, Solano County, California, Water Reclamation Study, JMM, September, 1987.

The information contained in each of these documents is discussed below. Section 3 of this report presents estimated water usage in more detail.

Memorandum to Eve Somjen from Rick Wood re: Vision 2020 Estimated Water Needs

Assuming water per housing unit of 0.60 acre-feet/year (acre-ft/yr) (which includes irrigated open space such as parks and golf courses), water use per job of 0.13 acre-ft/yr (which does not include allowance for water intensive industries), and additional water use for water intensive industries of 10,000 acre-ft/yr, the Vision 2020 General Plan Water Needs were estimated as shown in Table A-2. As stated in the memorandum, 1989 water consumption by

the City was 15,878 acre-feet, a 3.2 percent decrease from 1988 water consumption, and a 6.3 percent decrease from 1988 water consumption excluding Anheuser-Busch. While water consumption has historically varied annually, City water consumption growth has averaged 3.4 percent since 1978.

Industrial Water Usage Records, City of Fairfield

City staff provided JMM with copies of water consumption records dated January, 1989 through January, 1991 for several industrial water customers. These data include bimonthly water consumption data in units of 100 cubic feet (cf) and the associated service charge. Water usage is discussed in greater detail in Section 3.

Suisun Commercial Sewer Billing, FSSD

FSSD provided JMM with an analysis of Suisun Commercial Sewer Billing dated February 28, 1991. These data include bimonthly water consumption data in units of 100 cf and the associated sewer service charge. Water usage is discussed in greater detail in Section 3.

Solano County Water Requirement Projections from 1990 to Ultimate Development, Solano County Water Policy Advisory Committee, September, 1987 and August, 1992

The Solano County Water Policy Advisory Committee was formed in 1985 to consider the future water needs of Solano County. The results of this study as presented in the report are summarized in Table A-3. In summary, the committee identified significant water supply deficiencies, ranging from an approximate 16,000 acre-ft/yr deficiency in 2,000 to an ultimate deficiency of approximately 77,000 acre-ft/yr.

City of Fairfield, Solano County, California, Water Reclamation Study, JMM, September, 1987

Potential reclaimed water demands were developed for the central Fairfield study area as discussed above. A summary of potential reclaimed water demands as estimated by JMM in 1987 is presented in Table A-1. Figure A-1 shows the system envisioned to supply those demands.

WATER DUTIES

A unit water use duty of 2.5 acre-ft/yr was used in JMM's 1987 study to estimate potential average annual reclaimed water demands. A more detailed discussion of peaking factors and potential reclaimed water use is given in Section 3 of this report.

WATER QUALITY

Water quality data were collected for the PSC, Cache Slough, NBA, SID, groundwater, and the Fairfield-Suisun WWTP. A summary of collected data is given in Table A-8, showing parameters pertinent to this study. More detailed analyses of the water quality data is presented in Section 5 of this report.

WATER SUPPLY

Potential water supply sources were identified, and information regarding availability and utilization of water supply was collected from staff of several of the agencies mentioned above, from the memorandum to Eve Somjen from Rick Wood re: Vision 2020 Estimated Water Needs, and from Solano Irrigation District, Groundwater Resources, Summers Engineering,

TABLE A-1
1987 WATER RECLAMATION STUDY
SUMMARY
POTENTIAL RECLAIMED WATER DEMANDS[a] - PHASES I, II, III

User Group	Pacific Bell	Phase I[b]		Phase II		Phase III	
		w/o Pac Bell	w/Pac Bell	w/o Pac Bell	w/Pac Bell	w/o Pac Bell	w/Pac Bell
Schools		353	353				
Parks/Public Facil.		846	846				
Industrial/Comm.	252	160	412	610	610		
Residential						2360	2360
Total	252	1359	1611	610	610	2360	2360
Cum. Total Avg. Annual Demand (AAD)	252	1359	1611	1969	2221	4329	4581
Average Irrigation Day Demand (AID)							
acre-ft/day	0.7	6.5	7.2	9.4	10.1	20.6	21.3
mgd	0.23	2.1	2.3	3.1	3.3	6.7	6.9
gpm	160	1460	1620	2120	2280	4660	4820
Max. Day Demand (MDD)							
acre-ft/day	0.8	13.0	13.8	18.8	19.6	41.2	42.0
mgd	0.26	4.2	4.5	6.2	6.5	13.4	13.7
gpm	180	2920	3100	4240	4420	9320	9500
Peak 8 hr. Demand (PHD)							
acre-ft/day	0.8	39	39.8	56.4	57.2	123.6	124.4
mgd	0.26	12.6	12.9	18.3	18.6	40.2	40.5
gpm	180	8760	8940	12,720	12,900	26,960	28,140

ASSUMPTIONS:

[a]All numbers are in acre-feet/year except as noted.

[b]Phase I is composed of Stages 1 through 4 as summarized on Table 3-8 of the Water Reclamation Study, JMM, 1987.

TABLE A-2
VISION 2020 GENERAL PLAN ESTIMATED WATER NEEDS

Cordelia Growth Center	
Housing Units	6,865
Jobs	19,162
Water Needs (acre-ft/yr)	6,610
Central Fairfield	
Housing Units	28,392
Jobs	79,963
Water Needs (acre-ft/yr)	27,430
Northeast Growth Center	
Housing Units	17,659
Jobs	8,630
Water Needs (acre-ft/yr)	11,720
Total City (excludes Travis AFB)	
Housing Units	52,916
Housing Unit Water Needs (acre-ft/yr)	31,750
Jobs	107,755
Job Water Needs (acre-ft/yr)	14,010
Water Intensive Industries (acre-ft/yr)	10,000
TOTAL WATER NEEDS (acre-ft/yr)	**55,760**

Source: Memorandum to Eve Somjen from Rick Wood re: Vision 2020 Estimated Water Needs, July 13, 1990.

TABLE A-3

SOLANO COUNTY WATER REQUIREMENT PROJECTIONS
1995 - ULTIMATE
(Acre-Feet/Year)

	1995	2000	2005	2010	2020	Ultimate
Water Supplies	620,800	627,000	633,800	639,700	648,300	671,700
Water Demands	620,000	642,900	663,000	690,450	726,500	849,000
Surplus/(Deficiency)[a]	800	(15,900)	(29,200)	(50,750)	(78,200)	(177,300)
Omit Collinsville Demands	0	0	5,000	20,000	27,500	100,000
Surplus/(Deficiency)[b]	800	(15,900)	(24,200)	(30,750)	(50,700)	(77,300)

[a] Assumes no new imported water supplies

[b] Imported water supplies needed for deficiencies, assuming Collinsville is supplied directly from the Sacramento River (e.g., under Delta Protection Act).

Source: Solano County Water Requirement Projections from 1995 to Ultimate Development, Draft, Solano County Water Policy Advisory Committee, August, 1992.

TABLE A-4
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
WATER QUALITY DATA (a)

SOURCE / PARAMETER	Sodium	Calcium	Magnesium	Potassium	Ammonium	Chloride	Sulfate	Bicarbonate	Carbonate	Nitrate	Phosphate	pH	pHc	ECw (a)	SARadj (a)	Copper (a)	Zinc (a)	Manganese	Iron	Boron	Fluoride	TDS	Turbidity (a)	Total Coliforms(a)
Putah South Canal (b, c, h)																								
Minimum	8.5	9.3	9.2	0.96	0.05	4.3	18	13.3	0	<.04	0.01	7.78		0.33		0	<0.01	<0.01	<0.02		0	169	0.6	2
Maximum	23	28	30	2	0.28	15	40	198	8.4	1.2	0.05	8.72		0.35		0.04	0.07	0.04	2.2		0.26	244	820	2,400
Average	10.8	19.1	24.2	1.2	0.11	7.9	25	173	1	<.44	0.03	8.38	8.40	0.34	0.4	0.02	0.02	0.02	0.3	<0.1	0.13	187	13.8	106
Cache Slough (b, d, h)																								
Minimum	26	28.8	19.9	1.6		20	37	23	0	0		7.3		0.43		0	0	0.01	0.21		0.1	242	3.2	5
Maximum	93	68	47	4		89	130	244	0	4.5		8.8		1.04		30	0.09	0.22	1.1		0.5	630	82	54,000
Average	53.8	41.8	33.4	2.9	NA	52	70	238	0	2	NA	8.2	8.30	0.67	1.7	10	0.01	0.11	0.59	<0.1	0.3	388	22	1,000
North Bay Aqueduct (e, h)																								
Minimum					0.07	28					0.12	7.2		0.28		<10	<10	<0.03	0.43		0.01	90	4.8	6
Maximum					0.20	96					0.40	9.2		100		<50	<50	0.69	1.70		0.4	237	100	>240,000
Average	32	21.3	18	1.5	0.12	45	26.5	123	0	0.7	0.23	7.8	8.43	1.3	1.2	<28	<34	<0.42	1.12	<0.1	0.1	148	26	10,578
Groundwater Quality (f)																								
Minimum	16	18.9	8	0		5	13	192	0	0		7.5		0.41						0	0	247		
Maximum	84	79	105	7.4		65	109	698	26	63		8.8		1.42						6.1	0.4	683		
Average	47.7	41.7	42.1	1.7	NA	25	38	325	3.5	14.3	NA	8.1	3.08	0.69	2.3	<50	<10	0.47	<0.05	0.7	0.2	403	<1	<2.2
FSSD WWTP (g, h)																								
Minimum	150	32	33	10	<0.1	140	83	160	<0.1	11.2	14.2	6.9		1.1	4.3	3.3	16			0.7	0.2	720	0.2	<2
Maximum	180	46	40	12	0.6	210	110	240	<1	17.9	18	7.2		1.3	5.2	12	82.5			1.2	1.1	820	1.1	<2
Average	160	39.1	36	10.9	0.2	174	95.1	200	<1	15.1	16	7.1	8.39	1.2	4.8	6.6	48.8	<0.02	0.05	0.9	0.7	750	0.7	<2

NA = Not available.

(a) Units are mg/l except as noted here:
ECw (dS/m) Turbidity (NTU)
SARadj (units) Total Coliform(MPN/100ml)
Copper, Zinc (µg/l)

(b) Source: Joint Powers Policy Committee, North Bay Regional Water Treatment Plant Project, Compilation of Available Raw Water Quality Data, JMM, May, 1987.

(c) Monthly averages for (1/83 - 5/86); additional data for (11/79 - 12/85).

(d) Data for (4/83 - 4/84); yearly averages for (1969 - 1982).

(e) Data for (1988-1990); Source: City of Vallejo Laboratory Data Sheets, Raw Water Data, "NBA" North Bay Aqueduct at Cordelia.

(f) Data for (1912 - 1987); Source: Solano Irrigation District, Groundwater Resources, Summers Engineering, Inc., June, 1988.

(g) Monthly and yearly data for 1990; Source: Fairfield-Suisun Subregional Wastewater Treatment Plant 1990 Annual Report.

(h) Source for all single value data: NBRWTP Laboratory Data, May, 1991.

JACKSON HILL WTP AND RESERVOIR (BACKUP SUPPLY)

COVER VALLEY SCH. (PROPOSED)

CACHE SLOUGH PIPELINE (BACKUP SUPPLY)

SID CHADBOURNE LATERAL

HIGH SERVICE PUMP STATION

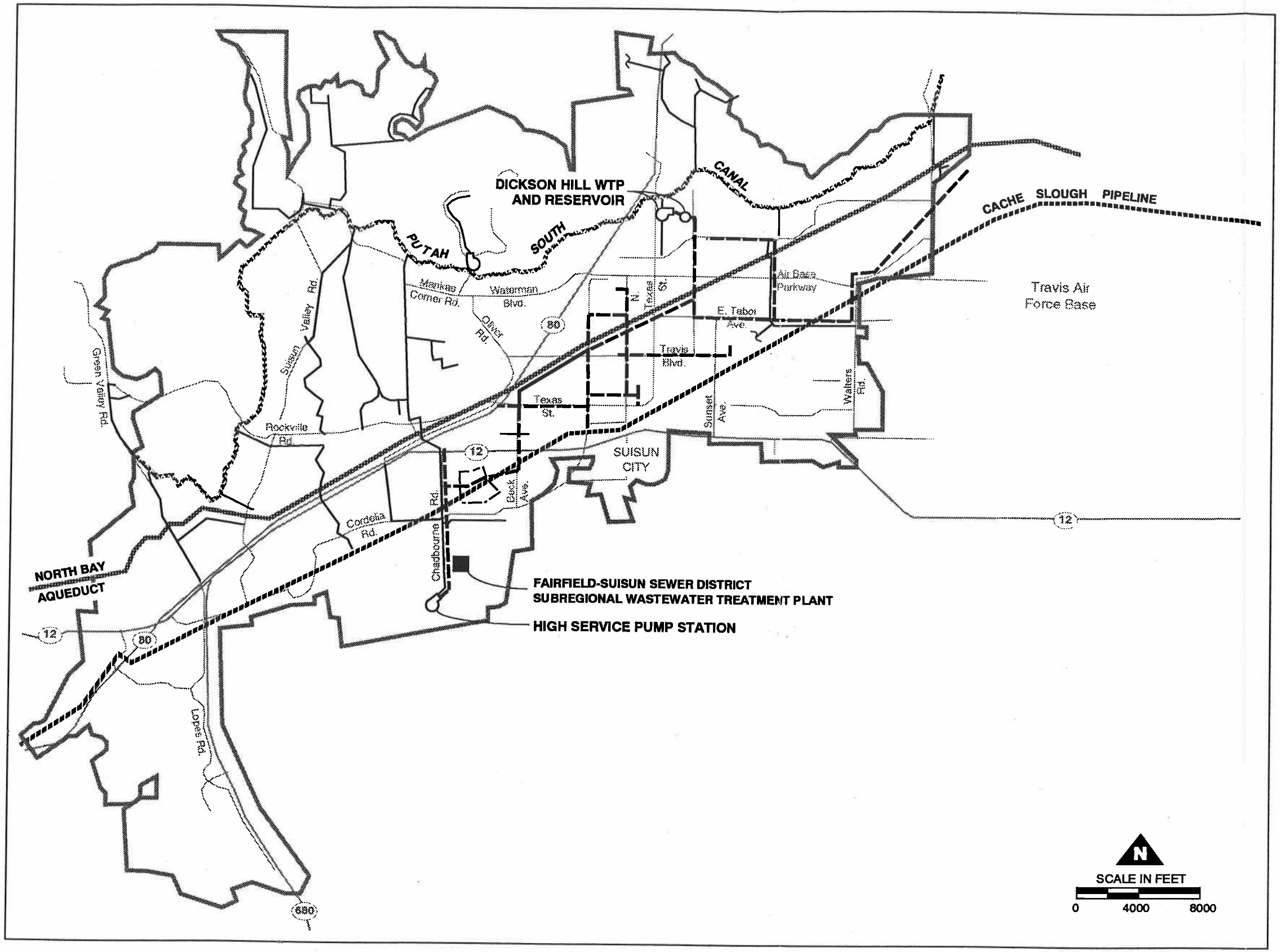
SCALE IN FEET

0 500 1000 2000

- PUMP STATION
- SERVICE CONNECTION
- STORAGE RESERVOIR
- TRANSMISSION PIPELINE
- DISTRIBUTION SYSTEM
- FUTURE PIPELINE ADDITIONS
- PARK
- SCHOOL

1987 WATER RECLAMATION STUDY RECOMMENDED PROJECT

FIGURE A-1



LEGEND

- PUMP STATION
- STUDY AREA
- EXISTING RECLAIMED WATER PIPELINE
- PROPOSED RECLAIMED WATER PIPELINE
- EXISTING RAW WATER PIPELINE
- PROPOSED RAW WATER PIPELINE

CITY OF FAIRFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN

EXISTING AND CURRENTLY PLANNED NONPOTABLE WATER DISTRIBUTION SYSTEMS

FIGURE A-2

Appendix B

APPENDIX B

EXCERPTS FROM CALIFORNIA STATE LAWS AND REGULATIONS PERTAINING TO USE OF RECLAIMED WATER

WASTEWATER RECLAMATION CRITERIA

An Excerpt from the

CALIFORNIA ADMINISTRATIVE CODE
TITLE 22, DIVISION 4

ENVIRONMENTAL HEALTH

1978

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH SERVICES
SANITARY ENGINEERING SECTION
2151 Berkeley Way, Berkeley 94704

INTENT OF REGULATIONS

The intent of these regulations is to establish acceptable levels of constituents of reclaimed water and to prescribe means for assurance of reliability in the production of reclaimed water in order to ensure that the use of reclaimed water for the specified purposes does not impose undue risk to health. The levels of constituents in combination with the means for assurance of reliability constitute reclamation criteria as defined in Section 13520 of the California Water Code.

As affirmed in Sections 13510 to 13512 of the California Water Code, water reclamation is in the best public interest and the policy of the State is to encourage reclamation. The reclamation criteria are intended to promote development of facilities which will assist in meeting water requirements of the State while assuring positive health protection. Appropriate surveillance and control of treatment facilities, distribution systems and use areas must be provided in order to avoid health hazards. Precautions must be taken to avoid direct public contact with reclaimed water which do not meet the standards specified in Article 5 for nonrestricted recreational impoundments.

TABLE OF CONTENTS

CHAPTER 3. RECLAMATION CRITERIA

Article 10. Alternative Reliability Requirements for Uses Requiring Oxidized, Disinfected Wastewater or Oxidized, Coagulated, Clarified, Filtered, Disinfected Wastewater

CHAPTER 3. RECLAMATION CRITERIA

Article 1. Definitions

60301. **Definitions.** (a) **Reclaimed Water.** Reclaimed water means water which, as a result of treatment of domestic wastewater, is suitable for a direct beneficial use or a controlled use that would not otherwise occur.

(b) **Reclamation Plant.** Reclamation plant means an arrangement of devices, structures, equipment, processes and controls which produce a reclaimed water suitable for the intended reuse.

(c) **Regulatory Agency.** Regulatory agency means the California Regional Water Quality Control Board in whose jurisdiction the reclamation plant is located.

(d) **Direct Beneficial Use.** Direct beneficial use means the use of reclaimed water which has been transported from the point of production to the point of use without an intervening discharge to waters of the State.

(e) **Food Crops.** Food crops mean any crops intended for human consumption.

(f) **Spray Irrigation.** Spray irrigation means application of reclaimed water to crops by spraying it from orifices in piping.

(g) **Surface Irrigation.** Surface irrigation means application of reclaimed water by means other than spraying such that contact between the edible portion of any food crop and reclaimed water is prevented.

(h) **Restricted Recreational Impoundment.** A restricted recreational impoundment is a body of reclaimed water in which recreation is limited to fishing, boating, and other non-body-contact water recreation activities.

(i) **Nonrestricted Recreational Impoundment.** A nonrestricted recreational impoundment is an impoundment of reclaimed water in which no limitations are imposed on body-contact water sport activities.

(j) **Landscape Impoundment.** A landscape impoundment is a body of reclaimed water which is used for aesthetic enjoyment or which otherwise serves a function not intended to include public contact.

(k) **Approved Laboratory Methods.** Approved laboratory methods are those specified in the latest edition of "Standard Methods for the Examination of Water and Wastewater", prepared and published jointly by the American Public Health Association, the American Water Works Association, and the Water Pollution Control Federation and which are conducted in laboratories approved by the State Department of Health.

(l) **Unit Process.** Unit process means an individual stage in the wastewater treatment sequence which performs a major single treatment operation.

(m) **Primary Effluent.** Primary effluent is the effluent from a wastewater treatment process which provides removal of sewage solids so that it contains not more than 0.5 milliliter per liter per hour of settleable solids as determined by an approved laboratory method.

(n) **Oxidized Wastewater.** Oxidized wastewater means wastewater in which the organic matter has been stabilized, is nonputrescible, and contains dissolved oxygen.

(o) **Biological Treatment.** Biological treatment means methods of wastewater treatment in which bacterial or biochemical action is intensified as a means of producing an oxidized wastewater.

(p) **Secondary Sedimentation.** Secondary sedimentation means the removal by gravity of settleable solids remaining in the effluent after the biological treatment process.

(q) **Coagulated Wastewater.** Coagulated wastewater means oxidized wastewater in which colloidal and finely divided suspended matter have been destabilized and agglomerated by the addition of suitable floc-forming chemicals or by an equally effective method.

(r) **Filtered Wastewater.** Filtered wastewater means an oxidized, coagulated, clarified wastewater which has been passed through natural undisturbed soils or filter media, such as sand or diatomaceous earth, so that the turbidity as determined by an approved laboratory method does not exceed an average operating turbidity of 2 turbidity units and does not exceed 5 turbidity units more than 5 percent of the time during any 24-hour period.

(s) **Disinfected Wastewater.** Disinfected wastewater means wastewater in which the pathogenic organisms have been destroyed by chemical, physical or biological means.

(t) **Multiple Units.** Multiple units means two or more units of a treatment process which operate in parallel and serve the same function.

(u) **Standby Unit Process.** A standby unit process is an alternate unit process or an equivalent alternative process which is maintained in operable condition and which is capable of providing comparable treatment for the entire design flow of the unit for which it is a substitute.

(v) **Power Source.** Power source means a source of supplying energy to operate unit processes.

(w) **Standby Power Source.** Standby power source means an automatically actuated self-starting alternate energy source maintained in immediately operable condition and of sufficient capacity to provide necessary service during failure of the normal power supply.

(x) **Standby Replacement Equipment.** Standby replacement equipment means reserve parts and equipment to replace broken-down or worn-out units which can be placed in operation within a 24-hour period.

(y) **Standby Chlorinator.** A standby chlorinator means a duplicate chlorinator for reclamation plants having one chlorinator and a duplicate of the largest unit for plants having multiple chlorinator units.

(z) **Multiple Point Chlorination.** Multiple point chlorination means that chlorine will be applied simultaneously at the reclamation plant and at subsequent chlorination stations located at the use area and/or some intermediate point. It does not include chlorine application for odor control purposes.

(aa) **Alarm.** Alarm means an instrument or device which continuously monitors a specific function of a treatment process and automatically gives warning of an unsafe or undesirable condition by means of visual and audible signals.

(bb) **Person.** Person also includes any private entity, city, county, district, the State or any department or agency thereof.

NOTE: Authority cited: Section 208, Health and Safety Code and Section 13521, Water Code. Reference: Section 13521, Water Code.

History: 1. New Chapter 4 (§§ 60301–60357, not consecutive) filed 4-2-73; effective thirtieth day thereafter (Register 73, No. 14).
2. Renumbering of Chapter 4 (Sections 60301–60357, not consecutive) to Chapter 3 (Sections 60301–60357, not consecutive), filed 10-14-77; effective thirtieth day thereafter (Register 77, No. 42).

Article 2. Irrigation of Food Crops

60303. Spray Irrigation. Reclaimed water used for the spray irrigation of food crops shall be at all times an adequately disinfected, oxidized, coagulated, clarified, filtered wastewater. The wastewater shall be considered adequately disinfected if at some location in the treatment process the median number of coliform organisms does not exceed 2.2 per 100 milliliters and the number of coliform organisms does not exceed 23 per 100 milliliters in more than one sample within any 30-day period. The median value shall be determined from the bacteriological results of the last 7 days for which analyses have been completed.

60305. Surface Irrigation. (a) Reclaimed water used for surface irrigation of food crops shall be at all times an adequately disinfected, oxidized wastewater. The wastewater shall be considered adequately disinfected if at some location in the treatment process the median number of coliform organisms does not exceed 2.2 per 100 milliliters, as determined from the bacteriological results of the last 7 days for which analyses have been completed.

(b) Orchards and vineyards may be surface irrigated with reclaimed water that has the quality at least equivalent to that of primary effluent provided that no fruit is harvested that has come in contact with the irrigating water or the ground.

60307. Exceptions. Exceptions to the quality requirements for reclaimed water used for irrigation of food crops may be considered by the State Department of Health on an individual case basis where the reclaimed water is to be used to irrigate a food crop which must undergo extensive commercial, physical or chemical processing sufficient to destroy pathogenic agents before it is suitable for human consumption.

Article 3. Irrigation of Fodder, Fiber, and Seed Crops

60309. Fodder, Fiber, and Seed Crops. Reclaimed water used for the surface or spray irrigation of fodder, fiber, and seed crops shall have a level of quality no less than that of primary effluent.

60311. Pasture for Milking Animals. Reclaimed water used for the irrigation of pasture to which milking cows or goats have access shall be at all times an adequately disinfected, oxidized wastewater. The wastewater shall be considered adequately disinfected if at some location in the treatment process the median number of coliform organisms does not exceed 23 per 100 milliliters, as determined from the bacteriological results of the last 7 days for which analyses have been completed.

Article 4. Landscape Irrigation

60313. Landscape Irrigation. (a) Reclaimed water used for the irrigation of golf courses, cemeteries, freeway landscapes, and landscapes in other areas where the public has similar access or exposure shall be at all times an adequately disinfected, oxidized wastewater. The wastewater shall be considered adequately disinfected if the median number of coliform organisms in the effluent does not exceed 23 per 100 milliliters, as determined from the bacteriological results of the last 7 days for which analyses have been completed, and the number of coliform organisms does not exceed 240 per 100 milliliters in any two consecutive samples.

(b) Reclaimed water used for the irrigation of parks, playgrounds, schoolyards, and other areas where the public has similar access or exposure shall be at all times an adequately disinfected, oxidized, coagulated, clarified, filtered wastewater or a wastewater treated by a sequence of unit processes that will assure an equivalent degree of treatment and reliability. The wastewater shall be considered adequately disinfected if the median number of coliform organisms in the effluent does not exceed 2.2 per 100 milliliters, as determined from the bacteriological results of the last 7 days for which analyses have been completed, and the number of coliform organisms does not exceed 23 per 100 milliliters in any sample.

NOTE: Authority cited: Section 208, Health and Safety Code and Section 13521, Water Code. Reference: Section 13520, Water Code.

History: 1. Amendment filed 9-22-78; effective thirtieth day thereafter (Register 78, No. 38).

Article 5. Recreational Impoundments

60315. Nonrestricted Recreational Impoundment. Reclaimed water used as a source of supply in a nonrestricted recreational impoundment shall be at all times an adequately disinfected, oxidized, coagulated, clarified, filtered wastewater. The wastewater shall be considered adequately disinfected if at some location in the treatment process the median number of coliform organisms does not exceed 2.2 per 100 milliliters and the number of coliform organisms does not exceed 23 per 100 milliliters in more than one sample within any 30-day period. The median value shall be determined from the bacteriological results of the last 7 days for which analyses have been completed.

60317. **Restricted Recreational Impoundment.** Reclaimed water used as a source of supply in a restricted recreational impoundment shall be at all times an adequately disinfected, oxidized wastewater. The wastewater shall be considered adequately disinfected if at some location in the treatment process the median number of coliform organisms does not exceed 2.2 per 100 milliliters, as determined from the bacteriological results of the last 7 days for which analyses have been completed.

60319. **Landscape Impoundment.** Reclaimed water used as a source of supply in a landscape impoundment shall be at all times an adequately disinfected, oxidized wastewater. The wastewater shall be considered adequately disinfected if at some location in the treatment process the median number of coliform organisms does not exceed 23 per 100 milliliters, as determined from the bacteriological results of the last 7 days for which analyses have been completed.

Article 5.1. Groundwater Recharge

60320. **Groundwater Recharge.** (a) Reclaimed water used for groundwater recharge of domestic water supply aquifers by surface spreading shall be at all times of a quality that fully protects public health. The State Department of Health Services' recommendations to the Regional Water Quality Control Boards for proposed groundwater recharge projects and for expansion of existing projects will be made on an individual case basis where the use of reclaimed water involves a potential risk to public health.

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

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

NOTE: Authority cited: Section 208, Health and Safety Code and Section 13521, Water Code. Reference: Section 13260, Water Code.

History: 1. New Article 5.1 (Section 60320) filed 9-22-78; effective thirtieth day thereafter (Register 78, No. 38).

Article 5.5. Other Methods of Treatment

60320.5. **Other Methods of Treatment.** Methods of treatment other than those included in this chapter and their reliability features may be accepted if the applicant demonstrates to the satisfaction of the State Department of Health that the methods of treatment and reliability features will assure an equal degree of treatment and reliability.

NOTE: Authority cited: Section 208, Health and Safety Code and Section 13521, Water Code. Reference: Section 13260, Water Code.

History: 1. Renumbering of Article 11 (Section 60357) to Article 5.5 (Section 60320.5) filed 9-22-78; effective thirtieth day thereafter (Register 78, No. 38)

(Next page is 1605)

Article 6. Sampling and Analysis

60321. **Sampling and Analysis.** (a) Samples for settleable solids and coliform bacteria, where required, shall be collected at least daily and at a time when wastewater characteristics are most demanding on the treatment facilities and disinfection procedures. Turbidity analysis, where required, shall be performed by a continuous recording turbidimeter.

(b) For uses requiring a level of quality no greater than that of primary effluent, samples shall be analyzed by an approved laboratory method of settleable solids.

(c) For uses requiring an adequately disinfected, oxidized wastewater, samples shall be analyzed by an approved laboratory method for coliform bacteria content.

(d) For uses requiring an adequately disinfected, oxidized, coagulated, clarified, filtered wastewater, samples shall be analyzed by approved laboratory methods for turbidity and coliform bacteria content.

Article 7. Engineering Report and Operational Requirements

60323. **Engineering Report.** (a) No person shall produce or supply reclaimed water for direct reuse from a proposed water reclamation plant unless he files an engineering report.

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

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

60325. **Personnel.** (a) Each reclamation plant shall be provided with a sufficient number of qualified personnel to operate the facility effectively so as to achieve the required level of treatment at all times.

(b) Qualified personnel shall be those meeting requirements established pursuant to Chapter 9 (commencing with Section 13625) of the Water Code.

60327. **Maintenance.** A preventive maintenance program shall be provided at each reclamation plant to ensure that all equipment is kept in a reliable operating condition.

60329. **Operating Records and Reports.** (a) Operating records shall be maintained at the reclamation plant or a central depository within the operating agency. These shall include: all analyses specified in the reclamation criteria; records of operational problems, plant and equipment breakdowns, and diversions to emergency storage or disposal; all corrective or preventive action taken.

(b) Process or equipment failures triggering an alarm shall be recorded and maintained as a separate record file. The recorded information shall include the time and cause of failure and corrective action taken.

(c) A monthly summary of operating records as specified under (a) of this section shall be filed monthly with the regulatory agency.

(d) Any discharge of untreated or partially treated wastewater to the use area, and the cessation of same, shall be reported immediately by telephone to the regulatory agency, the State Department of Health, and the local health officer.

60331. **Bypass.** There shall be no bypassing of untreated or partially treated wastewater from the reclamation plant or any intermediate unit processes to the point of use.

Article 8. General Requirements of Design

60333. **Flexibility of Design.** The design of process piping, equipment arrangement, and unit structures in the reclamation plant must allow for efficiency and convenience in operation and maintenance and provide flexibility of operation to permit the highest possible degree of treatment to be obtained under varying circumstances.

60335. **Alarms.** (a) Alarm devices required for various unit processes as specified in other sections of these regulations shall be installed to provide warning of:

(1) Loss of power from the normal power supply.
(2) Failure of a biological treatment process.
(3) Failure of a disinfection process.
(4) Failure of a coagulation process.
(5) Failure of a filtration process.
(6) Any other specific process failure for which warning is required by the regulatory agency.

(b) All required alarm devices shall be independent of the normal power supply of the reclamation plant.

(c) The person to be warned shall be the plant operator, superintendent, or any other responsible person designated by the management of the reclamation plant and capable of taking prompt corrective action.

(d) Individual alarm devices may be connected to a master alarm to sound at a location where it can be conveniently observed by the attendant. In case the reclamation plant is not attended full time, the alarm(s) shall be connected to sound at a police station, fire station or other full-time service unit with which arrangements have been made to alert the person in charge at times that the reclamation plant is unattended.

60337. **Power Supply.** The power supply shall be provided with one of the following reliability features:

(a) Alarm and standby power source.

(b) Alarm and automatically actuated short-term retention or disposal provisions as specified in Section 60341.

(c) Automatically actuated long-term storage or disposal provisions as specified in Section 60341.

Article 9. Alternative Reliability Requirements for Uses Permitting Primary Effluent

60339. Primary Treatment. Reclamation plants producing reclaimed water exclusively for uses for which primary effluent is permitted shall be provided with one of the following reliability features:

(a) Multiple primary treatment units capable of producing primary effluent with one unit not in operation.

(b) Long-term storage or disposal provisions as specified in Section 60341.

Article 10. Alternative Reliability Requirements for Uses Requiring Oxidized, Disinfected Wastewater or Oxidized, Coagulated, Clarified, Filtered, Disinfected Wastewater

60341. Emergency Storage or Disposal. (a) Where short-term retention or disposal provisions are used as a reliability feature, these shall consist of facilities reserved for the purpose of storing or disposing of untreated or partially treated wastewater for at least a 24-hour period. The facilities shall include all the necessary diversion devices, provisions for odor control, conduits, and pumping and pump back equipment. All of the equipment other than the pump back equipment shall be either independent of the normal power supply or provided with a standby power source.

(b) Where long-term storage or disposal provisions are used as a reliability feature, these shall consist of ponds, reservoirs, percolation areas, downstream sewers leading to other treatment or disposal facilities or any other facilities reserved for the purpose of emergency storage or disposal of untreated or partially treated wastewater. These facilities shall be of sufficient capacity to provide disposal or storage of wastewater for at least 20 days, and shall include all the necessary diversion works, provisions for odor and nuisance control, conduits, and pumping and pump back equipment. All of the equipment other than the pump back equipment shall be either independent of the normal power supply or provided with a standby power source.

(c) Diversion to a less demanding reuse is an acceptable alternative to emergency disposal of partially treated wastewater provided that the quality of the partially treated wastewater is suitable for the less demanding reuse.

(d) Subject to prior approval by the regulatory agency, diversion to a discharge point which requires lesser quality of wastewater is an acceptable alternative to emergency disposal of partially treated wastewater.

(e) Automatically actuated short-term retention or disposal provisions and automatically actuated long-term storage or disposal provisions shall include, in addition to provisions of (a), (b), (c), or (d) of this section, all the necessary sensors, instruments, valves and other devices to enable fully automatic diversion of untreated or partially treated wastewater to approved emergency storage or disposal in the event of failure of a treatment process, and a manual reset to prevent automatic restart until the failure is corrected.

60343. **Primary Treatment.** All primary treatment unit processes shall be provided with one of the following reliability features.

(a) Multiple primary treatment units capable of producing primary effluent with one unit not in operation.

(b) Standby primary treatment unit process.

(c) Long-term storage or disposal provisions.

60345. **Biological Treatment.** All biological treatment unit processes shall be provided with one of the following reliability features.

(a) Alarm and multiple biological treatment units capable of producing oxidized wastewater with one unit not in operation.

(b) Alarm, short-term retention or disposal provisions, and standby replacement equipment.

(c) Alarm and long-term storage or disposal provisions.

(d) Automatically actuated long-term storage or disposal provisions.

60347. **Secondary Sedimentation.** All secondary sedimentation unit processes shall be provided with one of the following reliability features:

(a) Multiple sedimentation units capable of treating the entire flow with one unit not in operation.

(b) Standby sedimentation unit process.

(c) Long-term storage or disposal provisions.

60349. **Coagulation.**

(a) All coagulation unit processes shall be provided with the following mandatory features for uninterrupted coagulant feed:

(1) Standby feeders,

(2) Adequate chemical storage and conveyance facilities.

(3) Adequate reserve chemical supply, and

(4) Automatic dosage control.

(b) All coagulation unit processes shall be provided with one of the following reliability features:

(1) Alarm and multiple coagulation units capable of treating the entire flow with one unit not in operation;

(2) Alarm, short-term retention or disposal provisions, and standby replacement equipment;

(3) Alarm and long-term storage or disposal provisions;

(4) Automatically actuated long-term storage or disposal provisions, or

(5) Alarm and standby coagulation process.

60351. **Filtration.** All filtration unit processes shall be provided with one of the following reliability features:

(a) Alarm and multiple filter units capable of treating the entire flow with one unit not in operation.

(b) Alarm, short-term retention or disposal provisions and standby replacement equipment.

(c) Alarm and long-term storage or disposal provisions.
(d) Automatically actuated long-term storage or disposal provisions.
(e) Alarm and standby filtration unit process.

60353. Disinfection.

(a) All disinfection unit processes where chlorine is used as the disinfectant shall be provided with the following features for uninterrupted chlorine feed:

(1) Standby chlorine supply,
(2) Manifold systems to connect chlorine cylinders,
(3) Chlorine scales, and
(4) Automatic devices for switching to full chlorine cylinders.

Automatic residual control of chlorine dosage, automatic measuring and recording of chlorine residual, and hydraulic performance studies may also be required.

(b) All disinfection unit processes where chlorine is used as the disinfectant shall be provided with one of the following reliability features:

(1) Alarm and standby chlorinator;
(2) Alarm, short-term retention or disposal provisions, and standby replacement equipment;
(3) Alarm and long-term storage or disposal provisions;
(4) Automatically actuated long-term storage or disposal provisions; or
(5) Alarm and multiple point chlorination, each with independent power source, separate chlorinator, and separate chlorine supply

60355. Other Alternatives to Reliability Requirements. Other alternatives to reliability requirements set forth in Articles 8 to 10 may be accepted if the applicant demonstrates to the satisfaction of the State Department of Health that the proposed alternative will assure an equal degree of reliability.

(Next page is 1701)

Photocomposition by
CALIFORNIA OFFICE OF STATE PRINTING

State of California
Department of Health Services

GUIDELINES FOR USE OF RECLAIMED WATER

I. General

A. Reclaimed water shall meet the Regional Water Quality Control Board (RWQCB) requirements and the requirements specified in the "Wastewater Reclamation Criteria." (Title 22, Div. 4, Section 60301 through 60355). These guidelines apply to those reclaimed water use areas supplied water from sewage treatment plants having reliability features and operational histories meeting the Regional Water Quality Control Board and "Wastewater Reclamation Criteria" requirements. Additional precautions may be required where these conditions are not met.

B. Reclaimed water should be confined to the authorized use area.

1. Direct or windblown spray should be confined to the area designated and approved for reclamation.

2. Precautions should be taken to assure that reclaimed water will not be sprayed on any facility or area not designated for reclamation such as passing vehicles, buildings, domestic water facilities or food handling facilities.

C. Notification should be provided to inform the public that reclaimed wastewater is being used. The notification should include the posting of conspicuous warning signs with proper wording of sufficient size to be clearly read.

D. Public contact with reclaimed water should be minimized except where specifically approved by the health agencies and the Regional Water Quality Control Board.

E. The reclaimed water distribution and transmission system piping should comply with the design requirements contained in the California-Nevada Section AWWA publication "Guidelines for Distribution of Nonpotable Water."

1. All piping, valves and outlets should be marked to differentiate reclaimed water from domestic or other water.

2. All reclaimed water controllers, valves, etc., should be affixed with reclaimed water warning signs.

F. All reclaimed water valves, outlets, quick couplers, and sprinkler heads should be of a type or secured in a manner that only permits operation by personnel authorized by the user.

G. Use or installation of hose bibbs on any irrigation system presently operating or designated to operate with reclaimed water, regardless of the hose bibb construction or identification, should not be permitted.

H. There should be at least a 10-foot horizontal and 1-foot vertical separation (with the domestic water above the reclaimed water pipeline) between all pipelines transporting reclaimed water and those transporting domestic water.

I. Plans and specifications for the reclaimed and domestic water systems should be submitted to the Sanitary Engineering Branch of the State Department of Health Services and the local health department for review and approval before construction of new reclamation facilities or system conversion.

J. An air-gap separation or reduced pressure principle device shall be provided at all domestic water service connections to reclaimed water use areas. (Title 17, Chapter 5, Section 7604).

K. There shall be no connection between the potable water supply and piping containing reclaimed water. Supplementing reclaimed water with water used for domestic supply shall not be allowed except through an air-gap separation. (Title 17, Chapter 5, Section 7604).

L. Supplementing reclaimed water with water from irrigation or industrial wells should not be allowed except through an air gap or reduced pressure principle device.

M. Drinking water facilities should be protected from direct or windblown reclaimed water spray.

N. Tank trucks and other equipment which are used to distribute reclaimed water should be clearly identified with warning signs.

O. There should be no irrigation or impoundment of reclaimed water within 500 feet of any well used for domestic supply or 100 feet of any irrigation well unless it can be demonstrated that special circumstances justify lesser distances to be acceptable.

P. Adequate measures should be taken to prevent the breeding of insects and other vectors of health significance, and the creation of odors, slimes or unsightly deposits.

Q. A user supervisor should be appointed by the user. The user supervisor should be responsible for installation, operation and maintenance of the reclamation system, prevention of potential hazards, implementing these Guidelines, and coordination with the cross-connection control program of the water purveyor or the local health department.

R. The user should maintain as-built plans of the use area showing all buildings, domestic and reclaimed water facilities, the sewage collection system, etc. Plans should be updated as modifications are made.

S. A contingency plan including notification of the RWQCB and health agencies should be developed outlining the action to be taken in the event effluent quality fails to meet required standards.

T. Inspection, supervision and employee training should be provided by the user to assure proper operation of the reclaimed water system. Records of inspection and training should be maintained by the user.

U. The producer and/or user should submit a monthly report to the State Department of Health Services and the local health agencies containing:

1. The quality and quantity of water reclaimed.

2. The use (the method of irrigation and the crop(s) and area(s) irrigated).

3. The reason for noncompliance with standards, if appropriate and the corrective action taken.

II. Landscape Irrigation

A. At parks, playgrounds, schoolyards, other areas (e.g. golf courses with contiguous residential development) where the public has similar access or exposure, and other areas irrigated with oxidized, coagulated, clarified, filtered, disinfected wastewater having a 7- day median number of coliform organisms not exceeding 2.2/100 ml, and a maximum concentration of coliform organism not exceeding 23/100 ml in any sample:

(The reclaimed water treatment and quality stated above also applies at use areas having adjacent property where the public may be subject to direct or indirect contact with reclaimed water spray for example; golf courses with contiguous residential development).

1. Adequate signs should be posted indicating that reclaimed wastewater is used for irrigation and is not safe for drinking (e.g. ATTENTION: RECLAIMED WASTEWATER - DO NOT DRINK).

B. At golf courses not included in A. above irrigated with oxidized, disinfected wastewater having a 7-day median number of coliform organisms not exceeding 23/100 ml or any two consecutive coliform samples not exceeding 240/100 ml:

1. Irrigation should only be practiced when golfers are not present.

2. Adequate signs should be posted indicating that reclaimed wastewater is used for irrigation and it is not safe for drinking or contact (e.g. ATTENTION: RECLAIMED WASTEWATER AVOID CONTACT - DO NOT DRINK).

3. Score cards should indicate that reclaimed wastewater is used.

4. Irrigation with reclaimed water should not occur in areas where food is handled or consumed.

5. Irrigation should be controlled to prevent ponding and runoff of reclaimed water unless acceptable to the Regulatory Agency.

C. At cemeteries irrigated with oxidized, disinfected wastewater having a 7-day median number of coliform organisms not exceeding 23/100 ml or any two consecutive coliform samples not exceeding 240/100 ml:

1. Irrigation should be scheduled for times the public is not present.

2. Adequate signs should be posted indicating that reclaimed wastewater is used for irrigation and it is not safe for drinking or contact (e.g. ATTENTION: RECLAIMED WASTEWATER AVOID CONTACT - DO NOT DRINK).

3. Potable water should be supplied for flower containers.

4. Irrigation should be controlled to prevent ponding and runoff of reclaimed water unless acceptable to the Regulatory Agency.

D. Highway landscape and other landscaped areas irrigated with oxidized, disinfected wastewater having a 7-day median number of coliform organisms not exceeding 23/100 ml or any two consecutive coliform samples not exceeding 240/100 ml:

1. Signs should be posted along the perimeter at points of access to the use area indicating that reclaimed wastewater is used for irrigation and it is not safe for drinking or contact (e.g. ATTENTION: RECLAIMED WASTEWATER AVOID CONTACT - DO NOT DRINK).

2. Irrigation should be controlled to prevent ponding and runoff of reclaimed water unless acceptable to the Regulatory Agency.

III. Impoundments

A. Nonrestricted recreational impoundments containing oxidized, coagulated, clarified filtered, disinfected wastewater having a 7-day median number of coliform organisms not exceeding 2.2/100 ml and a maximum concentration of coliform organisms not exceeding 23/100 ml in more than one sample in a 30-day period:

1. Impoundments should have perimeter signs indicating that the wastewater stored is not safe for drinking (e.g. ATTENTION: RECLAIMED WASTEWATER - DO NOT DRINK).

2. Runoff should be prevented from entering the pond unless the impoundment is sized to accept the runoff without discharge or an NPDES permit has been issued for the discharge.

3. There should be no discharge of reclaimed water to any pond with less than one foot of freeboard unless discharge from the pond is allowed by NPDES permit.

B. Restricted recreational impoundments containing oxidized, disinfected wastewater having a 7-day median number of coliform organisms not exceeding 2.2/100 ml:

1. Impoundments should have perimeter signs indicating that the wastewater stored is not safe for drinking or body contact (e.g. ATTENTION: RECLAIMED WASTEWATER AVOID CONTACT - DO NOT DRINK).

2. Runoff should be prevented from entering the pond unless the impoundment is sized to accept the runoff without discharge or an NPDES permit has been issued for the discharge.

3. There should be no discharge of reclaimed water to any pond with less than one foot of freeboard unless discharge from the pond is allowed by NPDES permit.

C. Landscape impoundments containing oxidized, disinfected wastewater having a 7-day median number of coliform organisms not exceeding 23/100 ml:

1. Impoundments should have perimeter signs indicating that the wastewater stored is not safe for drinking or body contact(e.g. ATTENTION: RECLAIMED WASTEWATER AVOID CONTACT - DO NOT DRINK).

2. Runoff should be prevented from entering the pond unless the impoundment is sized to accept the runoff without discharge or an NPDES permit has been issued for the discharge.

3. There should be no discharge of reclaimed water to any pond with less than one foot of freeboard unless discharge from the pond is allowed by NPDES permit.

IV. Agricultural Reuse Area Guidelines

A. At areas irrigated with undisinfected primary or undisinfected seconday effluent:

1. Warning signs reading "SEWAGE DISPOSAL AREA - KEEP OUT" should be posted at least every 500 feet with a minimum of one sign at each corner and one at each access road.

2. Fencing or other barriers should be installed where needed to restrict public access.

3. The perimeter of the disposal area should be graded to prevent ponding along public roads or other public areas.

4. Setbacks

a. Surface Irrigation - setbacks should be established where needed to restrict public contact.

b. Spray Irrigation - there should be no irrigation within 500 feet of the authorized spray boundary. A setback of less than 500 feet may be approved if warranted by the use area design. Some of the use area characteristics to be taken into account are: wind velocity and direction, topography, sprinkler characteristics and controls.

3. At areas irrigated with oxidized, disinfected, wastewater having a 7-day median number of coliform organisms not exceeding 23/100 ml:

1. Perimeter warning signs indicating that the reclaimed wastewater is not safe for drinking or contact (e.g. WARNING: RECLAIMED WASTEWATER AVOID CONTACT - DO NOT DRINK) should be posted at least every 500 feet with a minimum of one sign at each corner and one at each access road.

2. Fencing should be installed where needed to restrict public access.

3. The perimeter of the disposal area should be graded to prevent ponding along public roads or other public areas.

4. Setbacks

a. Surface Irrigation - Setbacks should be established where needed to restrict public contact.

b. Spray Irrigation - The amount of setback is to be determined by the use of the adjoining property.

C. At areas irrigated with oxidized, disinfected wastewater having a 7-day median number of coliform organisms not exceeding 2.2/100 ml:

1. Warning signs indicating that the reclaimed wastewater is not safe for drinking or contact (e.g. WARNING: RECLAIMED WASTEWATER AVOID CONTACT - DO NOT DRINK) should be posted with a minimum of one sign at each corner and one at each access road.

2. Fencing or other barriers should be installed where needed to restrict public access.

3. The perimeter of the disposal area should be graded to prevent ponding along public roads or other public areas.

4. Setbacks

   a. Surface Irrigation - Setbacks should be established where needed to restrict public contact.

   b. Spray Irrigation - The amount of setback is to be determined by the use of the adjoining property.

D. At areas irrigated with oxidized, disinfected, coagulated, clarified, filtered, disinfected wastewater having a 7-day median number of coliform organisms not exceeding 2.2/100 ml:

   a. Warning signs indicating that the reclaimed wastewater is unsafe to drink (e.g. WARNING: RECLAIMED WASTEWATER - DO NOT DRINK) should be posted every 500 feet with a minimum of one sign at each corner and one at each access road.

E. The following table indicates the minimum degree of treatment for the specific types of crops and methods of application:

TREATMENT GUIDELINES FOR
AGRICULTURAL USE OF RECLAIMED WATER

MINIMUM DEGREE OF TREATMENT FOR TYPE OF CROP AND METHOD OF APPLICATION

TYPE OF CROP	PRIMARY EFFLUENT	OXIDIZED, DISINFECTED TO 23 mpn/100 ml	OXIDIZED, DISINFECTED TO 2.2 mpn/100 ml	OXIDIZED, COAGULATED, CLARIFIED, FILTERED, DISINFECTED TO 2.2 mpn/100 ml
GENERAL				
d [illegible] ops	*	*	Surface(1)	Surface or Spray
cessed Food ps (2)	*	Surface or Spray	Surface or Spray	Surface or Spray
hards and Vineyards	Surface(3)	Surface(3)	Surface(3)	Surface or Spray
der, Fiber and d (4) Crops	Surface or Spray	Surface or Spray	Surface or Spray	Surface or Spray
ture for king Animals	*	Surface or Spray	Surface or Spray	Surface or Spray
SPECIFIC				
oduce General (Lettuce, Carrots, etc.)	*	*	*	Surface or Spray
Tomatoes (unprocessed)	*	*	Surface (3)	Surface or Spray
Tomatoes(2) (Processed - No gleaning)	*	Surface or Spray	Surface or Spray	Surface or Spray
Strawberries	*	*	*	Surface or Spray
Artichokes	*	*	Surface (3)	Surface or Spray
Watercress	*	*	*	Surface or Spray
gar Beets	*	Surface or Spray	Surface or Spray	Surface or Spray
rain - for human consumption	*	*	Surface (3)	Surface or Spray
ce	No effluent allowed in irrigation water because of mosquito propagation problems.			

TYPE OF CROP	PRIMARY EFFLUENT	OXIDIXED, DISINFECTED TO 23 mpn/100 ml	OXIDIZED, DISINFECTED TO 2.2 mpn/100 ml	OXIDIZED, COAGULATED, CLARIFIED, FILTERED, DISINFECTED TO 2.2 mpn/100 ml
n and Vines ost Protection	Surface	Surface or Spray (5)	Surface or Spray (5)	Surface or Spray
stachio or Walnut	*	*	*	Surface or Spray
lmond	*	*	*	Surface or Spray
trus	Surface (3)	Surface (3)	Surface (3)	Surface or Spray
vocado	Surface (3)	Surface (3)	Surface (3)	Surface or Spray
ive	Surface (3)	Surface (3)	Surface or Spray	Surface or Spray
r Crops d	*	*	Surface or Spray	Surface or Spray
amental Nursery tock	*	*	Surface or Spray	Surface or Spray
istmas Trees	*	Surface or Spray	Surface or Spray	Surface or Spray
ewood ustomer Cut	*	Surface or Spray	Surface or Spray	Surface or Spray
ewood Not Customer Cut	Surface or Spray	Surface or Spray	Surface or Spray	Surface or Spray

- Not Allowed

Not acceptable for root crops or crops where edible parts touch the ground.

Processed food crops must undergo extensive commercial, physical or chemical processing sufficient to destroy pathogenic agents. Processing does not include washing, pickling, fermenting, or milling.

Edible portion of plant does not contact the ground.

Not for human ingestion.

No spraying within 30 days of fruit formation.

V. Guidelines for Worker Protection

A. Workers should be informed of the potential health hazards involved with contact or ingestion of reclaimed water, and should be educated regarding proper hygienic procedures to protect themselves and their families.

B. Precautionary measures should be taken to minimize worker contact with reclaimed water.

1. Workers should not be subjected to reclaimed water sprays.

2. Workers should be provided with protective clothing when there will be more than casual contact with the reclaimed water.

3. Where oxidized, coagulated, clarified, filtered, disinfected wastewater is used, less stringent precautions may be allowed.

C. Safe drinking water should be supplied for workers. Where bottled water is provided, the water should be in contamination-proof containers and protected from reclaimed water and dust.

D. Handwashing facilities should be provided.

E. Precautions should be taken to avoid contamination of food taken into reclaimed water use areas. Food should not be taken into areas still wet with reclaimed water.

F. Workers should be notified that reclaimed water is in use. Notification should include the posting of conspicuous warning signs with proper wording of sufficient size to be clearly read.

In those locations where English is not the primary language of the workers, the signs should be in the appropriate language as well as English.

G. An adequate first aid kit should be available on location.

June 10, 1988

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH SERVICES
ENVIRONMENTAL MANAGEMENT BRANCH

POLICY STATEMENT FOR WASTEWATER RECLAMATION PLANTS WITH DIRECT FILTRATION

The California Department of Health Services (DHS) has the authority and responsibility to "establish statewide reclamation criteria for each varying type of use of reclaimed water where such use involves the protection of public health" (Section 13521 of the Porter-Cologne Water Quality Control Act). In response to this mandate, DHS has developed comprehensive wastewater reclamation regulations that establish treatment process, water quality, and treatment reliability requirements in order to ensure that the use of reclaimed water for the specified purposes does not impose undue health risks. While the regulations, known as the Wastewater Reclamation Criteria, prescribe specific treatment unit processes, DHS recognizes that other processes not described in the reclamation criteria also may provide adequate treatment and reliability. In particular, the regulations require an extensive treatment chain, i.e., oxidation, coagulation, clarification, filtration, and disinfection, where DHS has deemed it necessary to provide an essentially pathogen-free effluent because of direct or indirect human contact. The treatment and quality requirements were specifically included to insure removal or inactivation of pathogens, including viruses. Chemical pretreatment is required to enhance particulate removal and provide an adequate level of reliability to the overall treatment process. Filtration clarifies the wastewater so disinfection can be more effective, particularly for virus inactivation.

This policy statement is directed solely at direct filtration, an alternative treatment process intended to produce an effluent that is essentially pathogen-free. DHS evaluates wastewater reclamation proposals and submits appropriate recommendations to the Regional Water Quality Control Boards who, as authorized in the Porter-Cologne Water Quality Act, apply and enforce the reclamation criteria. Local health departments have independent authority and may be more restrictive than either the State DHS or the Regional Water Quality Control Boards.

Equivalent Treatment

Approved Alternatives— The Wastewater Reclamation Criteria include provisions for methods of treatment other than those included in the regulations. The determination of equivalency is made by the State DHS. DHS considers both treatment effectiveness and reliability during evaluation of alternative treatment methods. If, in the opinion of DHS, adequate data are not available to determine equivalency, studies will be required. Generally, data developed by equipment manufacturers are not sufficient, and independent studies conducted in California by qualified researchers, consulting engineers, or others, will be necessary. Pilot plant studies involving seeded virus

sampling may be required. The study protocol should be reviewed and approved by DHS in order to insure that the sampling techniques and data generated will be acceptable to DHS. An alternative may consist of:

1. A specific unit process, e.g., different types of filters;

2. A treatment process, e.g., direct filtration; or

3. A complete treatment chain.

Once an alternative method of treatment is approved for a specific installation, it generally will be acceptable at other locations in the State.

Secondary Effluent Quality

Prior to chemical addition, the wastewater must have received at least secondary treatment, i.e., be an oxidized wastewater as specified in the Wastewater Reclamation Criteria. For the direct filtration type of treatment, the secondary effluent should have a turbidity of less than ten turbidity units. It may be required to have continuous turbidity monitoring of the secondary effluent such that the subsequent coagulant addition can be automatically adjusted to provide adequate coagulant dosages under varying conditions.

Coagulation and Flocculation

1. <u>Coagulants</u>

Coagulants, such as alum, lime, or ferric chloride, and polymers are acceptable if it can be demonstrated that they are effective for turbidity removal and will not adversely affect filtration. The main purpose of coagulation, in conjunction with flocculation, is to enhance particulate removal during the filtration process.

Chemical pretreatment facilities are required in all cases -- even if a filtered effluent can meet the turbidity requirements specified in the Wastewater Reclamation Criteria under normal operating conditions without coagulant addition. Chemical addition prior to filtration may not be required when all of the following conditions are met:

a. There is continuous turbidity measurement of the secondary effluent;

b. The secondary effluent turbidity is five turbidity units or less;

c. Chemical addition is automatically actuated, or the wastewater is diverted prior to disinfection, when the secondary effluent turbidity exceeds five turbidity units; and

d. The filtered effluent turbidity does not exceed two turbidity units.

2. Dosages

Wastewaters can vary appreciably and preliminary studies should be conducted to determine the optimum dose of coagulant and polymer for each proposed project. Chemicals may be needed from a reliability standpoint to assure a high quality effluent under all operating conditions.

3. Coagulation

Adequate initial rapid mixing is necessary to assure effective dispersion of the coagulant into the wastewater.

4. Flocculation

Low energy mixing and sufficient contact time should be provided.

5. Contact Time

There should be adequate time after coagulant addition for a visible floc to form prior to filtration. This floc formation time varies for each wastewater and type of coagulant used. Floc formation may take five minutes or more and the time required should be determined for each individual case. Long contact times may require some form of slow mixing to prevent settling of flocculated particles. Flow turbulence and/or mixing should be controlled to prevent break-up of floc. The addition of coagulant at a location that does not provide adequate contact time is not acceptable and may cause a deterioration of the effluent by inducing flocculation after filtration.

Filtration

1. Rate

A maximum filtration rate of 5 gpm/ft^2 is allowed for all acceptable types of filters except the travelling bridge automatic backwash filter, for which the maximum allowable filtration rate is 2 gpm/ft^2. Compliance with the filtration rate requirement is based on the actual maximum flow rate. Maximum filtration rates less than 5 gpm/ft^2 may

be required for filters not currently shown to be equivalent to standard dual or mixed media filters. The determination of the acceptable filtration rates for such filters will be based on the required pilot plant studies discussed below.

2. Design

Conventional gravity or pressure dual media or mixed media filters are acceptable. Other filters may be acceptable to DHS if pilot plant studies are conducted and the filters are determined to be equivalent to the above-mentioned dual or mixed media filters. Filter equivalency is based on turbidity removal, reliability under varying operating and water quality conditions, etc. One of the currently acceptable alternatives includes the Hydroclear filter. There should be at least 6 minutes between pulses for the Hydroclear pulse mix system and not more than 25 pulses per filter run. The specific pulsing frequency should be determined on an individual case basis. Media specifications of some of the currently acceptable types of filters are given in the following table:

Type of Filter	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
Dual Media	anthracite: 24	1.00-1.20	1.30-1.40
	sand: 12	0.55-0.60	1.15-1.20
Mixed Media	anthracite: 18-24	1.00-1.20	1.60-1.65
	sand: 9	0.40-0.45	1.30-1.50
	garnet: 4-6	0.30-0.35	1.40-1.50
Hydroclear	sand: 10-12	0.45	1.50
Anthracite	anthracite: 48	1.50	1.40
Parkson DynaSand	sand: 40	1.30	1.50
Automatic Backwash	sand: 11	0.55	1.50

Determination of the number of filters to be constructed at a reclamation plant should take into account the fact that not all of the filters will be filtering wastewater at the same time due to backwashing, maintenance, etc. Hence, the design filtration rate should be based on operation under the most stressful expected conditions -- maximum flow rate with one or more filters in the backwash mode or otherwise out of service.

3. Filtered Wastewater Turbidity Monitoring

Turbidity by itself is not intended to be a measure of pathogen removal. Turbidity is used as a measure of the coagulation-flocculation-filtration process effectiveness and as a means of assuring a quality effluent upon disinfection. Therefore, the turbidity requirement specified in the Wastewater Reclamation Criteria must be met after filtration but before disinfection. The criteria state that the filtered wastewater cannot exceed an average of 2 turbidity units and cannot exceed 5 turbidity units more than 5 percent of the time during any 24 hour period. A continuous recording turbidimeter is required for the filtered water. Each filter should be monitored for turbidity to insure that they are all producing water that meets the turbidity standards. Continuous monitoring of each filter may not be necessary if it can be shown that periodic monitoring is adequate to indicate reliable operation of each filter.

Disinfection

1. Chlorine

Chlorine is the accepted disinfectant. Alternatives to chlorine will be considered by DHS if appropriate studies are conducted to demonstrate that the proposed alternative will assure an equal degree of disinfection and reliability. Virus inactivation studies will be required.

2. Contact Time

A theoretical chlorine contact time in a well-baffled contact basin or pipeline of at least 2.0 hours and an actual modal contact time of at least 90 minutes is required. Compliance with the disinfection contact time requirement is based on the actual maximum flow rate. In some cases, storage facilities can be used to help meet the required contact time. The reclamation criteria state that the coliform requirement must be met "at some location in the treatment process." If pipelines or other facilities are used to meet the required chlorine contact time, such facilities are considered to be part of the treatment process and are subject to regulatory controls.

If reduced contact times in combination with increased chlorine dosages are proposed, studies are required to demonstrate that an equivalent degree of disinfection will be provided. This will include virus inactivation studies. Seeded virus studies using attenuated polio virus are

be required for filters not currently shown to be equivalent to standard dual or mixed media filters. The determination of the acceptable filtration rates for such filters will be based on the required pilot plant studies discussed below.

2. Design

Conventional gravity or pressure dual media or mixed media filters are acceptable. Other filters may be acceptable to DHS if pilot plant studies are conducted and the filters are determined to be equivalent to the above-mentioned dual or mixed media filters. Filter equivalency is based on turbidity removal, reliability under varying operating and water quality conditions, etc. One of the currently acceptable alternatives includes the Hydroclear filter. There should be at least 6 minutes between pulses for the Hydroclear pulse mix system and not more than 25 pulses per filter run. The specific pulsing frequency should be determined on an individual case basis. Media specifications of some of the currently acceptable types of filters are given in the following table:

Type of Filter	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
Dual Media	anthracite: 24	1.00-1.20	1.30-1.40
	sand: 12	0.55-0.60	1.15-1.20
Mixed Media	anthracite: 18-24	1.00-1.20	1.60-1.65
	sand: 9	0.40-0.45	1.30-1.50
	garnet: 4-6	0.30-0.35	1.40-1.50
Hydroclear	sand: 10-12	0.45	1.50
Anthracite	anthracite: 48	1.50	1.40
Parkson DynaSand	sand: 40	1.30	1.50
Automatic Backwash	sand: 11	0.55	1.50

Determination of the number of filters to be constructed at a reclamation plant should take into account the fact that not all of the filters will be filtering wastewater at the same time due to backwashing, maintenance, etc. Hence, the design filtration rate should be based on operation under the most stressful expected conditions -- maximum flow rate with one or more filters in the backwash mode or otherwise out of service.

3. Filtered Wastewater Turbidity Monitoring

Turbidity by itself is not intended to be a measure of pathogen removal. Turbidity is used as a measure of the coagulation-flocculation-filtration process effectiveness and as a means of assuring a quality effluent upon disinfection. Therefore, the turbidity requirement specified in the Wastewater Reclamation Criteria must be met after filtration but before disinfection. The criteria state that the filtered wastewater cannot exceed an average of 2 turbidity units and cannot exceed 5 turbidity units more than 5 percent of the time during any 24 hour period. A continuous recording turbidimeter is required for the filtered water. Each filter should be monitored for turbidity to insure that they are all producing water that meets the turbidity standards. Continuous monitoring of each filter may not be necessary if it can be shown that periodic monitoring is adequate to indicate reliable operation of each filter.

Disinfection

1. Chlorine

Chlorine is the accepted disinfectant. Alternatives to chlorine will be considered by DHS if appropriate studies are conducted to demonstrate that the proposed alternative will assure an equal degree of disinfection and reliability. Virus inactivation studies will be required.

2. Contact Time

A theoretical chlorine contact time in a well-baffled contact basin or pipeline of at least 2.0 hours and an actual modal contact time of at least 90 minutes is required. Compliance with the disinfection contact time requirement is based on the actual maximum flow rate. In some cases, storage facilities can be used to help meet the required contact time. The reclamation criteria state that the coliform requirement must be met "at some location in the treatment process." If pipelines or other facilities are used to meet the required chlorine contact time, such facilities are considered to be part of the treatment process and are subject to regulatory controls.

If reduced contact times in combination with increased chlorine dosages are proposed, studies are required to demonstrate that an equivalent degree of disinfection will be provided. This will include virus inactivation studies. Seeded virus studies using attenuated polio virus are

acceptable, but it should be recognized that other enteric viruses may be more resistant to disinfection than polio virus. Hence, analyses for naturally-occurring viruses also may be required by the regulatory agencies.

3. Residual

The chlorine residual after the required contact time should be high enough to consistently meet the coliform requirements. In all cases, automatic control of chlorine dosage and automatic measuring and recording of chlorine residual will be required. The chlorination facilities should have adequate capacity to maintain a residual of 10 mg/l. It may be difficult to consistently meet the median total coliform limit of 2.2/100 ml and the maximum total coliform limit of 23/100 ml with chlorine residuals less than 10 mg/l, particularly if the chlorine is in the combined form, and virus inactivation may be inconsistent and less effective at residuals below that level. In no case should the chlorine residual after the required contact time be less than 5 mg/l. Assessment of pathogen inactivation is based on total coliform and virus studies.

Disinfection equivalency includes a seeded virus reduction of five logs or greater, and statistically equivalent removal of seeded viruses when compared to the contact time and residual stated above. Statistical equivalency should be determined at the 95 percent confidence level based on a minimum of 10 sets of samples.

4. Mixing

There should be a high energy rapid mix of chlorine at the point of application.

5. Design

The chlorine contact tank should be designed to have a length to width and length to depth ratio of at least 40:1 to minimize short circuiting.

State of California
Department of Health Services
Environmental Management Branch

GUIDELINES FOR THE USE OF RECLAIMED WATER FOR CONSTRUCTION PURPOSES

Controls at Treatment Plant

1. Reclaimed water used for soil compaction, dust control, and other construction purposes where the workers or the public have similar access or exposure shall be at all times an adequately disinfected, oxidized wastewater. The wastewater shall be considered adequately disinfected if the median number of coliform organisms in the effluent does not exceed 23 per 100 milliliters, as determined from the bacteriological results of the last seven days for which analyses have been completed, and the number of coliform organisms does not exceed 240 per 100 milliliters in any two consecutive samples.

2. Unless otherwise specified, all applicable sections of the Wastewater Reclamation Criteria must be complied with, including the design, operational, and reliability requirements.

    a. Exceptions to specified sections of the criteria will be considered by the Department of Health Services on an individual case basis.

Controls on Hauling and Use

1. Use sites must be approved by the Regional Water Quality Control Board and the State and local health departments.

2. Truck drivers should be instructed as to the requirements contained herein and the potential health hazards involved with the reuse of wastewater.

3. Tank trucks and other equipment which contain or come in contact with reclaimed water should be clearly identified with warning signs.

4. Tank trucks used for reclaimed water should be thoroughly cleaned of septage or other contaminants prior to use.

5. Use of reclaimed water should not create any odor or other nuisance.

6. Reclaimed water should be confined to the authorized use area.

    a. Ponding or runoff of reclaimed water should not occur.
    b. Aerosol formation during uses involving spraying should be minimized.

7. Reclaimed water should be applied so as to prevent public or employee contact with the water.

8. Reclaimed water must not be introduced into any permanent piping system and no connection shall be made between the tank truck and any part of a domestic water system.

9. Tank trucks should be cleaned and disinfected after the project is completed.

10. Tank trucks used to transport reclaimed water shall not be used to carry domestic water.

SES061680

CRITERIA FOR MOSQUITO PREVENTION IN WASTEWATER RECLAMATION OR DISPOSAL PROJECTS [1/]

California Department of Health Services

Environmental Management Branch

I. Background Statement

California water quality statutes and regulations and current emphasis upon reuse of wastewater have serious prospects for mosquito production. Proposals for reusing effluent and surface runoff or preventing these waters from flowing directly into estuaries or water courses can create new mosquito sources. Kinds of proposals under consideration for the diversion and reuse of wastewater are:

(1) Development of wetland habitat; (2) agriculture irrigation; (3) impoundments for reclamation; (4) recharge of ground water; and (5) industrial use.

The developing aquatic life stages of the mosquito occur in water-holding depressions, containers or other sites. A "mosquito source" is defined as a site suitable for mosquito development if left unmanaged.

The objective of mosquito control is to suppress the mosquito population below the threshold level required for disease transmission or nuisance tolerance level. Mosquito control is accomplished by one or a combination of three methods: (1) manipulation of physical features; (2) biological control; and (3) use of chemicals.

Manipulation of physical features to prevent a mosquito source from developing is the most desirable long-term solution. This can be accomplished through project design and management.

The best known and most common biological control agent is the mosquito-fish Gambusia affinis. This species is widely distributed throughout the state and, in certain situations, where the wastewater is of sufficient quality, is helpful in keeping populations of mosquito larvae down to acceptable levels. The effectiveness of this fish is influenced by such factors as density of the aquatic vegetation, rate of larval production, number of fish per unit of water volume, and the availability of other organisms preferred by the fish.

1/ Prepared in cooperation with the California Mosquito and Vector Control Association. Revised June, 1983.
These criteria will be reviewed by the Environmental Management Branch in 1988 to assess the need for additional criteria for avoidance of situations wherein wastewater is proposed to be discharged into a drainage course, pool or other area where conditions will foster formation of algae growths that can harbor

Chemicals are useful for intermittent or emergency control, but are not recommended for repeated long term use because of cost, environmental concerns and the mosquitoes' capability to develop physiological resistance to the chemicals.

The following criteria are based on knowledge of mosquito ecology. It is important that local mosquito control agencies and the Vector Biology and Control Branch, State Department of Health Services be notified and consulted about impending wastewater use projects. Coordination and cooperation among agencies is vital in order to avoid creation of unnecessary conditions conducive to mosquito production. Certain projects may require a contractual arrangement between the owner and the local mosquito control agency. This contract should provide for ongoing surveillance and for control measures should these become necessary. Any wastewater discharge from the marsh or any other reclamation project must meet requirements set by the Regional Water Quality Control Board.

II. Wastewater Management

A. Water Use

1. All sites designated for wastewater reclamation, recharge, or final disposal (as cropland, marshland, etc.) should either be graded or ditched as necessary for proper water management.

2. Sites for temporary impoundments used for waterfowl feeding areas or for production of food should be flooded according to time intervals seasonally adjusted to prevent the emergence of adult mosquitoes. Contact the local mosquito control agency or the Vector Biology and Control Branch, State Department of Health Services for specific details.

3. Design and operational plans should be developed for wastewater use in crop irrigation and reviewed by the local mosquito control agency. The use of wastewater in crop irrigation requires careful land preparation and judicious water management to prevent excess standing water areas.

4. Wetlands that are operated as shallow water areas (less than 1 foot) should be properly graded in order to facilitate drainage and ditched to provide access for mosquitofish. Deep water impoundments should be provided for at the low ends of the marsh. These impoundments serve as a holding facility for mosquitofish during times when shallow water areas are dewatered.

5. In shallow water areas the type and density of vegetation are critical in determining the effectiveness of mosquitofish. To maintain fish predation, the vegetative growth may have to be periodically removed or harvested. Another alternative for controlling vegetation is to vary the depth of water to discourage certain plant species.

6. Excess water at the low ends of sites used for marsh flooding or crop irrigation must be recycled, utilizing a return system, or disposed of in a drainage facility. If discharge of wastewater is necessary, it must be in compliance with the Regional Water Quality Control Board's discharge requirements.

7. Water control devices such as pumps, weirs, and flood gates should be of proper capacity to draw down the temporary impoundments within a time designated by the local mosquito control agency or the Vector Biology and Control Branch, State Department of Health Services. Where possible a 48-hour draw down period is recommended to interrupt the mosquito life cycle.

B. Storage Ponds

1. Ponds may be any shape but should not have small coves or irregularities around their perimeters.

2. Ponds should be designed to be emptied by gravity or pumping for cleaning or drying and have graded bottoms so all water can be removed.

3. Side slopes of excavations and levees should be as steep as possible, consistent with soil characteristics and risk factors.

4. Where steep side slopes are not feasible, the slopes should be lined with impervious material such as concrete to 3 ft. below the water line or periodically treated with herbicides to achieve weed control.

5. Minimum top width of embankments should be 12 ft. and adequately constructed to support maintenance vehicular traffic.

6. An access ramp should be provided on an inside slope for launching a small boat for midge sampling and control.

7. Ponds designed for long term storage should have a minimum storage depth of 4 ft. to inhibit aquatic vegetation.

8. A maintenance program for weed and erosion control along inner slopes is essential.

9. Accumulations of dead algae, vegetation and debris should be routinely removed from the impounded water surface and properly disposed of.

C. Water Conveyance Facilities

1. Ditches must be maintained free of emergent, marginal and floating vegetation. New seasonal growth of vegetation in ditches must be controlled prior to irrigation of crops with wastewater.

2. Ditches should be sized and graded for adequate flow and must not be used for water storage.

3. Unpressurized and low pressure pipelines should be designed to be emptied when not in use and should not be used for water storage because of the mosquito breeding potential in the partially filled pipes.

Assembly Bill No. 2217

CHAPTER 369

An act to amend Section 92.3 of the Streets and Highways Code, relating to transportation facilities.

[Approved by Governor July 18, 1990. Filed with Secretary of State July 19, 1990.]

LEGISLATIVE COUNSEL'S DIGEST

AB 2217, Baker. Freeways: landscape irrigation: reclaimed water.

Under existing law, the construction, maintenance, and repair of state highways is under the jurisdiction and control of the Department of Transportation. The department is generally required to implement drought resistant freeway landscaping in counties where over 80% of the water supply is imported and use reclaimed water for irrigation purposes whenever possible. Existing law also directs the department to conduct a demonstration project, in cooperation with a local public agency selected by the department, to test and evaluate the use of reclaimed water for freeway landscape irrigation and the transmission of reclaimed water to others when to do so will promote a beneficial use of reclaimed water and that transmission does not unreasonably interfere with use of the highway or unreasonably increase any hazard to vehicles, subject to specified conditions.

This bill would require the department to generally implement drought resistant freeway landscaping and would delete the reference to a demonstration project.

The bill would require the department to permit local public agencies, as defined, and water public utilities, as defined, to place transmission lines for reclaimed water in freeway rights-of-way for their use in transmitting reclaimed water to others, subject to specified conditions and restrictions.

The people of the State of California do enact as follows:

SECTION 1. Section 92.3 of the Streets and Highways Code is amended to read:

92.3. (a) The department shall do both of the following:

(1) Discontinue further water intensive freeway landscaping and use drought resistant landscaping whenever feasible, taking into consideration such factors as erosion control and fire retardant needs.

(2) Eliminate any dependency on imported water for landscaping as soon as practicable.

(b) The department shall require the use of reclaimed water for the irrigation of freeway landscaping when it finds and determines that all of the following conditions exist:

1) The reclaimed water is of adequate quality and is available in
quate quantity for the proposed use.
2) The proposed use of the reclaimed water is approved by the
ifornia regional water quality control board having jurisdiction.
3) There is a direct benefit to the state highway program for the
posed use of reclaimed water.
4) The reclaimed water is supplied by a local public agency or
ter public utility able to contract for delivery of water and the
tallation, maintenance, and repair of facilities to deliver the water.
5) The installation of the water delivery facilities does not
easonably increase any hazard to vehicles on the freeway or
ate unreasonable problems of highway maintenance and repair.
c) The department shall report to the Legislature on or before
uary 1, 1988, and every three years thereafter, on the progress of
department in complying with this section. For each landscaping
ject subject to this section which is listed in the most recently
pted state transportation improvement program, the
partment shall identify the closest potable water supply and the
sest reclaimed water supply, together with a statement explaining
ich water source was selected for irrigation purposes, and the
sons why that source was selected.
(d) In cooperation with local public agencies and water public
lities, the department shall permit local public agencies and water
blic utilities to place transmission lines for reclaimed water in
eway rights-of-way for use by the local public agencies and water
blic utilities to transmit reclaimed water to others, when to do so
ll promote a beneficial use of reclaimed water and that
nsmission does not unreasonably interfere with use of the freeway
unreasonably increase any hazard to vehicles on the freeway,
ject to paragraphs (1) to (5), inclusive, of subdivision (b) and the
lowing additional requirements:
(1) The local public agency or water public utility holds the
partment harmless for any liability caused by a disruption of
vice to other users of the reclaimed water and will defend the
partment in any resulting legal action and pay any damages
arded as a result of that disruption.
(2) The department, in cooperation with the local public agency
water public utility, may temporarily interrupt service in order to
l to or modify its facilities without liability, as specified in
ragraph (1).
(3) The local public agency or water public utility obtains and
nishes the department an agreement by all other users of
claimed water from the transmission system holding the
partment harmless for any disruption in service.
(4) The local public agency or water public utility has furnished
e department a list of other reclaimed water users and information
any backup system or other source of water available for use in
e of a service disruption.

(5) The local public agency is responsible for the initial cost or any relocation cost of the reclaimed water transmission lines for service to other users in the right-of-way and waives its rights to require the department to pay the relocation costs pursuant to Sections 702 and 704.

(6) The local public agency or water public utility maintains the water transmission system subject to reasonable access for maintenance purposes to be negotiated between the department and the local public agency or water public utility.

(7) The department has first priority with respect to the reclaimed water supply contracted for by the department.

(8) The local public agency or water public utility installs an automatic control system which will allow the water transmission system to be shut down in case of an emergency. The department shall have access to all parts of the transmission system for purposes of the agreement.

(9) All transmission lines are placed underground and as close as possible to the freeway right-of-way boundary or at other locations authorized by the department.

(10) The plans and specifications for the reclaimed water transmission facilities have been approved by the department prior to construction.

(e) As used in this section:

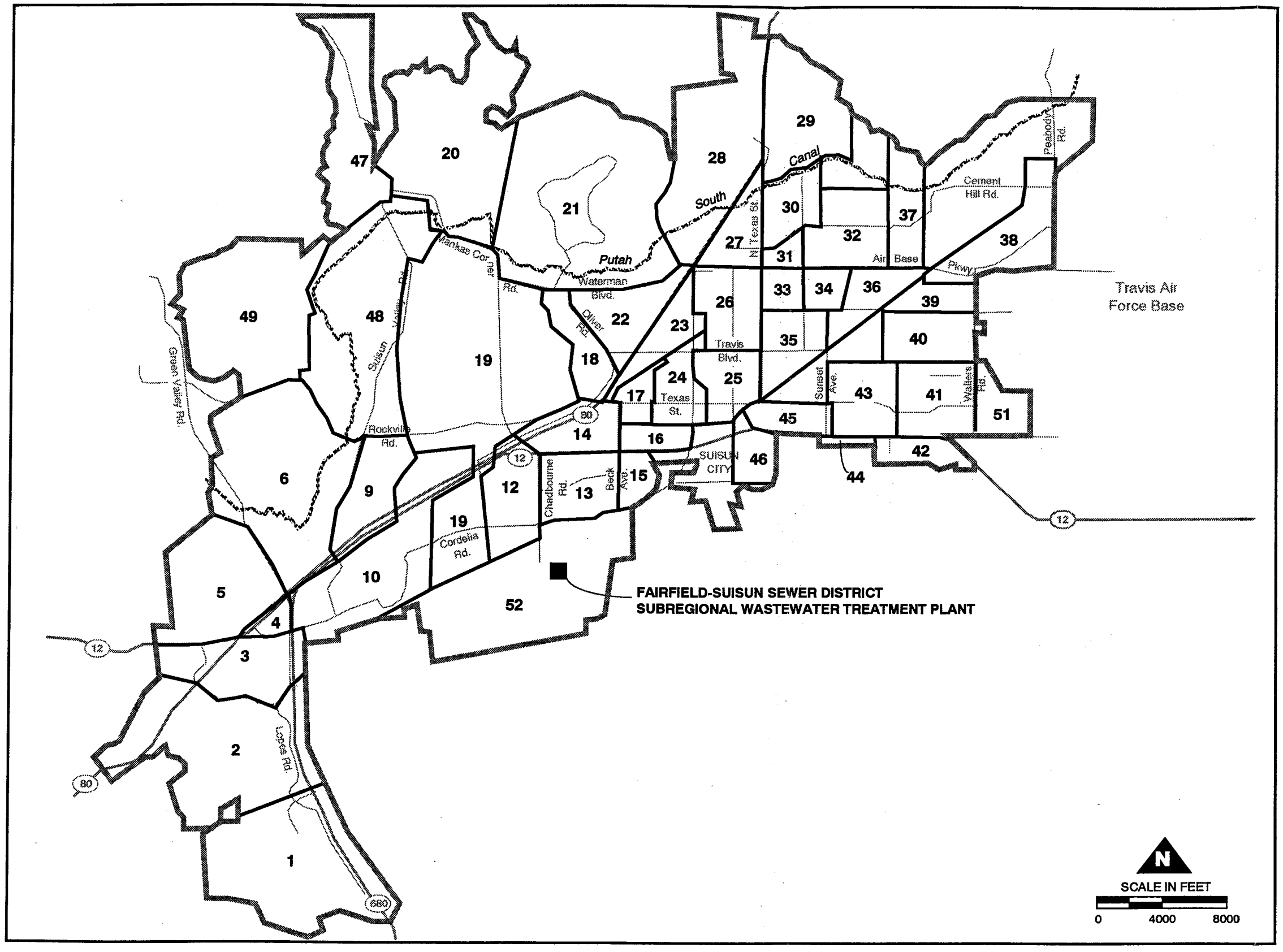
(1) "Local public agency" means any local public agency which transmits or supplies reclaimed water to others.

(2) "Water public utility" means any privately owned water corporation which is subject to the jurisdiction and control of the Public Utilities Commission.

Appendix C

APPENDIX C

POTENTIAL NON-POTABLE WATER DEMANDS



LEGEND

- STUDY AREA
- DEMAND POLYGON BOUNDARY
- 38 POLYGON NUMBER

CITY OF FAIRFIELD
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
WATER DEMAND POLYGONS

FIGURE C-1

JMM

TABLE C-1
NON-POTABLE WATER DEMANDS BY POLYGON

Polygon (a)	Demands (acre-ft/yr) Irrigation	Industrial	Major Customers
1	6.84		Future public facilities and commercial
2	54.73		Oakbrook School, Ridgeview Park, Lopes Rd/Silver Creek Rd./Oakbrook Drive; future recreation and commercial
3	100.12		Industrial, Red Top Rd/Lopes Rd; future industrial
4	21.09		Industrial; future industrial.
5	70.00		Future public facilities and recreation
6	70.00		Suisun Valley Rd.; future industrial, public facilities, and recreation
9	190.00		Solano Community College and FF Corp Commons (total ≈ 230 AF/yr), and industrial (both existing and future)
10	333.00		Agricultural - Young Lateral, and public facilities; future agricultural
12	390.98		Busch Corporate Center, Hwy 12/I-80, and Chadbourne Rd.; future industrial
13	152.54	341.60	Solano and Low Business Parks, Pacific Bell, S. Watney Way, Beck Avenue, Courage Drive; future industrial
14	11.50		I-80/West Texas St.
15	47.45		Industrial; future industrial (Gentry-Pierce Business Park)
16	33.77		Industrial and public facility (Sheldon School, Woolner Ave. School), Redevelopment Agency; future industrial
17	173.01		Linear Park, Allan Witt Park, Old County Jail, and Juvenile Hall
18	19.47		Woodcreek Park and Oliver Rd.; future commercial
19	2,050.00		Agricutltural - Pierce Lateral B and Chadbourne Lateral
20	671.00		Agricutltural - Lambert Lateral (@ 50 percent total demand)
21	857.95		Rancho Solano golf course, B. Gale Wilson Elementary and pub. facility
22	113.49		K.I. Jones Elementary, Mankas Park, Waterman WTP, Howe St./Waterman Blvd./Woodcrk/Cap; future recreation
23	76.42		Weir School, North Bay Medical Center, Solano Mall, N. Bay Dr., I-80/Travis, Pennsylvania, Travis, Dana Dr.
24	47.21		Fairview School, Civic Center, FF Medical Arts, FF Corp Yard, FF/Suisun Adult H.S., Sem Yeto H.S., Penn.
25	122.59		Lee Bell Park, Tot Lot, Fairfield School,P.O., Armijo H.S., Webster St., N. Texas St.
26	116.05		Sullivan School, Fairfield/Suisun Cemetery, Veterans Memorial Park, Bransford Sch, Fire Sta #1, Texas, Travis
27	33.68		Hillview Park, Amy Blanc School, I-80/ABP, ABP, N. Texas St.
28	170.31		Agricutltural, Martin Road (NOT INCLUDED IN ANALYSIS)
29	2,134.54		Future Paradise Valley and Lagoon Valley
30	0.00		Sunrise Park, Church of Jesus Christ, Dickson Hill WTP, Dickson Hill/Dover
31	95.12		Fairfield High School, Air Base Parkway, Cement Hill/Dover, Dover/Atlantic
32	108.22		Public facility and Laurel Park; future recreation
33	18.87		Mary Bird School, Dover School, E. Pacific Ave., E. Tabor Ave.
34	17.01		Gordon School
35	41.92		Kyle School, Dover Park, Sunset Avenue; future recreation
36	53.62		Grange School, H.G. Richardson School, Meadow Park, Tabor Park, Dover Park Trail
37	152.45		Det. Facil., Animal Shelter, industrial, Cement Ranch, ABP/Cement Hill/Baytree
38	163.67		Industrial, Peabody Rd/Dobe Lane/Whitney Drive; future Tolenas Industrial Park (NOT INCLUDED IN ANAL.)
39	9.00		Tolenas Park
40	700.00		Commercial, Tolenas School, recreation, rural residential (Tolenas), and Prosperity Road landscape
41	35.48		Dan Root Elementary, Goepp Park, and Highway 12, Scandia Road, and Walters Road landscapes
42	35.18		Lawler Ranch area and Potrero Hills landfill
43	54.99		Suisun Elementary, Carl E. Hall Park/Comm. Rec. Ctr./Fire Station, Heritage Park, and Hwy. 12 landscape
44	8.06		Future commercial office
45	8.75		Highway 12 landscape
46	69.16		Crescent Elementary, Mike Day Park and Todd Park
47	586.00		Agricultural - Lambert Lateral "A" (@ 50 percent total demand)
48	303.50		Agricultural - Lateral 49 (@ 50 percent total demand)
49	718.50		Future White Wing Golf Course
50	39.90		Highway 12 landscaping and Potrero Hills landfill
51	200.00		Suisun Sports Complex
52	2,000.00		Turf nursery
Total (acre-ft/yr)	13,153.13	341.60	

(a) Refer to Figure C-1 for delineation of polygon areas.

TABLE C-2
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
INVENTORY OF EXISTING POTENTIAL IRRIGATION WATER DEMANDS

Irrigation Site	Gross Acreage	Landscaped Acreage	Water Duty (acre-ft/acre/yr)	Average Annual Demand (acre-ft/yr)
SCHOOLS				
Amy Blanc Elementary	11.3	8.0	2.8	22.46
Bransford Elementary	7.2	3.6	2.8	10.08
Crescent Elementary (K-3)	N/A	14.7	2.8	41.13
Dan Root	N/A	4.6	2.8	12.85
Dover Elementary	9.3	5.5	2.8	15.32
Fairfield Elementary	N/A	21.9	2.8	61.21
Fairview Elementary	9.9	4.3	2.8	11.90
Gordon Elementary	10.2	6.1	2.8	17.00
K. I. Jones Elementary	N/A	4.0	2.8	11.23
Kyle Elementary	9.5	5.5	2.8	15.32
Oakbrook Elementary	N/A	8.3	2.8	23.13
Richardson Elementary	10.7	4.9	2.8	13.61
Sheldon Elementary	8.3	3.2	2.8	8.85
Weir Elementary	8.7	3.9	2.8	10.89
B. Gale Wilson Elementary (SID)	N/A	24.3	2.8	68.01
Suisun Elementary (K-4)	N/A	6.2	2.8	17.36
Tolenas Elementary	N/A	10.3	2.8	28.92
Grange Middle	10.0	4.7	2.8	13.27
Sullivan Middle	10.4	6.0	2.8	16.66
Armijo High School	36.2	17.6	2.8	49.28
Fairfield High School (SID)	50.5	20.0	2.8	56.11
Mary Bird Con. High School	2.4	1.1	2.8	3.05
Sam Yeto Con. High School	2.6	0.2	2.8	0.56
Fairfield-Suisun Adult	2.8	0.8	2.8	2.24
Solano Community College	N/A	N/A	N/A	120.00
SUBTOTAL	N/A	N/A	N/A	650.43

TABLE C-2
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
INVENTORY OF EXISTING POTENTIAL IRRIGATION WATER DEMANDS

Irrigation Site	Gross Acreage	Landscaped Acreage	Water Duty (acre-ft/acre/yr)	Average Annual Demand (acre-ft/yr)
PARKS- FAIRFIELD (a)				
Allan Witt	50.0	27.0	2.5	67.50
Linear Park Trail	31.1	9.6	2.5	24.00
Lee Bell	7.2	5.5	2.5	13.75
Dover	8.2	5.2	2.5	13.00
Laurel Creek	27.9	20.4	2.5	51.10
Laurel Creek Bike Trail	4.1	0.0	2.5	0.00
Hillside Bike Trail	6.6	0.0	2.5	0.00
Hillview	5.4	4.8	2.5	12.00
Mankas	6.4	5.6	2.5	14.00
Meadow	4.3	4.0	2.5	9.90
Rialto Bike Trail	1.5	0.8	2.5	1.88
Ridgeview	6.9	6.0	2.5	15.00
Sunrise	7.0	6.3	2.5	15.80
Tabor	6.0	3.0	2.5	7.50
Tolenas	4.1	3.6	2.5	9.00
Veterans Memorial	5.0	4.5	2.5	11.15
Woodcreek	5.6	4.9	2.5	12.23
Camrose Park Trail	1.1	1.1	2.5	2.75
Dover Park Trail	4.3	4.3	2.5	10.75
SUBTOTAL	192.6	116.5	N/A	291.30
PARK MAINTENANCE AREAS (a)				
Corp Yard	0.2	0.2	2.5	0.55
Dickson Hill WTP	0.2	0.2	2.5	0.38
Fire Station No. 1	0.4	0.4	2.5	0.93
Fire Station No. 4	0.9	0.8	2.5	2.12
Martin Hill Reservoir	2.5	1.0	2.5	2.48
Parking Lots - No. 8	2.0	0.1	2.5	0.31
Post Office	1.1	0.5	2.5	1.20
Ray Venning WTP	0.1	0.1	2.5	0.35
Tot Lots	0.3	0.2	2.5	0.40
Waterman WTP	28.2	1.2	2.5	2.88
SUBTOTAL	35.9	4.6	N/A	11.59

TABLE C-2
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
INVENTORY OF EXISTING POTENTIAL IRRIGATION WATER DEMANDS

Irrigation Site	Gross Acreage	Landscaped Acreage	Water Duty (acre-ft/acre/yr)	Average Annual Demand (acre-ft/yr)
STREETSCAPES (a)				
Beck Avenue & Areas	6.4	6.4	2.5	15.96
Airbase Parkway	42.6	42.6	2.5	106.56
Bay Tree Drive & Cement Hill Rd.	0.2	0.1	2.5	0.22
Cement Hill Rd. & Dover Avenue	2.9	1.2	2.5	3.00
Dickson Hill Rd. & Dover Avenue	1.0	0.6	2.5	1.47
Dover Avenune & Atlantic Avenue	0.3	0.2	2.5	0.38
East Pacific Avenue	0.1	0.1	2.5	0.22
East Tabor Avenue	0.2	0.1	2.5	0.16
Howe Street	0.7	0.5	2.5	1.36
Lopes Road & Silver Creek Road	0.3	0.2	2.5	0.57
Martin Road	0.2	0.1	2.5	0.32
North Bay Drive	0.1	0.1	2.5	0.14
North Texas Street	0.9	0.9	2.5	2.16
Oakbrook Drive	0.8	0.5	2.5	1.19
Oakbrook Drive & Lopes Road	1.6	1.0	2.5	2.51
Oliver Road	2.5	1.4	2.5	3.55
Red Top Road & Lopes Road	2.8	1.7	2.5	4.32
Suisun Valley Road	0.7	0.7	2.5	1.67
Sunset Avenue	0.4	0.2	2.5	0.61
Waterman Boulevard	1.1	0.5	2.5	1.36
Webster Street	0.9	0.8	2.5	2.12
Woodcreek Drive & Capitola Way	0.2	0.2	2.5	0.38
Willow Lane & Peppertree Drive	0.1	0.1	2.5	0.16
Courage Drive	21.2	21.2	2.5	53.00
South Watney Way	0.9	0.9	2.5	2.25
Chadbourne Road	9.0	9.0	2.5	22.50
Pennsylvania Avenue	1.3	1.3	2.5	3.25
Claybank Rd./Cement Hill Rd./Canal St.	0.5	0.5	2.5	1.3
Cement Hill Rd./Baltic Ct.	0.1	0.1	2.5	0.2
Airbase Parkway/Claybank Rd.	0.1	0.1	2.5	0.1
Dixon Hill Rd/Peppertree Dr/Evergreen	1.1	1.1	2.5	2.9
Gulf Drive/Peppertree Drive	0.2	0.2	2.5	0.4
Peabody Rd./Dobe Lane/Whitney Drive	1.1	1.1	2.5	2.8
Rancho Solano Clubhouse	1.1	0.4	2.5	1.07
Downtown Area	0.3	0.3	2.5	0.8
Travis Boulevard	1.3	1.2	2.5	2.91
SUBTOTAL	104.9	97.5	N/A	243.78

TABLE C-2
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
INVENTORY OF EXISTING POTENTIAL IRRIGATION WATER DEMANDS

Irrigation Site	Gross Acreage	Landscaped Acreage	Water Duty (acre-ft/acre/yr)	Average Annual Demand (acre-ft/yr)
HIGHWAY INTERCHANGES				
West Texas Avenue/I-80	4.6	4.6	2.5	11.50
Highway 12/I-80	4.0	4.0	2.5	10.00
Travis Boulevard/I-80	4.0	4.0	2.5	10.00
Airbase Parkway/I-80	4.0	4.0	2.5	10.00
SUBTOTAL	12.6	12.60	N/A	41.50
PUBLIC FACILITIES/RECREATION				
County Jail/Juvenile Hall Complex	N/A	16.0	2.5	40.00
Civic Center	33.4	6.2	2.5	15.50
Cemetery	N/A	29.0	2.5	72.58
County Detention Facility/Animal Shelter	N/A	61.0	2.5	152.45
Rancho Solano Golf Course	N/A	N/A	N/A	738.00
White Wing Golf Course	N/A	165.0	2.5	412.50
SUBTOTAL	N/A	N/A	N/A	1,431.03
INDUSTRIAL / COMMERCIAL				
Solano and Low Business Parks	260.0	33.0	2.5	82.50
Pacific Bell	N/A	N/A	N/A	89.59
Busch Corporate Center	250.0	35.0	2.5	87.50
Gentry-Pierce Business Park	78.0	11.0	2.5	27.50
Fairfield Redevelopment Agency	27.0	4.0	2.5	10.00
Tolenas Industrial Park	460.0	52.0	2.5	130.00
Strassberger Industrial Park	35.0	5.0	2.5	12.50
Cement Ranch	329.0	46.0	2.5	115.00
Cross Industrial Park	10.0	1.0	2.5	2.50
Solano Mall	131.0	18.0	2.5	45.00
SUBTOTAL	N/A	N/A	N/A	602.09

TABLE C-2
CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
INVENTORY OF EXISTING POTENTIAL IRRIGATION WATER DEMANDS

Irrigation Site	Gross Acreage	Landscaped Acreage	Water Duty (acre-ft/acre/yr)	Average Annual Demand (acre-ft/yr)
SUISUN CITY (b)				
Mike Day Park	2.8	1.1	2.5	2.70
Minipark Florida	0.1	0.1	2.5	0.33
Civic Center Blvd. Median	1.2	0.0	2.5	0.00
Minipark Plaza	0.9	0.0	2.5	0.04
Scandia Rd. Landscape	1.5	0.4	2.5	1.09
Geopp Park	4.4	4.1	2.5	10.27
Hall Park/Rec. Center/Fire Station	11.4	4.8	2.5	12.12
Todd Park	10.5	10.1	2.5	25.31
Classics West Landscape	2.5	0.6	2.5	1.39
3-Acre Lawler Park	3.0	2.8	2.5	6.89
1-Acre Lawler Park	1.0	0.9	2.5	2.25
Lawler Ranch-1 Landscape	1.1	0.4	2.5	1.06
Heritage Park	9.4	6.8	2.5	16.88
Heritage Park Landscape	0.8	0.8	2.5	2.00
Montebello Vista Park	5.1	4.8	2.5	11.96
Blossom Heights Landscape	0.8	0.1	2.5	0.31
Blossom Meadows Landscape	0.1	0.0	2.5	0.05
Walters Rd. Landscape (West Side Only)	0.3	0.3	2.5	0.75
Prosperity Rd. Landscape	1.5	1.5	2.5	3.75
Montebello Vista Lndsc. (E.Walters Rd)	0.7	0.7	2.5	1.75
Boat Launch Park	2.5	0.2	2.5	0.42
Park & Ride Facility	1.0	0.0	2.5	0.00
Lawler Ranch-2	2.4	0.0	2.5	0.00
Lawler Ranch-3	3.1	0.6	2.5	1.41
Lawler Unit 3 - Highway 12 Streetscape	0.1	0.0	2.5	0.02
Lawler Unit 4	0.2	0.0	2.5	0.00
Lawler Unit 4A	0.6	0.0	2.5	0.00
Lawler Unit 6	0.1	0.0	2.5	0.00
Lawler Ranch Villas	0.5	0.5	2.5	1.14
Potrero Hills Landfill	N/A	N/A	N/A	22.40
Suisun Sports Complex	N/A	N/A	N/A	200.00
SUBTOTAL	N/A	N/A	N/A	326.30
TOTAL	N/A	N/A	N/A	3,598.02

(a) Source: City of Fairfield Parks Division
(b) Source: City of Suisun City

Appendix D

APPENDIX D

LANDSCAPE INVENTORY AND EVALUATION

CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
PLANT INVENTORY

Introduction

The following plant palette is a compilation of plant lists provided by the City of Fairfield and the Fairfield Suisun School District and a visual inventory of other plants found at ten study sites and other areas within the study area. The categories in which these plant materials appear refer to their expected overall horticultural performance when irrigated with reclaimed water.

Plant Category • Selection Criteria

The criteria used to categorize the plants are as follows:

1. *General plant tolerance to salt conditions, with an emphasis on the increased sodium content often associated with reclaimed water.* This factor was the most important in determining the potential effect of reclaimed water on overall plant performance.

2. *General drainage requirements of the plant material related to soil type when combined with the application of reclaimed water.* In general, the drainage characteristics of the soils in the Fairfield/Suisun area are moderate to slow draining clay soils. This condition in combination with the increased salt content of reclaimed water can affect plant performance, making it the next most important consideration in determining the appropriate category for a particular plant.

3. *Wind tolerance.* This was used to verify a plant's wind tolerance to the weather conditions of the Fairfield/Suisun area.

4. *Climate Zone 15.* All of the plants listed were recommended for Climate Zone 15 (Cold-Winter Portions of Northern California's Coastal Climate) as defined in the *Sunset Western Garden Book.*

Additional Assumptions and Considerations

Plant tolerance categories reflect the following additional considerations and/or assumptions:

a. Only reclaimed water is to be used for irrigation.

b. Plants in the moderate or low to poor tolerance categories would potentially perform better if a suitable raw water source were occasionally used to control salts and elemental accumulation in the soil that would be typical of a reclaimed water only application.

c. Plants whose tolerance of reclaimed water has yet to be field-tested or observed have been placed in the Unknown category.

CENTRAL SOLANO DUAL WATER SYSTEMS MASTER PLAN
PLANT INVENTORY

PLANT MATERIAL WITH GOOD SALT TOLERANCE

Plants that typically exhibit reasonable growth characteristics, normal overall appearance and color.

TREES:

Casuarina equisetifolia - Horsetail Beefwood*
Cedrus deodara - Deodar Cedar
Palm spp. - Palm varieties (most species do well)*
Pinus halepensis 'Brutia' - Calabrian Pine
Salix babylonica - Weeping Willow
Trachycarpus fortunei - Windmill Palm*

SHRUBS:

Cortaderia selloana - Pampas Grass
Dodonea viscosa 'Purpurea' - Purple Hopseed Bush
Nerium oleander - Oleander*
Pyracantha - Firethorn*

GROUNDCOVER & VINES:

Baccharis pilularis - Coyote Bush*
Coprosma kirkii - Coprosma*
Myoporum parvifolium - N.C.N.
Myoporum parvifolium 'Prostratum' - N.C.N.*
Osteospermum - African Daisy*
Rosmarius officinalis - Rosemary
Rosmarinus officinalis - Rosemary (upright variety)
Rosmarinus officinalis 'Prostratus' - Dwarf Rosemary
Carpobrotus Edulus - Ice Plant

PLANT MATERIAL WITH MODERATE SALT TOLERANCE

Plants that may exhibit light to moderate leaf burn or yellowing on older leaves, especially during the drier months. Their overall appearance is reasonably good.

TREES:

Acacia longifolia - Acacia*
Acacia melanoxylon - Golden Wattle Acacia*
Alnus rhombifolia - White Alder*
Ceratonia siliqua - Carob Tree*
Cupressocyparis leylandii - Leyland Cypress
Eucalyptus globulus - Blue Gum*
Eucalyptus globulus 'Compacta' - Dwarf Blue Gum*
Eucalyptus melliodora - Honey-scented Eucalyptus*
Eucalyptus polyanthemos - Silver Dollar Gum*

TREES (cont.):

Eucalyptus sideroxylon - Red Ironbark*
Eucalyptus sideroxylon 'Rosea' - Red Bark Eucalyptus*
Eucalyptus viminalis - Manna Gum*
Fraxinus oxycarpa 'Raywood' - Raywood Ash
Fraxinus uhdei - Evergreen Ash*
Juniperus occidentalis - Western Juniper
Liquidambar styraciflua - American Sweet Gum
Morus alba - White Mulberry
Pinus halepensis - Aleppo Pine
Pinus pinea - Italian Stone Pine
Pinus radiata - Monterey Pine
Populus alba 'Pyramidalis' - Bolleana Poplar
Populus nigra 'Italica' - Lombardy Poplar
Pyrus 'Kawakami' - Evergreen Pear
Pyrus calleryana 'Bradford' - Bradford Pear
Ulmus parvifolia - Chinese Elm

SHRUBS:

Abelia grandifolia - Glossy Abelia
Agapanthus africanus - Lily-of-the-Nile
Arctostaphylos hookeri - Monterey Manzanita
Callistemon - Bottlebrush*
Ceanothus 'Concha' - Wild Lilac var.
Elaeagnus pungens - Silverberry
Escallonia 'Fradesi' - Escallonia*
Escallonia rubra - N.C.N.*
Euryops - N.C.N.*
Grevillia noellii - N.C.N.
Heteromeles arbutifolia - Toyon
Juniperus chinensis - Juniper
Juniperus chinensis 'Columnaris' - Columnar-type Juniper
Juniperus chinensis 'Pfitzerana' - Pfitzer Juniper
Juniperus chinensis 'Torulosa' - Hollywood Juniper
Juniperus procumbens - Japanese Garden Juniper
Lantana radiation - N.C.N.*
Lantana selloniana - N.C.N.*
Ligustrum japonicum - Japanese Privet
Nandina 'Nana compacta' - Heavenly Bamboo
Nandina compacta 'Nana' - Heavenly Bamboo
Nandina domestica var. - Heavenly Bamboo
Phormium tenax - New Zealand Flax
Photinia - N.C.N.
Photinia fraseri - Photinia
Photinia serrulata - Chinese Photinia
Pittosporum tenuifolium - N.C.N.
Pittosporum tobira - Tobira
Pittosporum tobira 'Wheelers Dwarf' - Tobira

SHRUBS (cont.):

Pittosporum undulatum - Victorian Box
Platycladus orientalis - Oriental arborvitae
Plumbago capensis - Cape Plumbago*
Raphiolepis - N.C.N.
Raphiolepis indica - India Hawthorn
Raphiolepis indica 'Springtime' - India Hawthorn
Rhamnus alaternus - Italian Buckthorn
Rosa - Hybrid Tea Roses
Xylosma congestum - Shiny Xylosma

GROUNDCOVER & VINES:

Acacia redolens - N.C.N.*
Arctotheca calendula - Capeweed
Festuca - Hard Fescue
Hypericum - St. Johnswort*
Jasminium polyanthum - Jasmine
Lonicera japonica - Japanese Honeysuckle

TURF GRASSES:

Red Fescue - Turf

PLANT MATERIAL WITH LOW TO POOR SALT TOLERANCE

Plants that may exhibit retarded growth, significant leaf burn and, in some cases, early leaf drop. Their overall aesthetics are noticeably reduced.

TREES:

Acer palmatum - Japanese Maple
Acer spp. - Red or Silver Maple
Albezia julibrissan - Silk Tree
Betula spp. - Birch*
Fraxinus oxycarpa 'Raywood' - Raywood Ash
Lagerstoemia indica - Crape Myrtle
Liriodendron tulipifera - Tulip Tree
Magnolia grandiflora - Bull Bay
Magnolia grandiflora 'Russett' - Southern Magnolia
Magnolia soulangiana - Saucer Magnolia
Malus floribunda - Japanese Flowering Crabapple*
Pinus canariensis - Canary Island Pine*
Pistache chinensis - Chinese Pistache
Prunus cerasifera - Cherry Plum
Prunus cerasifera 'Atropurpurea' - Flowering Purple-leaf Plum
Prunus serrula - Birch Bark Cherry
Prunus spp. - Ornamental Cherry
Prunus yedoensis - Yoshino Flowering Cherry
Quercus agrifolia - Coast Live Oak
Sequoia sempervirens - Coast Redwood

SHRUBS:

Arctostaphyllos spp. - Manzanita
Camellia japonica - N.C.N.*
Ceanothus 'Frosty Blue' - Wild Lilac
Cistus spp. - Rockrose
Cotoneaster lacteus - Parney Cotoneaster
Rhododendron azalea - Evergreen Azalea

GROUNDCOVER & VINES:

Cotoneaster dammeri - Bearberry Cotoneaster
Hedera helix - English Ivy
Trachleospermum jasminoides - Star Jasmine

PLANT MATERIAL WITH UNKNOWN SALT TOLERANCE

TREES:

Cinnamomum camphora - Camphor Tree*
Crataegus - Hawthorn
Crataegus phaenopyrum - Washington Thorn
Eriobotrya japonica - Loquat
Fraxinus velutina 'Modesto' - Modesto Ash
Ginko biloba - Maidenhair Tree
Gleditsia triacanthos var. - Honey Locust
Maytenus boaria - Mayten Tree
Olea europaea - Olive
Picea pungens - Colorado Spruce
Pinus canariensis - Canary Island Pine
Pinus muricata - Bishop Pine
Pinus thunbergiana - Japanese Black Pine
Platanus acerifolia 'Yarwood' - London Plane Tree
Platanus racemosa - California Sycamore
Platycladus orientalis - Oriental arborvitae
Podocarpus gracilior - Fern Pine
Quercus ilex - Holly Oak
Quercus palustris - Pin Oak
Quercus suber - Cork Oak
Quercus wislizenii - Interior Live Oak
Rhus spp. - Sumac
Schinus molle - California Pepper*
Sequoiadendron giganteum - Giant Sequoia
Zelkova serrata - Sawleaf Zelkova

SHRUBS:

Acacia redolens - Acacia*
Berberis mentorensis - Barberry
Berberis thunbergii - Japanese Barberry
Berberis thunbergii 'Atropurpurea' - Red-leaf Japanese Barberry

SHRUBS (cont.):

Chaenomeles - Flowering Quince
Coleonema - Breath of Heaven*
Dietes - Fortnight Lily*
Elaegnus pungens/fruitlandii - Fruitland Silverberry
Escallonia exoniensis 'Compacta' - N.C.N
Fatsia japonica - Japanese Aralia
Felicia amelloides - Blue Marguerite
Fremontodendron - Flannel Bush
Genista racemosa - Sweet Broom
Ilex cornuta 'Rotunda' - Dwarf Chinese Holly
Ilex morea - Holly
Mahonia aquifolium - Oregon Grape
Prunus caroliniana - Carolina Laurel Cherry
Prunus laurocerasus "Zabeliana' - Zabel Laurel
Rumohra adiantiformus - Leatherleaf Fern
Wisteria sinensi - Chinese Wisteria

GROUNDCOVER & VINES:

Bergeneia - N.C.N.*

FRUIT TREES / VINES

Apricot
Fig
Grape vines
Juglans hindsii - Black Walnut
Juglans regia - English Walnut

**City of Fairfield staff have noticed one or more of the following problems with the species marked with an asterisk:*

a) Maintenance or cultural problems.
b) Plant disease problems
c) Freeze or mortality problems from the freeze of 1990-1991 (11°F with wind chill).

N.C.N. = No Common Name

Appendix E

APPENDIX E

FSSD RECLAIMED WATER FACILITIES REVIEW

TECHNICAL MEMORANDA

FAIRFIELD-SUISUN SEWER DISTRICT
SUBREGIONAL WASTEWATER TREATMENT PLANT

TECHNICAL MEMORANDUM NO. 1

SUBJECT: Reclaimed Water Facilities

DATE: July 1, 1991

PREPARED BY: James W. Gossett

This technical memorandum summarizes existing wastewater reclamation requirements and their application to the use of Fairfield-Suisun Sewer District (FSSD) treatment facilities to produce reclaimed water. The limitations of existing facilities related to reclamation are addressed and the impact of potential changes in the regulations are evaluated.

RECLAMATION REQUIREMENTS AND GUIDELINES

Use of FSSD plant effluent as reclaimed water is governed by the requirements of Title 22, Division 4 of the California Administrative Code, Wastewater Reclamation Criteria, along with subsequent supplemental guidelines established in the 1988 Department of Health Services (DOHS) "Policy Statement for Wastewater Reclamation Plants With Direct Filtration." Title 22 regulations for Spray Irrigation of Food Crops, the most stringent of the reclamation regulations addressed in this document, require that the reclaimed water "...be at all times an adequately disinfected, oxidized, coagulated, clarified, filtered wastewater." These same requirements apply to landscape irrigation with direct public contact, such as that for parks, playgrounds and school yards. As defined in Title 22, "...wastewater shall be considered adequately disinfected if at some location in the treatment process the median number of coliform organisms does not exceed 2.2 per 100 milliliters and the number of coliform organisms does not exceed 23 per 100 milliliters in more than one sample within any 30 day period." The Filtered Wastewater definition contained in Title 22 requires that effluent turbidity following filtration does not exceed an average of 2 turbidity units and does not exceed 5 turbidity units more than 5 percent of the time in any 24 hour period.

Attached Table 5-4 from the Stage I and Stage II Expansion Preliminary Design Report (December 1989) summarizes Title 22 reclaimed water requirements for various food and fodder crop applications, landscape irrigation, and other purposes.

For all of the above reclamation applications which Title 22 requires coagulation and clarification prior to filtration, the 1988 "Policy Statement For Wastewater Reclamation Plants with Direct Filtration" permits elimination of the clarification step under very specific conditions. The specific conditions under which such direct filtration is permitted are as follows:

- Secondary effluent turbidity is less than 10 turbidity units.

- Chemical coagulants such as alum, lime or ferric chloride, and polymers are added to the filter feed with adequate initial rapid mixing to assure effective dispersion into the wastewater.

- There is adequate contact time after coagulant addition for a visible floc to form prior to filtration. (Five minutes is recommended as a minimum contact time.)

- Filter loading rates are limited to 5 gpm/ft^2 at maximum flow.

- Filter effluent turbidity is continuously recorded and does not exceed Title 22 limits.

- Chlorine system has capacity to dose at least 10 mg/l chlorine at all times.

- Theoretical chlorine contact time is at least 120 minutes and the chlorine contact tank has a minimum length to width and length to depth ratio of 40:1.

- Chlorine residual at the end of the contact tank is maintained above 5 mg/l.

Although the District's treatment facilities were designed to provide reclaimed water for unrestricted use, the majority of current reclamation usage is for irrigation of sod at Warren's Turf Nursery. Current regulations for this usage require an oxidized wastewater disinfected to achieve a 2.2 MPN/100 ml coliform level at some point in the treatment process. Coagulation and sedimentation are not required; therefore the above described specific conditions for direct filtration of effluent need not be met for irrigation of sod as long as the required coliform level can be achieved.

RECLAMATION TREATMENT FACILITIES

The wastewater treatment facilities which were constructed in 1976 consisted of grit removal, primary sedimentation, intermediate biological treatment with oxidation towers and intermediate clarifiers, activated sludge secondary treatment, filtration, chlorination, and dechlorination. The plant was designed for an average dry weather flow of 10.35 mgd with a maximum day flow of 16.2 mgd and a peak hour flow of 24.7 mgd. The tertiary filters consisted of four 520 sq. ft. cells with an average day filter loading rate of 4.6 gpm/sq. ft. with one cell out of service. Maximum day filter loading rate was 7.2 gpm/sq. ft. with one cell out of service. A 12.7 million gallon balancing reservoir was provided ahead of the filter feed pumps to equalize diurnal flow variations and preclude loading above the maximum day rate. The chlorine contact facilities provided a total volume of 377,000 gal in each of two tanks, yielding a detention time of 67 minutes at the maximum day flow rate. Coagulant addition ahead of the filters was not provided. Disinfected effluent was conveyed through a 54-inch pipeline to the Utility/Outfall Pump Station, which operated in conjunction with three final effluent holding reservoirs to provide final effluent to the Solano Irrigation District (SID) for reclamation and to the plant utility water system. Final effluent flows beyond the requirements of SID were dechlorinated and discharged through a gravity outfall to Boynton Slough. A diversion box was provided along the outfall where treated effluent could be diverted to an irrigation ditch ("Center Ditch") for reclamation purposes.

The 1979 plant expansion project incorporated several features to increase plant capacity to 15.6 mgd average flow and enhance the reclamation capabilities of the tertiary treatment facilities. The tertiary treatment system improvements consisted of the following:

- Addition of four new filter cells (for a total of eight cells), each with a filtration area of 520 sq. ft. This addition increased the maximum Title 22 filtration capacity to 26.2 mgd at 5 gpm/sq. ft. with one cell out of service.

- Addition of a jet injection chlorine mixing system.

- Addition of a new sulfur dioxide diffuser and Parshall flume at the chlorine contact basin outlet for flow metering and sulfur dioxide mixing.

- Expansion of each of the two chlorine contact tanks to provide a volume of 868,000 gallons in each tank. This addition increased the capacity of the chlorine contact tanks to 10.4 mgd in each of the two tanks at a contact time of 120 minutes and increased the average L:W ratio to 36:1. Including the 63 foot long by 16 foot wide backwash pump wet well, through which all flow from Chlorine Contact Tank No. 1 must pass prior to dechlorination at the outlet Parshall flume, the L:W ratio for Contact Tank No. 1 was increased to 40:1 and the contact volume was increased by 105,550 gallons. Therefore the effective total contact volume of the two tanks was increased to a total of 1,841,000 gallons.

As part of the 1985 Flow Equalization Facilities project, which increased the rated plant capacity to 17.5 mgd, the flow pattern through the contact basins was modified by the construction of an effluent bypass pipe and sluice gate which were added to the discharge end of Chlorine Contact Tank No. 2. The design concept of this bypass line was to split the flows between the two contact tanks such that all reclaimed water passed through Contact Tank No. 1 while flow passing through Contact Tank No. 2 was discharged through the outfall to Boynton Slough. As summarized in the Stage I and Stage II Expansion Preliminary Design Report, the purpose of this modification was to address the NPDES Permit requirement to maximize irrigation disposal during the spring when total plant flows could conceivably exceed 20.8 mgd and total chlorine contact time, with equal flows through the two parallel contact tanks, is less than 120 minutes. Unfortunately, as indicated in the Preliminary Design Report, it is not possible to accurately control the flow split through the two contact basins such that the reclaimed water contact time in Contact Tank No. 1 is greater than 120 minutes at all times.

RECLAMATION CONVEYANCE FACILITIES

Following coagulation, filtration, and disinfection, all flows not discharged directly through the outfall to Boynton Slough are conveyed through a 54-inch pipe to the Utility/Outfall Pump Station. The water surface in the wet well of this pump station is common with that of the three effluent holding reservoirs. The water surface in the wet well and reservoirs can vary from elevation 12.0 to 17.5, providing a total effective effluent storage volume of over 20 million gallons. This volume can be pumped by the Utility Water Pumps for reuse on the plant site as utility water, lifted by the Effluent Pumps to the inlet of the Irrigation Effluent Pump Station, or back fed by gravity through the 54-inch feed pipe to the Chlorine Contact Tank discharge and through the outfall to Boynton Slough. It can also be discharged by gravity to

the SID irrigation ditch west of the plant over a weir at the Irrigation Effluent Pump Station wet well. The current installed capacity of the Irrigation Effluent Pump Station is 5.8 mgd; therefore the final effluent holding reservoir capacity provides nearly 3.5 days reclaimed water storage capacity at current delivery capacity. At present, effluent can be reclaimed by pumping from the effluent holding reservoir system to either the in-plant utility water system or through the Irrigation Effluent Pump Station to the Solano Irrigation District. Additional effluent can be reclaimed through the diversion box on the Boynton Slough outfall which permits flows to be diverted to an irrigation ditch ("Center Ditch")

At present the District has the capability of dechlorinating plant flow either at the entrance to the Boynton Slough outfall pipe or just ahead of the Parshall flume which conveys all flow to the 54-inch pipe to the Utility/Outfall Pump Station and the effluent holding reservoirs. The normal mode of operation is to dechlorinate only flows going to the outfall. Even if only flow entering the outfall is dechlorinated, however, the relatively long detention time with exposure to sunlight in the effluent holding ponds, along with the presence of algae, aquatic life, and waterfowl in these ponds, likely eliminates any chlorine residual in these reservoirs prior to reclamation.

LIMITATIONS TO RECLAMATION

The existing tertiary facilities at the FSSD currently meet all regulatory requirements for unrestricted reclaimed water use. Each of the specific requirements of Title 22 and the 1988 "Policy Statement for Wastewater Reclamation Plants with Direct Filtration" is met. Unrestricted reclamation capacity is limited by the size and configuration of the chlorine contact tanks to 20.8 mgd when total plant flow is 20.8 mgd or less and to 10.4 mgd when plant flows exceed 20.8 mgd and only flow through Contact Tank No. 1 meets the Title 22 requirement of 120 minutes contact time. Flow diverted to sod irrigation from the Boynton Slough Outfall meets all requirements for this type of reuse.

In order to meet permit requirements to maximize reclamation even when total plant flows exceed 20.8 mgd, it is necessary to modify the bypass from Contact Tank No. 2 to the Boynton Slough outfall to control the split of flows between Tank No. 1 and Tank No. 2. The recommended modification to this bypass, shown in Figure 1, is to construct a weir trough across the 16-foot width of the downstream end of Contact Tank No. 2, providing a total overflow weir length of 32 feet.

The throat elevation of the existing Parshall Flume is at Elevation 17.5. At a maximum flow of 10.3 mgd, to insure a contact time greater than 120 minutes in Contact Tank No. 1, the depth of flow over the flume is 0.87 ft. By setting the elevation of the proposed 32 lin. ft. bypass weir at Elevation 17.9, the water surface above the weir yields a bypass flow of 23.2 mgd through Contact Tank No. 2 when the flow through Contact Tank No. 1 is 10.3 mgd. By installation of this weir trough, a detention time in Contact Tank No. 1 greater than 120 min. is insured up to a total plant flow of 33.5 mgd. Based upon historical plant flows, it is extremely unlikely that peak plant flows will exceed this level during periods when any irrigation of reclaimed wastewater is possible.

As shown in Table 1 flow through both contact tanks decreases as total plant flow decreases below 33.5 mgd. However, the flow to the outfall decreases much more rapidly than that to reclamation. At a total plant flow of 19.4 mgd, reclaimed water

flow through Contact Tank No. 1 decreases to only 7.4 mgd while flow to the outfall drops to 12.0 mgd. As long as total reclamation flows through Contact Tank No. 1 do not exceed approximately 6 mgd, the 42-inch gate on the bypass pipe can remain permanently in the open position if dechlorination of flows to the outfall is controlled by the outfall meter. For reclaimed water demand greater than approximately 6 mgd, the 42-inch bypass gate must remain closed, preventing flow through the bypass, until flows over the Parshall Flume reach 20.8 mgd. At this total plant flow, the bypass gate must be opened to keep the contact time in Contact Tank No. 1 greater than 120 minutes.

At a plant design capacity of 17.5 mgd ADWF and a combined reclaimed water/utility water demand of less than about 7 mgd, no modifications of the facilities except the bypass weir trough addition are required to meet all current requirements for unrestricted use of reclaimed effluent. Under current regulations, exposure of the reclaimed effluent to algae, waterfowl, and other aquatic life in the effluent ponds does not impact its suitability for unrestricted reuse under Title 22. This aspect of reuse potential has been verified with both Mr. Blair Allen of the Regional Water Quality Control Board, San Francisco Bay Region, and Mr. Mike Kiado of the State Department of Health, Reclamation Division. Suitability of the effluent for industrial uses, such as cooling water, will depend solely on the requirements at the industry. Some additional level of treatment may be required of the industries.

As indicated in the December 1989 Stage 1 and Stage II Expansion Preliminary Design Report, two additional filters must be added to handle maximum filter hydraulic loads when the plant is expanded to an average daily design load of 20 mgd. These additional filters are required to meet the Title 22 filter loading criterial for unrestricted use of reclaimed water, 5 gpm/sq. ft. of filter area with one filter cell out of service. In addition, if demand for reclaimed water develops significantly in the near future, the District must provide additional chlorine contact volume. With the current facilities, the District is limited to a combined plant utility water/reclaimed water demand of 10.4 mgd when plant flows exceed 20.8 mgd.

POTENTIAL CHANGES IN RECLAMATION REQUIREMENTS

In May 1990, the California Department of Health Services distributed proposed revisions to current reclamation requirements for public comment. Mr. Mike Kiado of DOHS has indicated that DOHS intends to finalize revisions to Title 22 by late 1991. Although the final nature of these revisions is uncertain, several aspects of the May 1990 draft could have significant impact on potential reclamation of District effluent. The attached August 17, 1990 memorandum by JMM's Gwen Buchholz and Paul Swaim summarizes these key aspects of the proposed changes. Recent conversations with Mr. Kiado indicate that the summary described in this memorandum is still pertinent.

Should the revised regulations ultimately be adopted in the form presented in the May 1990 draft, the requirement to maintain a chlorine residual at the point of use would present significant difficulties for reuse of District effluent. If the existing effluent ponds were to be used in conjunction with a piped reclaimed water distribution system, and combined reclaimed water/plant utility water flows exceeded plant flow during a portion of the day, additional chlorination would be required at the Utility Outfall Pump Station to provide a final chlorine residual. Control of this final chlorination step would be difficult because of changing character of the water

in the final ponds and the variability of the detention time in a pipe distribution system.

The potential change to require redisinfection at the point of use following conveyance in an open ditch could limit potential reuse applications for the District. However, the problem of redisinfecting the reclaimed water would likely be the responsibility of the user; therefore, the requirement would likely have no impact on District owned and operated facilities.

Because these potential future changes in regulations could significantly impact District reclaimed water facilities, it is recommended that the District closely monitor the status of those pending changes.

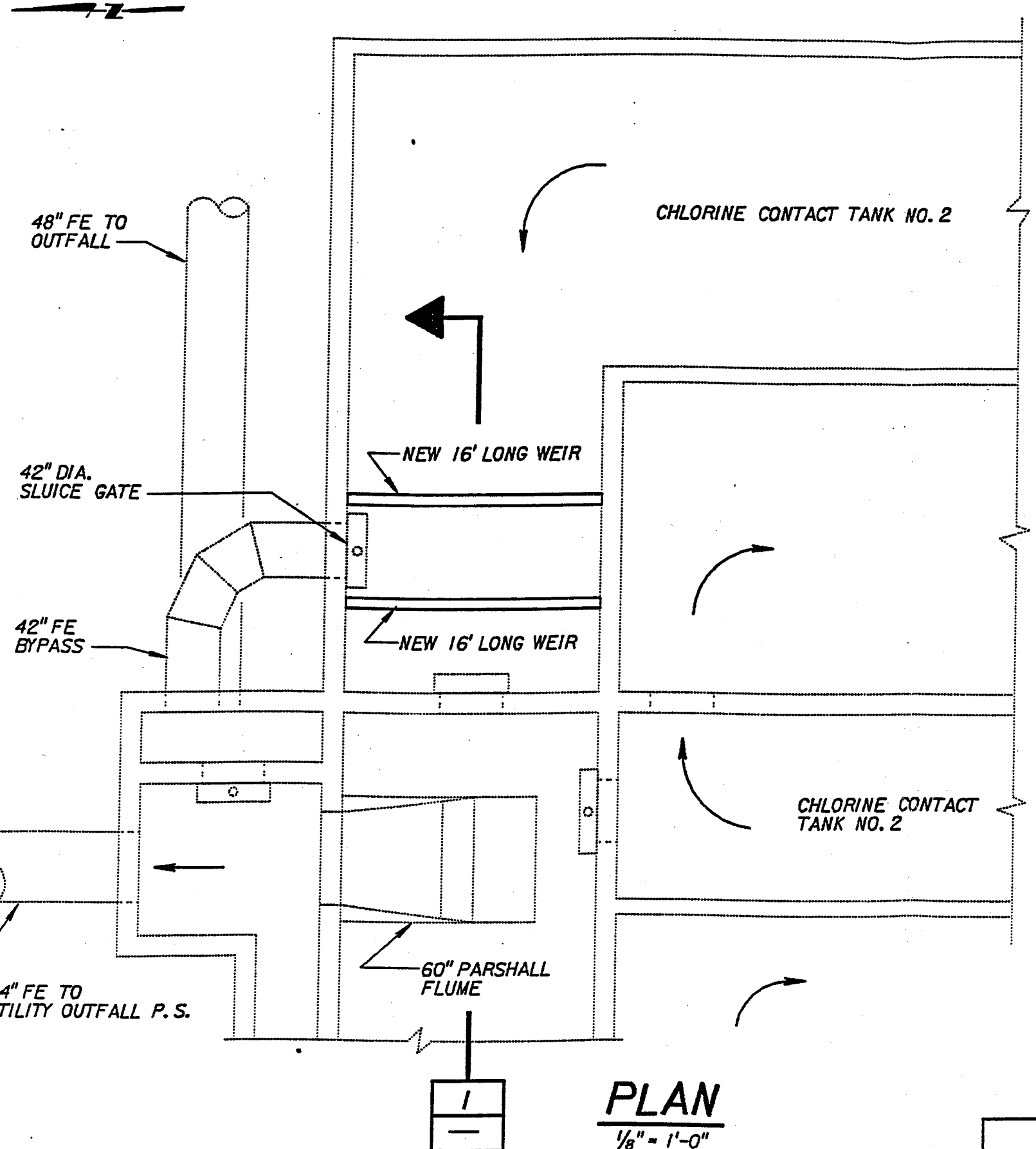
Table 1

FLOW RELATIONSHIPS AFTER
INSTALLATION OF NEW BYPASS WEIR TROUGH

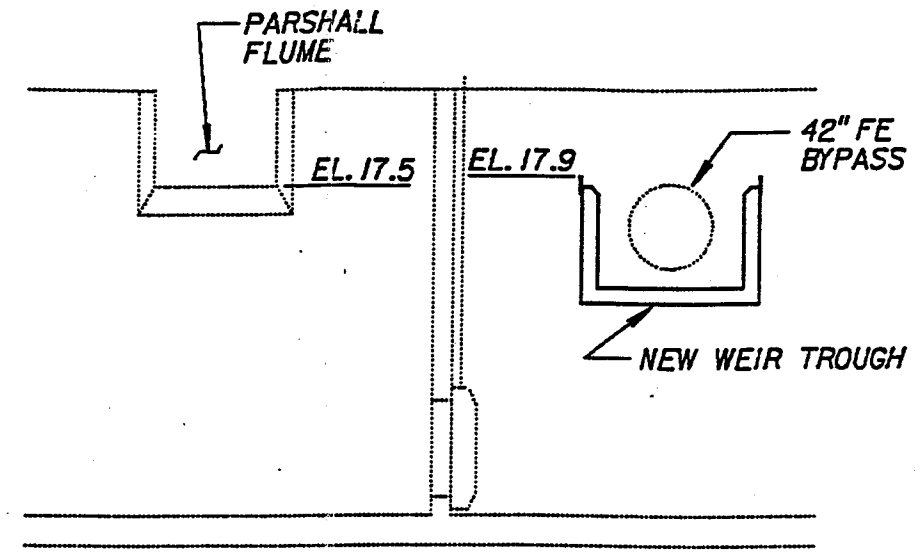
Head on Bypass Weir (ft.)	Flow thru[1] Bypass (mgd)	Head on Parshall Flume (ft.)	Flow over[2] Parshall Flume (mgd)	Total Plant Flow (mgd)
0	0	0.4	3.0	3.0
0.1	2.7	0.5	4.3	7.0
0.2	6.8	0.6	5.8	12.6
0.3	12.0	0.7	7.4	19.4
0.4	18.0	0.8	9.0	27.0
0.45	21.7	0.85	10.0	31.7
0.47	23.2	0.87	10.3	33.5

(1) Flow thru Contact Tank No. 2 to Boynton Slough Outfall

(2) Flow thru Contact Tank No. 1 to Reclamation



PLAN
1/8" = 1'-0"



SECTION 1
1/8" = 1'-0"

JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.	PROPOSED MODIFICATIONS TO 42" BYPASS FROM CONTACT TANK NO. 2 TO OUTFALL

JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC.

MEMORANDUM CONCERNING PROPOSED CHANGES IN REGULATIONS WHICH AFFECT WASTEWATER RECLAMATION

FROM: Gwen Buchholz and Paul Swaim **DATE:** August 17, 1990

The purpose of this memo is to summarize the proposed changes in the wastewater reclamation regulations established by the California Department of Health Services (DHS) and the California State Water Resources Control Board (SWRCB). This memo includes information obtained during discussion with Mike Kiado of DHS. Mr. Kiado has requested that all comments concerning DHS's proposed regulations be submitted by September 1, 1990 for inclusion in his presentation to the CAREW conference in late-September.

Most of the proposed regulations do not significantly change reclamation requirements established by Title 22 or the *Guidelines for Use of Reclaimed Water*. However, several changes will significantly effect reclamation operations, as summarized below.

- Maintenance of a chlorine residual in all reclaimed water at the point of use. The proposed regulations could be interpreted that the residual should be 5 mg/l. However, Mr. Kiado indicated that the proposed regulations would require a 5 mg/l chlorine residual after the required contact time. The residual at the point of use would need to be sufficient to prevent regrowth of microorganisms.

- Reclaimed water conveyed in an open ditch or stream (ie, for agricultural use) would be required to be redisinfected at the point of use. Mr. Kiado indicated that this requirement was necessary to prevent contamination by *Klebsiella*.

- Biocide would be required to be added to all reclaimed water used in cooling towers or areas which mist from spray irrigation may transmit *Legionella*.

- Reclaimed water will not be allowed in a recreational impoundment used for body-contact sports.

- The proposed regulations require all reclaimed water applied by spray irrigation must evaporate or infiltrate prior to the next use. For example, all reclaimed water applied to a golf course must be applied at night and evaporate or infiltrate prior to the next period of use by golfers. Mr. Kiado indicated that he has received numerous complaints about this item. Many of the respondents have indicated that existing reclamation uses would be eliminated by this requirement.

- All treatment facilities used for reclaimed water in which wastewater is "aerated or agitated" must be separated by a 500-foot wide barrier strip from residences or from agricultural land, golf courses, cemeteries, highway landscaping, parks, playgrounds, and impoundments which use reclaimed water. A "Residence" is defined as the home and yard; land frequented by children, such as parks; and building and land used by sick people for recuperation, such as a hospital or convalescent center. The supporting documentation is detailed about the reasons for this barrier. I am concerned that this type of barrier may be placed around all treatment plants and could include all lands which are used for public use and agriculture.

- Proposed regulations for groundwater recharge would allow up to 50 percent of the withdrawn water to be reclaimed water.

- The proposed regulations require a more detailed engineering report than previously required. However, most of the proposed requirements were required by the Regional Water Quality Control Boards for Waste Discharge Permits. Therefore, the format has changed but the total amount of effort has not increased.

EXISTING RECLAMATION REGULATIONS

Reuse of treated wastewater is regulated by federal and state laws and is under the jurisdiction of several state and local agencies. Federal and California state laws provide legislation for reclamation and reuse through the Clean Water Act and the California Water Code, respectively. The federal Clean Water Act specifically encourages water reclamation as an integral part of water pollution control projects. The California Water Code is explicit in favoring water reuse projects both as part of water pollution control projects and, more importantly, on their own merits as water supply projects.

Basis for Regulations

The State of California has primary responsibility for the development of regulations, criteria, and guidelines for water reclamation and reuse within the state. Basic legislation is derived from the California Water Code, Division 7, Sections 13000 et seq.; entitled the "Porter-Cologne Water Quality Control Act." This Act establishes the SWRCB as the agency with primary authority for water reclamation, and the nine Regional Water Quality Control Boards (RWQCBs) as the agencies to administer the SWRCB's authority. The SWRCB accordingly provides policy and guidance for water reuse and the RWQCBs establish actual water use regulations for specific projects.

The DHS has special authority under Section 13521 of the Porter-Cologne Act to set criteria for reclaimed water production and uses of reclaimed water wherever reclamation would require special protection of public health. In response to this mandate, DHS developed comprehensive wastewater reclamation regulations that establish treatment processes, water quality criteria, and treatment reliability requirements in order to ensure that use of reclaimed water for the specified purposes does not impose undue health risks. These

regulations are listed in Title 22, Division 4 of the California Administrative Code, and are incorporated into the waste discharge permits issued by the RWQCBs to the wastewater reclamation producers and users. The DHS also established guidelines for the design and operation of reclaimed water systems. In addition to Title 22 and the *Guidelines for Use of Reclaimed Water*, DHS also established guidelines through the issuance of specific permits. For example, DHS did not establish specific criteria for industrial applications. However, for reclaimed water used in cooling towers where workers or the public could be affected by wind-blown spray, DHS required the reclaimed water to be treated to the most stringent requirements specified by Title 22 (bio-oxidation, coagulation and clarification, filtration, and disinfection in order to provide a total coliform level equal to or less than 2.3 MPN/100 ml). The Vector Biology and Control Branch of DHS, in cooperation with the California Mosquito and Vector Control Association, developed a set of criteria for mosquito control. These criteria also were incorporated into the proposed regulations.

Groundwater recharge guidelines developed by DHS specify information which must be evaluated in the engineering report. However, specific treatment and withdrawal criteria were developed on a case-by-case basis.

PROPOSED NON-GROUNDWATER RECHARGE RECLAMATION REQUIREMENTS

The proposed regulations identify four categories of reclaimed water which are similar to the categories previously defined in Title 22. The categories are listed below.

Class A - Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l, and to eliminate *Cryptosporidium*, *Giardia*, and *Entamoeba*.

Class B - Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l.

Class C - Oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml.

Class D - Oxidation, disinfection to limit coliforms to 23 MPN/100 ml.

Proposed treatment requirements are summarized in Table 1. Existing and proposed treatment requirements are compared in Table 2.

Most of the proposed requirements are similar to the existing requirements. However, the need to limit enteric viruses to less than 1/40 liters is a new requirement (Class A and Class B). The documentation attached to the proposed requirements indicates that this limit can be attained by meeting a turbidity level of 2 NTUs in the final effluent and providing 2 hours of chlorine contact time with a 5 mg/l residual at the end of the contact time. These disinfection requirements are the same as those specified in the existing regulations and guidelines to limit coliforms to 2.2 MPN/100 ml.

For use of reclaimed water on some food crops, *Cryptosporidium*, *Giardia*, and *Entamoeba* cysts must be removed. The documentation does not indicate a proven method for eliminating cysts. The JMM Walnut Creek Water Department staff indicated that this limit may be met by reducing turbidity to less than 0.5 NTUs in the final effluent.

Another significant change in the proposed treatment requirements is the need to redisinfect reclaimed wastewater transported in an open ditch to agricultural lands. Many farmers may choose not to use reclaimed water if they need to redisinfect the water in the fields or construct transmission pipelines.

The need to add biocide to cooling tower water also may be significant. However, other DHS staff members have indicated that all cooling towers, air conditioners, and similar equipment will be required to add biocides to eliminate *Legionella* with or without the use of reclaimed water.

The existing guidelines suggest that reclaimed water should not be applied when users are present. For example, golf courses should not apply water when golfers are present. The proposed regulations include this restriction and require that unless the water is filtered that the reclaimed water should be applied between 9:00 pm and 5:00 am. The proposed regulations also require that all applied reclaimed water should be allowed to evaporate or infiltrate prior to the next use. This criteria may be difficult for coastal areas which are foggy and moisture tends to accumulate not evaporate during the night.

The existing guidelines also required the following design criteria for all reclamation uses that needed oxidized, filtered, and disinfected water. All of these criteria are included in the proposed regulations.

- Average filtered wastewater turbidity equal to or less than 2 turbidity units.
- Coagulant addition prior to filtration is required in all cases except when all of the following conditions are met: (a) continuous turbidity measurements of secondary effluent; (b) secondary effluent turbidity equal to or less than 5 turbidity units; (c) when the secondary effluent turbidity exceeds 5 turbidity units, chemical addition is automatically actuated or the wastewater is diverted prior to disinfection; and (d) filtered effluent turbidity is less than 2 turbidity units.
- Adequate time after coagulant addition for a visible floc to form prior to filtration.
- A maximum filtration rate of 5 gpm/sq ft.
- High-energy rapid mix of chlorine and a theoretical chlorine contact time of 2 hours.
- Chlorine contact chamber length-to-depth and length-to-width ratios of 40:1.

- Chlorine residual after the required contact time must not be less than 5 mg/l.

As indicated above, direct filtration is allowed if the secondary effluent turbidity is less than 5 NTUs and the filtered effluent turbidity is less than 2 NTUs. The proposed regulations allow this use of direct filtration but requires construction of chemical pretreatment facilities. The proposed regulations do not define "chemical pretreatment", but Mr. Kiado indicated that pretreatment facilities would not include clarifiers.

PROPOSED GROUNDWATER RECHARGE RECLAMATION REQUIREMENTS

At the same time as the DHS issued the working draft of proposed changes for non-groundwater reclamation regulations, proposed guidelines for groundwater recharge using reclaimed water were issued. The groundwater recharge guidelines were jointly issued by the State of California Interagency Water Reclamation Coordination Committee (with representatives from the SWRCB, DHS, and California Department of Water Resources) and the DHS Groundwater Recharge Committee.

The proposed criteria recognize that groundwater recharge with reclaimed water may occur incidentally such as infiltration from receiving waters or infiltration from irrigated land. However, DHS staff has indicated that the proposed regulations pertain only to planned recharge programs and exclude incidental recharge by inference.

The proposed guidelines specify treatment requirements, minimum soil depth requirements, dilution requirements for organics, and nitrogen requirements for five categories of recharge projects. The categories are listed below.

Category I - Allows up to 50 percent of the withdrawn water to be reclaimed water. Recharge must occur through surface spreading. The reclaimed water must remain underground for at least 6 months prior to withdrawal. Recharge basin and extraction well must be separated by a distance of at least 500 feet. The depth of unsaturated soils under recharge basins must be at least 10 feet in depth if percolation rates are less than or equal to 0.2 in/min, and at least 20 feet in depth if percolation rates are between 0.2 and 0.33 in/min.

Category II - Allows up to 20 percent of the withdrawn water to be reclaimed water. Recharge must occur through surface spreading. The reclaimed water must remain underground for at least 6 months prior to withdrawal. Recharge basin and extraction well must be separated by a distance of at least 500 feet. The depth of unsaturated soils under recharge basins must be at least 10 feet in depth if percolation rates are less than or equal to 0.2 in/min, and at least 20 feet in depth if percolation rates are between 0.2 and 0.33 in/min.

Category III - Allows up to 20 percent of the withdrawn water to be reclaimed water. Recharge must occur through surface spreading. The reclaimed water must remain underground for at least 12 months prior to withdrawal. Recharge basin and extraction well must be separated by a distance of at least 1000 feet. The depth of unsaturated soils under recharge basins must be at least 20 feet in depth if percolation rates are less than or equal to 0.2 in/min, and at least 50 feet in depth if percolation rates are between 0.2 and 0.33 in/min.

Category IV - Allows up to 20 percent of the withdrawn water to be reclaimed water. Recharge must occur through surface spreading. The reclaimed water must remain underground for at least 12 months prior to withdrawal. Recharge basin and extraction well must be separated by a distance of at least 1000 feet. The depth of unsaturated soils under recharge basins must be at least 50 feet in depth if percolation rates are less than or equal to 0.2 in/min, and at least 100 feet in depth if percolation rates are between 0.2 and 0.33 in/min.

Category V - Allows up to 20 percent of the withdrawn water to be reclaimed water. Recharge must occur through direct injection for the purpose of salt water intrusion barrier or groundwater replenishment. The reclaimed water must remain underground for at least 12 months prior to withdrawal. Injection wells and extraction wells must be separated by a distance of at least 2000 feet. Reclaimed water may be injected directly into the aquifer.

Groundwater recharge projects using surface spreading will not be allowed if percolation rates are greater than 0.33 in/min.

Proposed treatment requirements for these categories of use are summarized in Table 3. As shown in Table 3, treatment requirements for Category II are similar to requirements for proposed non-groundwater recharge regulations for Class B uses. Treatment requirements for Category III are similar to requirements for proposed non-groundwater recharge regulations for Class D uses. Category IV does require oxidation but does not require disinfection. Nitrogen concentrations in the reclaimed water generally cannot exceed 10 mg/l.

For Category I, the total amount of TOC cannot be greater than the total amount which would occur under Category III. The proposed regulations include the following formula to be used to determine additional TOC removal rates for Category I projects. The TOC removal may occur by filtration or other treatment methods.

$$Additional\%TOCReduction=(1-(\frac{20}{\%R}))*100*(\frac{TOCofOxidizedEffluent}{15})$$

The calculated value represents the additional TOC removal which must be achieved following oxidation.

TABLE 2
COMPARISON OF EXISTING AND PROPOSED RECLAMATION TREATMENT REQUIREMENTS

Reclaimed Water Use	Existing Regulations	Proposed Regulations
Spray Irrigation of Food Crops		
Orchard & Vineyards (From 30 days before Fruit Formation) (Not Including Olives)	Bio-oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l, and to eliminate *Cryptosporidium*, *Giardia*, and *Entamoeba* (Class A).
Orchard & Vineyards (More than 30 days Prior to Fruit Formation or if Fruit Does Not Contact Water or Ground)	Bio-oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
Olive Orchards	Bio-oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml (Class C).
Root Crops	Bio-oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l, and to eliminate *Cryptosporidium*, *Giardia*, and *Entamoeba* (Class A).
Sugar Beets	Bio-oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
Tomatoes Cooked at Commercial Canneries	Bio-oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
All Other Food Crops	Bio-oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l, and to eliminate *Cryptosporidium*, *Giardia*, and *Entamoeba* (Class A).

TABLE 2
COMPARISON OF EXISTING AND PROPOSED RECLAMATION TREATMENT REQUIREMENTS

Reclaimed Water Use	Existing Regulations	Proposed Regulations
Drip, Surface, or Subsurface Irrigation of Food Crops		
Root Crops (Except Sugar Beets)	Bio-oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l, and to eliminate *Cryptosporidium*, *Giardia*, and *Entamoeba* (Class A).
Sugar Beets	Bio-oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
Crops with Edible Parts Within 2 ft of Ground or Contacts Water	Bio-oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l, and to eliminate *Cryptosporidium*, *Giardia*, and *Entamoeba* (Class A).
Crops with Edible Parts Above 2 ft of Ground or Does Not Contact Water	Bio-oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml (Class C).
Orchards and Vineyards	Primary Treatment.	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
Tomatoes Cooked at Commercial Canneries	Bio-oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
Feed, Fodder, and Seed Crops		
Fodder Crops not for Human Food	Primary Treatment (Usually Oxidation, Disinfection Required).	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
Pasture for Dairy Animals	Bio-oxidation, disinfection to limit coliforms to 23 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
Pasture for Other Animals	Primary Treatment (Usually Oxidation, Disinfection Required).	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
Non-Edible Crops (Trees, Cotton, etc)	Primary Treatment (Usually Oxidation, Disinfection Required).	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).

TABLE 2
COMPARISON OF EXISTING AND PROPOSED RECLAMATION TREATMENT REQUIREMENTS

Reclaimed Water Use	Existing Regulations	Proposed Regulations
Feed, Fodder, and Seed Crops		
Sod for Commercial Installation	Bio-oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
Sod for General Public Installation	Bio-oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml (Class C).
Ornamental Nursery Stock	Bio-oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml (Class C).
Irrigation of Areas with Limited Public Access		
Golf Courses, Cemeteries, Highway Landscaping which are not adjacent to areas with public access	Bio-oxidation, disinfection to limit coliforms to 23 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
Irrigation of Areas with High Risk of Public Exposure		
School Yards, Parks, and Playgrounds; and Golf Course, Cemeteries, and Highway Landscaping which are adjacent to areas with public access that could be affected by mist	Bio-oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l (Class B).
Recreational Impoundments		
For Fishing and Boating	Bio-oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml (Class C).
For Swimming and Non-Restricted Access	Bio-oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml.	Not Allowed.
Landscape Impoundments	Bio-oxidation, disinfection to limit coliforms to 23 MPN/100 ml.	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
Decorative Fountains	Bio-oxidation, disinfection to limit coliforms to 23 MPN/100 ml.	Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l (Class B).

TABLE 2

COMPARISON OF EXISTING AND PROPOSED RECLAMATION TREATMENT REQUIREMENTS

Reclaimed Water Use	Existing Regulations	Proposed Regulations
Cooling Towers	Bio-oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml.	Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l, and addition of biocide to eliminate *Legionella* and *Klebsiella* (Class B).
Laundry Water Reused for Laundry Water	Generally Not Allowed.	Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l (Class B).
Street Cleaning and Construction Use with Limited Public and Worker Exposure	Bio-oxidation, disinfection.	Oxidation, disinfection to limit coliforms to 23 MPN/100 ml (Class D).
Sewer Flushing	Bio-oxidation, disinfection. (According to Practice not Regulation)	Oxidation.

TABLE 1
PROPOSED RECLAIMED WATER TREATMENT REQUIREMENTS FOR NON-GROUNDWATER RECHARGE PROJECTS

Proposed Treatment Requirement	Reclaimed Water Use
Class A	
Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l, and to eliminate *Cryptosporidium*, *Giardia*, and *Entamoeba*.	Spray irrigation of orchards and vineyards (not including Olives) from 30 days before fruit formation.
	Spray irrigation of any food crop except sugar beets and tomatoes cooked at commercial canneries.
	Surface and subsurface irrigation of root crops (not including sugar beets).
	Surface and subsurface irrigation of any food crop with edible parts within 2 feet of the ground surface or with edible parts that contacts reclaimed water.
Class B	
Oxidation, coagulation, clarification, filtration, disinfection to limit coliforms to 2.2 MPN/100 ml, and to limit enteric viruses to less than 1/40 l.	Irrigation of areas with a high risk of public exposure (school yards; parks; playgrounds; and golf courses, cemeteries, and highway landscaping which are adjacent to areas with public access that could be affected by mist).
	Cooling towers.
	Decorative fountains.
	Outdoor fire fighting.
	Corporate vehicle washes in buildings that prevent human contact with reclaimed water.
	Wash-down water for corporation yards.
	Artificial snow-making.
	Toilet flushing if pipes are located outside of walls.
	Drinking water for non-dairy livestock.
	Laundry water reused for laundry water.

TABLE 3
PROPOSED RECLAIMED WATER TREATMENT REQUIREMENTS FOR GROUNDWATER RECHARGE

Groundwater Recharge Category	Proposed Treatment Requirements
Category I Allows up to 50 percent of the withdrawn water to be reclaimed water. Recharge must occur through surface spreading. The reclaimed water must remain underground for at least 6 months prior to withdrawal. The depth of unsaturated soils under recharge basins must be at least 10 feet in depth if percolation rates are less than or equal to 0.2 in/min, and at least 20 feet in depth if percolation rates are between 0.2 and 0.33 in/min.	Oxidation (to achieve 20 mg/l TOC, 30 mg/l BOD, and 30 mg/ SS), filtration (to achieve 2 NTU), and disinfection to limit coliforms to 2.2 MPN/100 ml. The TOC must be further reduced to not exceed TOC levels which would occur for Category II uses.
Category II Allows up to 20 percent of the withdrawn water to be reclaimed water. Recharge must occur through surface spreading. The reclaimed water must remain underground for at least 6 months prior to withdrawal. The depth of unsaturated soils under recharge basins must be at least 10 feet in depth if percolation rates are less than or equal to 0.2 in/min, and at least 20 feet in depth if percolation rates are between 0.2 and 0.33 in/min.	Oxidation (to achieve 20 mg/l TOC, 30 mg/l BOD, and 30 mg/ SS), filtration (to achieve 2 NTU), and disinfection to limit coliforms to 2.2 MPN/100 ml.
Category III Allows up to 20 percent of the withdrawn water to be reclaimed water. Recharge must occur through surface spreading. The reclaimed water must remain underground for at least 12 months prior to withdrawal. The depth of unsaturated soils under recharge basins must be at least 20 feet in depth if percolation rates are less than or equal to 0.2 in/min, and at least 50 feet in depth if percolation rates are between 0.2 and 0.33 in/min.	Oxidation (to achieve 20 mg/l TOC, 30 mg/l BOD, and 30 mg/ SS) and disinfection to limit coliforms to 23 MPN/100 ml.
Category IV Allows up to 20 percent of the withdrawn water to be reclaimed water. Recharge must occur through surface spreading. The reclaimed water must remain underground for at least 12 months prior to withdrawal. The depth of unsaturated soils under recharge basins must be at least 50 feet in depth if percolation rates are less than or equal to 0.2 in/min, and at least 100 feet in depth if percolation rates are between 0.2 and 0.33 in/min.	Oxidation (to achieve 20 mg/l TOC, 30 mg/l BOD, and 30 mg/ SS).
Category V Allows up to 20 percent of the withdrawn water to be reclaimed water. Recharge must occur through direct injection for the purpose of salt water intrusion barrier or groundwater replenishment. The reclaimed water must remain underground for at least 12 months prior to withdrawal.	Oxidation (to achieve 20 mg/l TOC, 30 mg/l BOD, and 30 mg/ SS), filtration (to achieve 2 NTU), and disinfection to limit coliforms to 2.2 MPN/100 ml. The TOC must be further reduced to not exceed 1 mg/l.

TABLE 1

PROPOSED RECLAIMED WATER TREATMENT REQUIREMENTS FOR NON-GROUNDWATER RECHARGE PROJECTS

Proposed Treatment Requirement	Reclaimed Water Use
Class C	
Oxidation, disinfection to limit coliforms to 2.2 MPN/100 ml.	Spray irrigation of olive orchards.
	Surface or subsurface irrigation of any food crop with edible parts above 2 feet of the ground surface or with edible parts that do not contacts reclaimed water, except orchards and vineyards.
	Spray or surface irrigation of sod for installation by the public.
	Spray or surface irrigation of ornamental nursery stock.
	Recreational impoundments for fishing and boating.
	Wash-water for non-dairy livestock.
Class D	
Oxidation, disinfection to limit coliforms to 23 MPN/100 ml.	Spray irrigation of orchard and vineyards up to 30 days prior to fruit formation.
	Spray, surface, or subsurface irrigation of sugar beets.
	Surface or subsurface irrigation of orchard and vineyards.
	Spray, surface, or subsurface irrigation of tomatoes cooked at commercial canneries.
	Spray or surface irrigation of fodder crops not for human consumption.
	Spray or surface irrigation of pasture for dairy and non-dairy animals.
	Spray or surface irrigation of non-edible crops.
	Spray or surface irrigation of sod for commercial installation.
	Spray irrigation of golf courses, cemeteries, or highway landscaping which are not adjacent to areas with public access.
	Landscape Impoundments.
	Street cleaning or construction use with limited public and worker exposure.
Oxidation Only	Sewer flushing.

FAIRFIELD-SUISUN SEWER DISTRICT
SUBREGIONAL WASTEWATER TREATMENT PLANT

TECHNICAL MEMORANDUM NO. 2

SUBJECT: Use of Dual Forcemains for Transport of Reclaimed Water

DATE: July 1, 1991

PREPARED BY: James W. Gossett

With the completion of the new 27-inch Cordelia Force Main in 1990, the District now has in place over five miles of dual raw sewage force mains extending from Cordelia to central Fairfield. This technical memorandum evaluates the potential dry weather use of these dual forcemains to transport reclaimed water and discusses capacity and regulatory limitations to use of these pipelines for this purpose.

DESCRIPTION OF EXISTING FACILITIES

In 1989 the District completed construction of the new 48-inch Central Force Main to convey flows from the Central Pump Station to the wastewater treatment plant. This 2.2 mile long pipeline parallels the 36-inch Suisun Force Main for its entire length and is connected to the Suisun Force Main at the Central Pump Station, located between Highway 12 and Illinois Avenue, near the southern end of Jackson Street. Pumped flows from the Central Pump Station can be conveyed to the treatment plant through either force main.

The 3.2 mile long 27-inch Cordelia Force Main was completed in 1990 and extends from the Cordelia Pump Station, located at the intersection of Pitman Road and Cordelia Road, to the treatment plant. It parallels the original 18-inch Cordelia Force Main along its entire route to the treatment plant and is connected to the original force main at each end.

The second force main from each pump station to the wastewater treatment plant was installed solely to handle peak wet weather pumping conditions; a single force main from each pump station is adequate to handle peak dry weather flows for the foreseeable future. Therefore, during periods when demands for reclaimed wastewater for irrigation occur, one of the two parallel force mains from each pump station is not needed for transporting raw sewage, the purpose for which it was constructed.

The design concept for each of the second force mains from each pump station included provision to drain the entire pipeline back into the wet well of its respective pump station and fill the pipeline with chlorine solution and/or plant utility water. For the Cordelia force mains, a 6-inch utility water connection and a 2-inch chlorine solution connection were installed for both the original 18-inch and new 27-inch pipelines. A 6-inch utility water connection and 4-inch chlorine solution connection was installed only for the new 48-inch Central Force Main. No such connection currently exists for the original 36-inch Suisun Force Main which parallels the 48-inch Central Force Main. The District is currently using the Central Force Main

to convey reclaimed water (utility water) to a newly installed landscape irrigation system at the Central Pump Station.

RECLAMATION CAPACITY OF EXISTING SYSTEM

The existing reclaimed water transport capacity of the two dual force main systems is dependent upon the capacity of the plant utility water system to deliver water to the connections to the force mains. These connections are made from a 6-inch utility water loop around the north end of the treatment plant. The capacity of the Utility Water Pump Station and the current utility water demands at the treatment plant are discussed in detail in JMM's October 15, 1991 technical memorandum entitled "Evaluation of Chemical Feed and Utility Systems." As summarized in that document, the existing Utility Water Pump Station has a design capacity of 4.75 mgd at 65 psi with three pumps operating. Current operation of the pump station is at a discharge pressure of 85 psi to accommodate demand at the Dissolved Air Flotation Thickeners (DAF's). This change has reduced the utility water system capacity to approximately 2.6 mgd with three pump operating.

As described in Attachment D to the October 15, 1990 technical memorandum, the current normal demand on the utility water system is approximately 1230 gpm (1.8 mgd), excluding all turf farm irrigation. If 1,000 gpm is included for turf farm irrigation, demand on the system increases to 2230 gpm (3.2 mgd), which is beyond the capacity of the existing system operating at the higher pressure. The 3.2 mgd demand excludes all potential utility water uses which are not normally in operation, such as froth sprays in the aeration basins, filter channel aeration, caustic dilution, water for the engine-driven blowers, flushing of sludge lines, and filling/flushing of the dual force mains.

If the utility water system is returned to its original design pressure of 60-65 psi, which could be accomplished by installing a booster pump for the DAF flow, the full 4.75 mgd design capacity would be available to meet basic utility water demands, turf farm irrigation, and reclaimed water demand along the dual force mains. If this were done, approximately 1.5 mgd would theoretically be available for delivery through the dual force mains. Normal utility water demands on the 6-inch utility water loop to which the force mains are connected are relatively small, generally less than 100 gpm. Therefore, pressure drops in the north utility water system loop are modest even with relatively large flows directed to the dual force mains. If the District desires to maintain pressures in the force mains above 50 psi, total pressure drops in the utility water loop must be kept less than 10 psi on average. On this basis total reclaimed water flow to the force main connection is limited to a total of approximately 0.9 mgd.

REGULATORY CONSIDERATIONS

During our evaluation of potential use of the dual force mains to convey reclaimed water, we contacted Mr. Blair Allen of the Regional Water Quality Control Board, San Francisco Bay Region, and Mr. Mike Kiado of the State Department of Health Services. Although not speaking formally on behalf of their respective agencies, both individuals concurred that there should be no regulatory obstacles to the use of these dual force mains for transport of reclaimed water as long as the District can demonstrate that the entire pipeline has been adequately disinfected to ensure the public health and safety. Both individuals felt that this condition would be satisfied

if the District completely drained the contents of the pipelines, disinfected the pipelines, flushed the chlorine solution, and then demonstrated that Title 22 coliform requirements for the particular reuse intended could be met continuously at the far end of the pipe and/or the point of reuse. If a 2.2 MPN/100 ml level could not be maintained, the pipeline could still be utilized for transport of reclaimed water for uses requiring a 23 MPN/100 ml coliform level provided that standard could be met at the end of the pipe and/or point of reuse.

The practicality of disinfecting the dual forcemains to meet Title 22 requirements after they have been used for conveying raw sewage can not be easily addressed. Actual experience is the only means of making a reliable determination. We believe that achieving Title 22 levels of disinfection within the pipelines after extended periods of exposure to raw sewage will be difficult. Therefore, we recommend that the District conduct a full scale test of the existing facilities prior to making any firm commitments for transport of reclaimed water through these pipelines.