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WATER SUPPLY STUDY
CUTLER - OROSI AREA

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BACKGROUND

The Orosi Public Utility District (OPUD) and the Cutler Public Utility District (CPUD) provide domestic water to the residents of the unincorporated communities of Orosi and Cutler, respectively. Each district relies solely on groundwater to meet the water demands of its customers. OPUD presently utilizes four wells. CPUD has two active wells.

In Orosi, the water quality and quantity of the existing groundwater supply delivered to the water users is good. Nitrate levels at inactive well sites, however exceed the regulatory standard of 45 mg/l. The community of Cutler is experiencing a similar situation, although CPUD's existing wells are currently experiencing elevated nitrate levels which are jeopardizing the long term viability of the existing water supply.

PURPOSE

Currently, each district has sufficient water supply to meet existing water demands. Additional water supplies, however, are necessary to meet future water needs or to insure sufficient water supplies in the event any existing wells experience elevated contamination over time that require either district to remove well(s) from active status. Two very different options that represent potential solutions for addressing the districts' future water demands are: treatment of the groundwater or the use and treatment of surface waters. The purpose of this Report is to evaluate each water supply option and establish the most feasible approach.

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SECTION 2
DISTRICT WATER SUPPLY FACILITIES
WATER SUPPLY STUDY
CUTLER - OROSI AREA

GENERAL

The Cutler Public Utility District (CPUD) and the Orosi Public Utility District (OPUD) are located in Tulare County, approximately 15 miles north of the City of Visalia. The locations of the districts are shown on Figure 2-1. The residents of Cutler and Orosi are served by County maintained roads and State Route 63 which runs north and south through the middle portions of the districts.

Since the districts do not have access to a surface water supply, the domestic water supplies are developed through the pumping of groundwater. Each district's water supply system consists of groundwater wells, storage tanks, hydropneumatic tanks and appurtenances. The water supply facilities for each district are described in this section of the report.

CUTLER PUBLIC UTILITY DISTRICT

CPUD has a good groundwater supply in terms of most water quality constituents. CPUD is able to meet bacteriological standards without providing chlorination of the individual wells. There are concerns, however, regarding potential DBCP and/or nitrate contamination of the aquifer serving the community. CPUD has lost two existing wells because of high concentrations of nitrates and one well is not connected to the system because of high concentrations of DBCP. Water testing for all existing and new wells have shown elevated nitrate concentrations that are continuing to increase over time.

Wells

CPUD has a total of four developed wells. The data for the wells is summarized in Table 2-1. Two of the wells are active and two of the wells are inactive at this time. The two inactive wells were taken out of service because water test results exceeded the Maximum Contaminant Level (MCL) limit for nitrates. Well Nos. 5 and 6 are the two active wells that supply water for the community.

Additional Wells

There is a well within CPUD (Well No. 7) that is not owned by CPUD. The well is owned by the Tulare County Redevelopment Agency and is used for fire flow at a local industry. This well has water that shows concentrations of DBCP which exceeds its MCL. CPUD has considered taking ownership if the owner supplies treatment for DBCP. CPUD also has two proposed wells in various stages of development. Well No. 8 was completed in April, 2006. Water quality testing, however, has revealed high nitrate concentrations approaching the MCL. Future use of Well No. 8 is uncertain. Well No. 9 was drilled on the site for a proposed blending tank facility for CPUD. The well facility, when completed, will allow for water from Well Nos. 3 and 4 to be used in combination with flows from Well No. 5 and Well No. 9. The availability of sufficient quantities of low nitrate concentration water from CPUD's wells is uncertain.

TABLE 2-1
CPUD GROUNDWATER WELLS
WATER SUPPLY STUDY
CUTLER - OROSI AREA

WELL NO.	DATE DRILLED	DEPTH (Feet)	FLOW RATE (g.p.m.)	STATUS
3	1951	298	797	Inactive
4	1961	368	334	Inactive
5	1962	500	1,000	Active
6	1979	540	497	Active
7	1991	400	700	Not connected to system.
8	2006	330	300	Not complete.
9	Test hole only.	--	--	Not complete.
TOTAL ACTIVE WELL CAPACITY			1,497 (2.2 MGD)	

CPUD utilizes one elevated water tank for water system storage and pressure. The tank holds 50,000 gallons. The tank is connected to the distribution system by a common fill inlet and outlet configuration. CPUD's water supply and distribution system is shown on Figure 2-2.

OROSI PUBLIC UTILITY DISTRICT

OPUD also has a good groundwater supply in terms of most water quality parameters. There are concerns, however, regarding potential EDB, DBCP and/or nitrate contamination of the aquifer serving the community. OPUD has had to destroy one well (Well No. 3) because of high concentrations of DBCP and EDB. One well (Well No. 6) has been designated as inactive due to high nitrate concentrations.

<u>Wells</u>

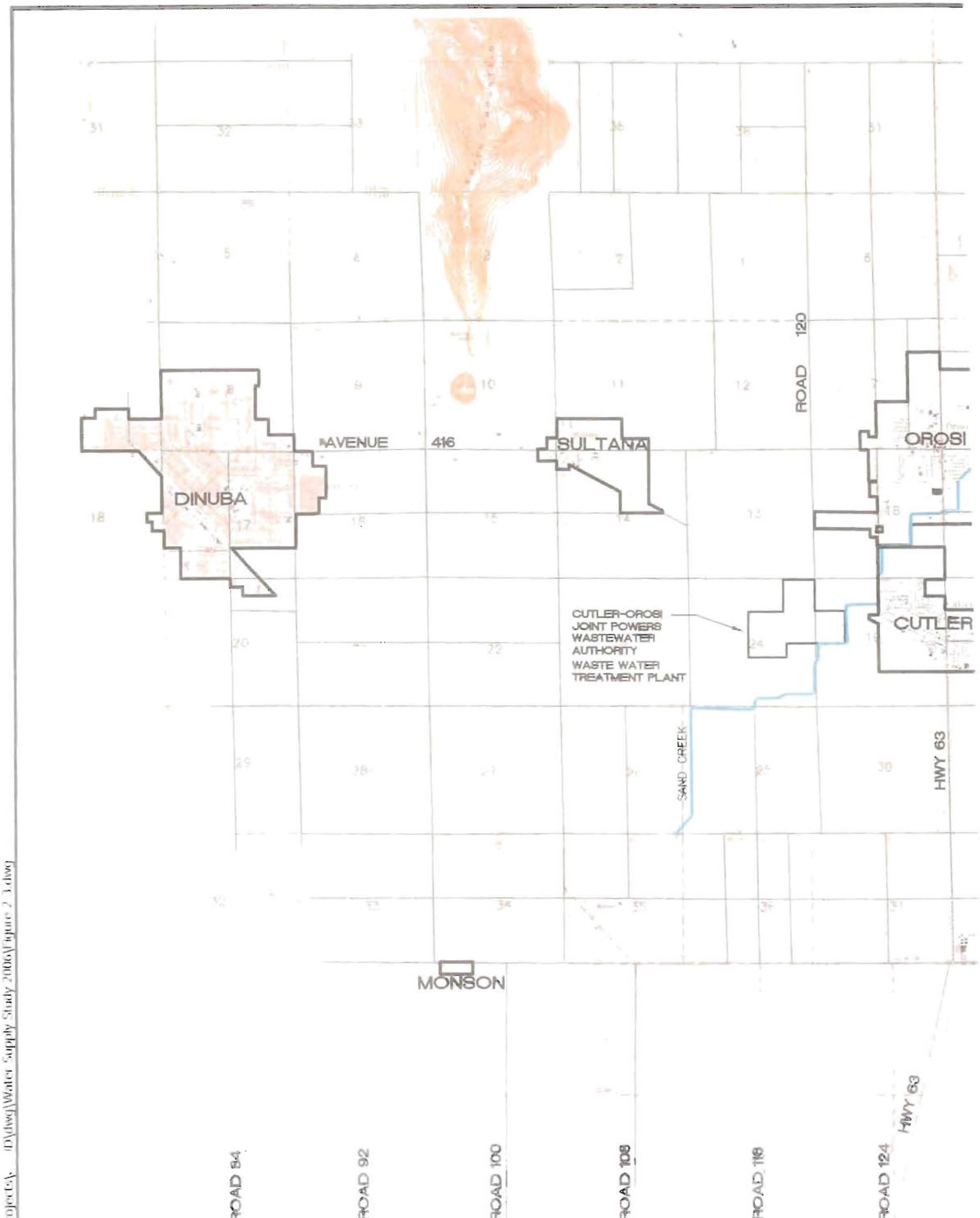
OPUD has a total of six developed wells. The information regarding the active wells is summarized in Table 2-2. Four of the wells are active and two of the wells are inactive at this time. Well No. 6 is inactive and was taken out of service because water test results exceeded the MCL limit for nitrates. Well No. 9 is also considered inactive due to high nitrates and is not connected to the system because of a development dispute. Well Nos. 4, 5A, 7 and 8 are the four active wells that supply water for the community.

TABLE 2-2
OPUD GROUNDWATER WELLS
WATER SUPPLY STUDY
CUTLER - OROSI AREA

WELL NO.	DATE DRILLED	DEPTH (Feet)	FLOW RATE (g.p.m.)	STATUS
4	1966	425	500-600	Active
5A	1990	433	700	Active
6	1977	291	200-300	Inactive
7	1981	400	600-800	Active
8	1996	455	850	Active
9	1993	400	285	Not connected
10	2006		--	Test hole only
TOTAL WELL CAPACITY			2,650-2,950 (3.8 - 4.2 MGD)	

Storage

OPUD has one ground level water storage tank and four hydropneumatic tanks that also provide some limited water storage. The ground level tank has a capacity of 750,000 gallons and delivers water to the system through two booster pumps located at the site of Well No. 5A. There is a 10,000 gallon hydropneumatic tank at each of the active wells. OPUD's water supply and distribution system is shown on Figure 2-3.



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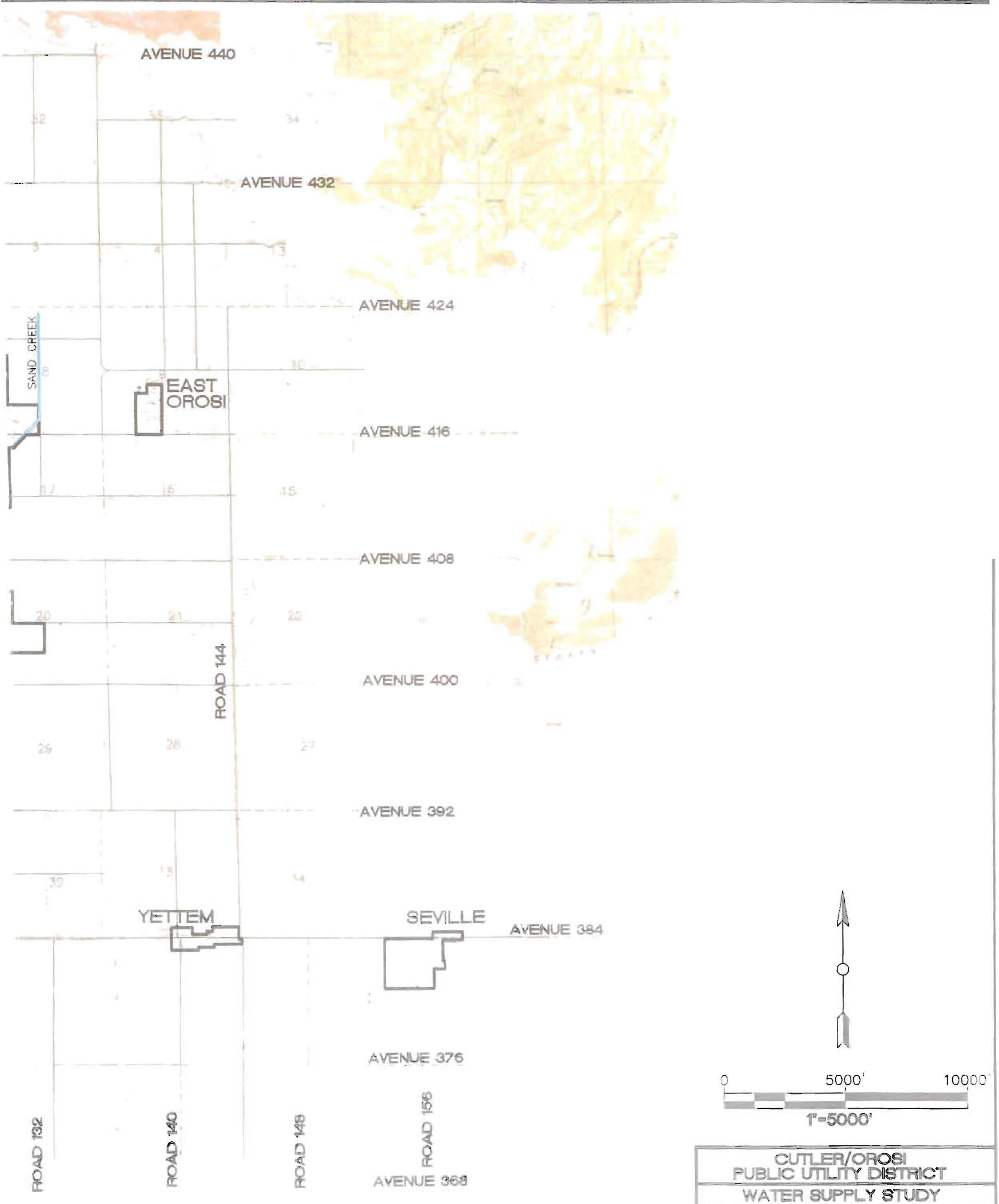

CUTLER/OROSI
PUBLIC UTILITY DISTRICT

WATER SUPPLY STUDY

CUTLER-OROSI AREA

KELLER/WEGLEY

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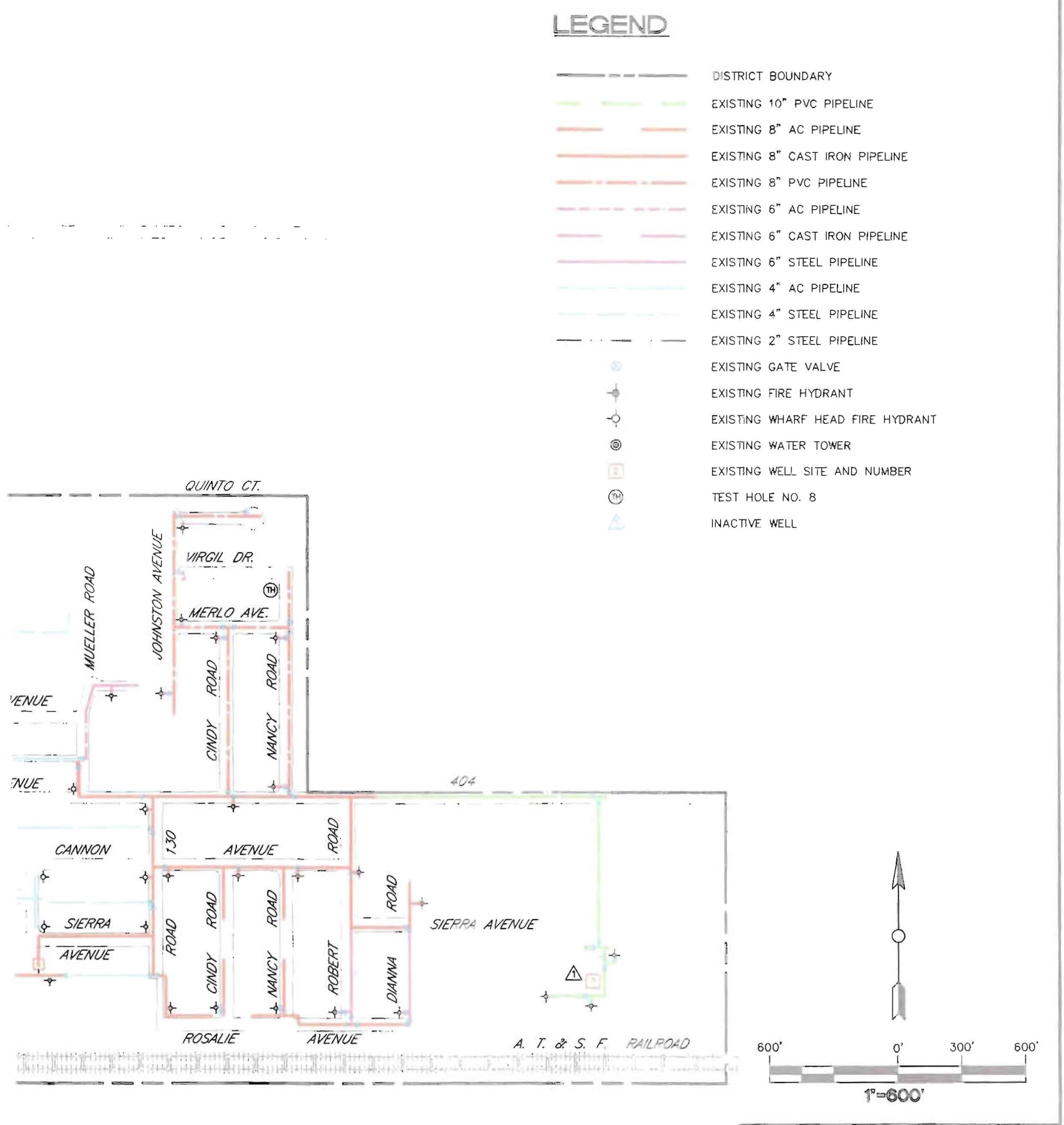

CUTLER
PUBLIC UTILITY DISTRICT
WATER SUPPLY STUDY
CUTLER-OROSI AREA

KELLER/WEGLEY

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LEGEND

DISTRICT BOUNDARY

EXISTING BLOW-OFF ASSEMBLY

EXISTING WHARF HEAD TYPE FIRE HYDRANT

EXISTING PUMPER TYPE FIRE HYDRANT WITH SHUT-OFF VALVE

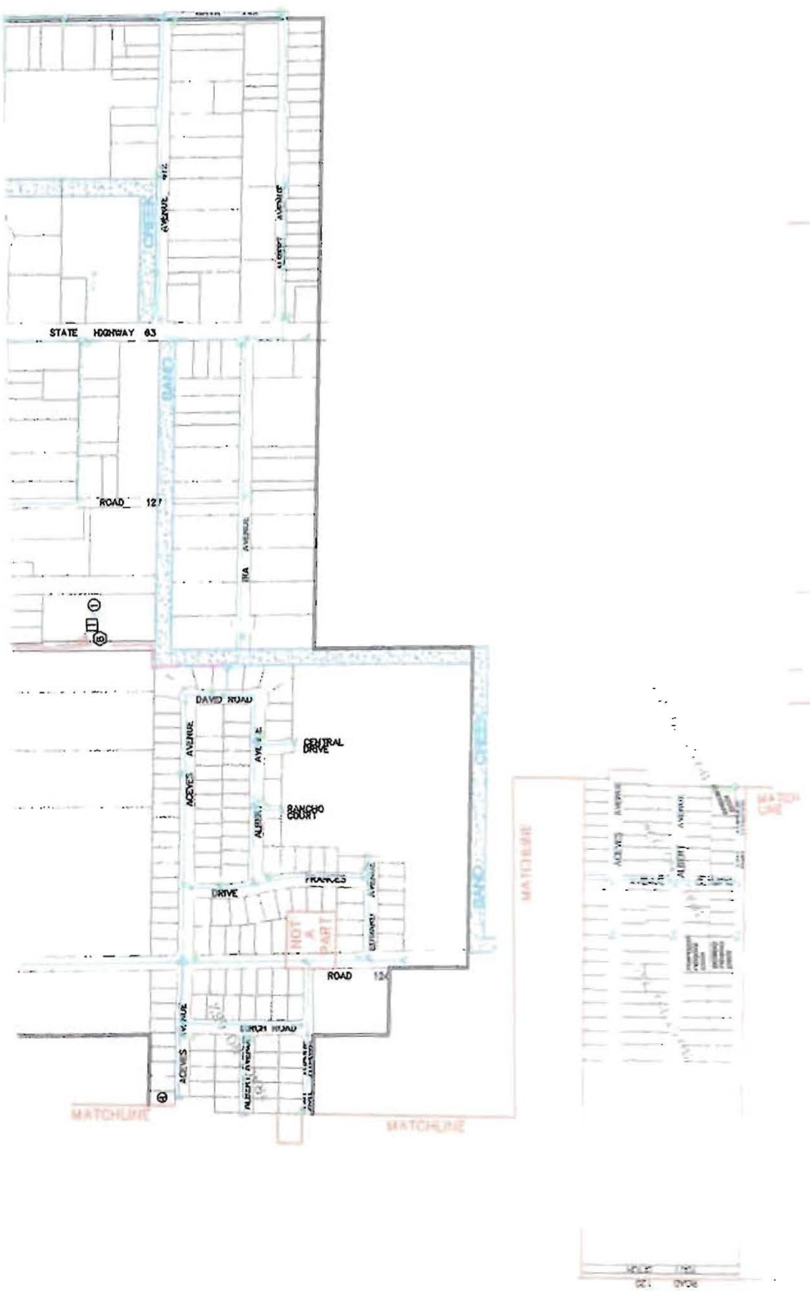
EXISTING GATE VALVE

① EXISTING WELL LOCATION AND NUMBER AS SHOWN. PUMP DISCHARGES INTO HYDROPNEUMATIC TANK.

⑤ EXISTING WELL LOCATION AND NUMBER AS SHOWN. PUMP DISCHARGES INTO STORAGE TANK.

[1] EXISTING BOOSTER PUMP LOCATION AND NUMBER AS SHOWN. PUMPS DISCHARGEMATIC INTO HYDROPNEU TANK.

EXISTING 2" STEEL WATER LINE
EXISTING 3" STEEL WATER LINE
EXISTING 4" AC WATER LINE
EXISTING 4" STEEL WATER LINE
EXISTING 6" AC WATER LINE
EXISTING 6" PVC WATER LINE
EXISTING 8" AC WATER LINE
EXISTING 8" PVC WATER LINE
EXISTING 8" DUCTILE IRON WATER LINE
EXISTING 10" AC WATER LINE
EXISTING 10" PVC WATER LINE
EXISTING 10" DUCTILE IRON WATER LINE
EXISTING 12" DUCTILE IRON WATER LINE
EXISTING 16" DUCTILE IRON WATER LINE



600' 0' 300' 600'

1"=600'

OROSI
PUBLIC UTILITY DISTRICT

WATER SUPPLY STUDY

CUTLER-OROSI AREA

KELLER/WEGLE

SECTION 3
PROJECTED WATER DEMANDS
WATER SUPPLY STUDY
CUTLER - OROSI AREA

GENERAL

The purpose of this section is to evaluate historical water usage for the Orosi Public Utility District (OPUD) and the Cutler Public Utility District (CPUD) and establish projected water demands. The projected water demands serve as the basis of water supply alternative development.

POPULATION DATA

Table 3-1 summarizes the United States Census population data of the two communities for the period 1980 through 2000. During this time period, the population in Tulare County increased by an average of approximately two percent per year. The present population within the districts are a combination of permanent and seasonal residents. The majority of the residents are employed in the larger urban centers of Tulare County, at industries and businesses located with the Orosi and Cutler areas or on adjacent agriculturally related enterprises. Most of the seasonal residents are employed within the agricultural services industry. There is potential for both moderate population increases and decreases in each community related to fluctuations in the economic environment of this part of Tulare County.

As shown in Table 3-1, Orosi has experienced more consistent growth of the two communities. For the purpose of this study, an annual growth rate of three percent was used. Cutler on the other hand, has experienced more sporadic growth. The most recent census period documented very little population growth. A population growth rate of one percent was used for population projections within the community of Cutler.

TABLE 3-1
HISTORICAL POPULATION DATA
WATER SUPPLY STUDY
CUTLER - OROSI AREA

	1980	1990	2000	ANNUAL GROWTH RATE (1)
Tulare County	245,738	311,921	368,021	2.04%
Orosi	4,076	5,486	7,318	2.97%
Cutler	3,149	4,450	4,491	1.79%

NOTE:

1. Based upon 20-year population change.

To develop projected populations for the two communities, a facility design period of twenty years was established. Table 3-2 summarizes the population projections for the next twenty years at five-year intervals.

TABLE 3-2
PROJECTED POPULATIONS
WATER SUPPLY STUDY
CUTLER - OROSI AREA

YEAR GROWTH RATE	OROSI 3%	CUTLER 1%
2000	7,318	4,491
2007	9,000	4,815
2012	10,434	5,061
2017	12,096	5,319
2022	14,022	5,590
2027	16,255	5,875

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2027	16,255	5,875

ESTIMATED WATER USE

Table 3-3 summarizes OPUD's water production for the 10-year period from 1996 to 2005. Based upon the estimated population for that time period, the average water use was 169 gallons per capita per day (gpcd). OPUD, however, completed a water meter installation program in 2004, which resulted in a significant reduction in per capita water use as shown in Table 3-3. Based on the assumption that the water conservation which occurred during the first two years after the installation of the water meters would continue a projected water use in Orosi, of 150 gpcd was used. This per capita daily use represents a balance between historical and the most recent water use trend. The 2027 projected annual water use is estimated to be approximately 900 million gallons which is equivalent to 2.4 million gallons per day (MGD).

Table 3-4 summarizes CPUD's water production from 1996 to 2005. The average water use was approximately 208 gpcd based upon population estimates for this time period. CPUD does not utilize individual water meters on each service. To develop a projected water use amount, 205 gpcd was used. Although water use has been decreasing over the past four years, this per capita daily use reflects a combination of the historical average water use with recent water usage figures. The projected 2027 annual water use in Cutler is estimated to be approximately 440 million gallons (1.2 MGD)

PROJECTED WATER NEEDS

Table 3-5 summarizes each district's current water capacity and projected water demands and needs. A peaking factor was established to estimate the projected peak water demand during the month of highest water use.

TABLE 3-3
OROSI PUBLIC UTILITY DISTRICT HISTORIC AND PROJECTED WATER USE
WATER SUPPLY STUDY
CUTLER-OROSI AREA

Year	Population Estimate (1)	Total Water Production (MG) (2)	Average Use (MGD)	Water Use/Person (gpcd) (3)
1996	6,479	424.03	1.162	179
1997	6,679	462.51	1.267	190
1998	6,886	461.36	1.264	184
1999	7,098	464.22	1.272	179
2000	7,318	457.80	1.254	171
2001	7,538	464.83	1.274	169
2002	7,764	475.95	1.304	168
2003	7,997	469.79	1.287	161
2004	8,236	484.06	1.326	161
2005	8,484	387.77	1.062	125
Average		455.23	1.25	169
Projected Water Use 2027	16,255	889.96	2.438	150

Notes:

1. Population for Year 2000 based upon census data. One percent annual growth used for other years.
2. District data.
3. Based upon estimated population.

TABLE 3-4
CUTLER PUBLIC UTILITY DISTRICT HISTORIC AND PROJECTED WATER USE
WATER SUPPLY STUDY
CUTLER-OROSI AREA

Year	Population Estimate (1)	Total Water Production (MG) (2)	Average Use (MGD)	Water Use/Person (gpcd) (3)
1996	4,314	319.52	0.875	203
1997	4,358	350.19	0.959	220
1998	4,402	332.32	0.910	207
1999	4,446	351.18	0.962	216
2000	4,491	361.42	0.990	220
2001	4,536	342.19	0.938	207
2002	4,581	355.93	0.975	213
2003	4,627	344.79	0.945	204
2004	4,673	342.47	0.938	201
2005	4,720	333.26	0.913	193
Average		343.33	0.94	208
Projected Water Use				
2027	5,875	439.60	1.204	205

Notes:
1. Population for Year 2000 based upon census data.
   One percent annual growth used for other years.
2. District data.
3. Based upon estimated population.

TABLE 3-5
PROJECTED WATER NEEDS
WATER SUPPLY STUDY
CUTLER-OROSI AREA

	CPUD	OPUD
Total Active Water Supply Capacity (1)	1,497 gpm	2,950 gpm
Firm Water Supply Capacity (2)	497 gpm 0.7 MGD	2,100 gpm 3.0 MGD
Projected Average Water Demand (2027)	1.2 MGD	2.4 MGD
Peak Demand Factor	1.7 (3)	1.5 (3)
Projected Peak Water Demand (2027)	2.1 MGD	3.6 MGD
Projected Water Needs - Average Demand (2027)	0.5 MGD	-
Projected Water Needs - Peak Demand (2027)	1.4 MGD	0.6 MGD

Note:
1. See Tables 2-1 and 2-2.
2. Water supply capacity with largest active well out of service.
3. Peak Demand Factor based upon ratio of highest monthly water use to average monthly water use using historical data.

CPUD's lack of water supply capacity affects both existing and projected water needs. Each CPUD well must be in service to meet existing water demands. The existing wells will not be able to meet projected average nor projected peak water demands. Additional water supply is necessary. CPUD needs approximately 1.4 MGD to meet projected peak water demands.

Recent projects completed by OPUD have significantly augmented OPUD's water supply. Well No. 8 increased OPUD's potential water supply. OPUD installed water meters which has resulted in significantly reduced water use. Subsequently, OPUD will not need any additional water supply to meet projected average water demands. OPUD will, however, need an additional 0.6 MGD to meet projected peak water demands.

SECTION 4
TREATMENT PROCESS CONSIDERATIONS
WATER SUPPLY STUDY
CUTLER - OROSI AREA

PURPOSE

The Cutler Public Utility District (CPUD) and Orosi Public Utility District (OPUD) presently rely entirely on groundwater for domestic water supply purposes. Additional water supplies need to be developed to meet projected water needs. Since each district is experiencing elevated nitrates and other contaminants in the local groundwater, the additional water supplies must originate from the treatment of groundwater or from a supplemental surface water supply. Due to drinking water regulations, any surface water supply will require treatment.

The purpose of this section is to present information and data for consideration and subsequent development and to identify treatment process alternatives that address the districts' needs.

DRINKING WATER REGULATIONS

There are several drinking water regulations that warrant special consideration during the development of the Project alternatives for the districts. These regulations are:

1. National Primary Drinking Water Regulations;
2. Long Term 2 Enhanced Surface Water Treatment Rule; and
3. Disinfectant/Disinfection By-Product Rule.

National Primary Drinking Water Regulations (NPDWR)

The NPDWR establishes the current drinking water standards for public water systems.

The standards represent threshold levels of contaminant levels in drinking water. These levels are known as Maximum Contaminant Levels (MCLs). The California Department of Health Services enforces these MCLs, as well as establishes additional MCLs. Contaminant concentrations below the MCLs can be achieved naturally as a result of good source water quality or through treatment to reduce the concentration.

Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)

The LT2ESWTR establishes water quality monitoring and treatment requirements for surface water treatment plants and subsequent monitoring. Both districts use groundwater as the only source for their domestic water supply and, therefore, are not presently subject to LT2ESWTR. Development of a surface water treatment plant, however, would require compliance with the LT2ESWTR.

The LT2ESWTR enhances treatment requirements established by the Surface Water Treatment Rule (SWTR) in 1989. The SWTR requires filtration and disinfection of surface water sources. The treatment requirements of the LT2ESWTR are based upon source water monitoring. Monitoring results determine a "bin" placement that establishes the extent of additional treatment requirements.

Disinfectant/Disinfection By-Products (D/DBP) Rule

Each district uses chlorine to accomplish disinfection of its water supply and to provide a disinfectant residual in the distribution system. Subsequently, the districts are subject to the D/DBP Rule.

The D/DBP Rule establishes MCLs for disinfection by-products that result from chlorine disinfection. The rule has two steps. Stage 1 has been in effect for the districts since 2004.

Stage 1 of the D/DBP Rule establishes numerous limits for trihalomethanes and haloacetic acids along with additional monitoring requirements. Stage 2 was promulgated in January, 2006, and will become effective for the districts in April, 2008. Stage 2 of the D/DBP Rule establishes more detailed monitoring and rule compliance measures.

Disinfection by-products are formed when chlorine reacts with organic material (precursors) in the water source. Typically, surface waters have higher concentrations of disinfection by-product precursors as compared to groundwater. Water treatment processes must be designed to reduce precursor concentrations and to implement optimal operation procedures in utilizing disinfection to minimize the formation of disinfection by-products.

WATER QUALITY

Groundwater

Table 4-1 summarizes recent general water quality constituents for OPUD's water supply wells. Overall, the groundwater quality is good. Nitrate and arsenic represent the only constituents of concern. Since elevated nitrate levels exist in Well Nos. 7 and 8., the District has conducted more frequent testing at these locations. Table 4-2 summarizes recent nitrate concentrations for OPUD's active groundwater wells. Historic nitrate concentrations for OPUD's inactive well is summarized in Table 4-3. The arsenic levels in the District's wells are well below the new standard of 10 mg/l.

The groundwater quality for CPUD's water supply wells is very similar to OPUD's groundwater. Table 4-4 presents the test results from CPUD's most recent testing effort. CPUD monitors nitrate and DBCP on a monthly basis due to elevated concentrations. Table 4-5 summarizes recent test results for nitrates and DBCP at CPUD's active wells.. Well No. 6 has

TABLE 4-1
OROSI PUBLIC UTILITY DISTRICT - GROUNDWATER QUALITY
WATER SUPPLY STUDY
CUTLER-OROSI AREA

		Well 4	Well 5A	Well 7	Well 8
CONSTITUENTS	Units	8/24/04	8/24/04	8/24/04	8/15/05
Alkalinity (as CaCO3)	mg/L	160	150	190	180
Aluminum (Al) (Primary)	ug/L	< 50.0	< 50.0	< 50.0	< 50.0
Antimony	ug/L	< 6.0	< 6.0	< 6.0	< 6.0
Arsenic (As)	ug/L	2	3	2	3
Barium (Ba)	ug/L	< 100.0	< 100.0	< 100.0	< 100.0
Beryllium	ug/L	< 1.0	< 1.0	< 1.0	< 1.0
Bicarbonate (HCO3)	mg/L	200	180	230	220
Cadmium (Cd)	ug/L	< 1.0	< 1.0	< 1.0	< 1.0
Calcium (Ca)	mg/L	40	34	48	48
Carbonate Alkalinity(CO3)	mg/L	< 1	< 1	< 1	1
Chloride (Cl)	mg/L	16	11	17	14
Chromium (Total Cr)	ug/L	< 10.0	< 10.0	< 10.0	< 10.0
Color (Unfiltered)	UNITS	< 1	< 1	< 1	1
Copper (Cu)	ug/L	< 50.0	< 50.0	< 50.0	< 50.0
Cyanide	ug/L	< 100.0	< 100.0	< 100.0	< 100.0
Fluoride (F) Temp. Depend.	mg/L	0.1	0.1	0.1	0.1
Hardness (as Ca CO3)	mg/L	160	140	200	190
Hydroxide Alkalinity (OH)	mg/L	< 1	< 1	< 1	1
Iron (Fe)	ug/L	< 100.0	< 100.0	< 100.0	< 100.0
Lead (Pb)	ug/L	< 5.0	< 5.0	< 5.0	< 5.0
Magnesium (Mg)	mg/L	16	13	19	17
Manganese (Mn)	ug/L	< 20.0	< 20.0	< 20.0	< 20.0
MBAS (Foaming Agents)	ug/L	< .05	< .05	< .05	0.05
Mercury (Mn)	ug/L	< 1.0	< 1.0	< 1.0	< 1.0
Nickel	ug/L	< 10.0	< 10.0	< 10.0	< 10.0
Nitrate (NO3)	mg/L	20	16	26	32
Odor Threshold at 60° C	TON	1	1	1	1
pH (Laboratory)	Std Units	8	8.1	8	8.2
Potassium (K)	mg/L	3	3	3	4
Selenium (Se)	ug/L	< 5.0	< 5.0	< 5.0	< 5.0
Silver (Ag)	ug/L	< 10.0	< 10.0	< 10.0	< 10.0
Sodium (Na)	mg/L	21	20	24	25
Specific Conductance (E.C.)	umhos/cm	390	330	450	470
Sulfate (SO4)	mg/L	9	6	14	ND
Thallium	ug/L	< 1.0	< 1.0	< 1.0	< 1.0
Total Filterable Residue at 180° C (TDS)	mg/L	280	250	320	330
Turbidity (Lab)	NTU	< .1	0.2	< .1	0.2
Zinc (Zn)	ug/L	< 50.0	< 50.0	< 50.0	< 50.0

TABLE 4-2
OROSI PUBLIC UTILITY DISTRICT - NITRATE DATA FOR ACTIVE WELLS
WATER SUPPLY STUDY
CUTLER-OROSI AREA

Sample Date	Well 4 NO3 (mg/L)	Well 5A NO3 (mg/L)	Well 7 NO3 (mg/L)	Well 8 NO3 (mg/L)
2/10/04				19
3/23/04			29	
4/27/04			26	30
8/24/04	20	16	26	39
11/9/04			33	17
1/20/05			34	25
2/8/05			32	18
5/10/05			37	25
8/15/05	20	16	24	32
12/13/05			33	43
6/6/2006			36	18
8/8/2006	22	18	32	21
Average	21	17	31	26
Maximum	22	18	37	43
Minimum	20	16	24	17
No. of Samples	3	3	11	11

TABLE 4-3
OROSI PUBLIC UTILITY DISTRICT - NITRATE DATA FOR INACTIVE WELLS
WATER SUPPLY STUDY
CUTLER-OROSI AREA

Sample Date	Well 6 NO3 (mg/L)
9/21/89	21
7/14/92	198
9/29/92	39.8
7/5/94	44
9/29/94	168
11/3/94	138
12/12/94	120
7/17/02	140
Average	109
Maximum	198
Minimum	21
No. of Samples	8

TABLE 4-4
CUTLER PUBLIC UTILITY DISTRICT - GROUNDWATER QUALITY
WATER SUPPLY STUDY
CUTLER-OROSI AREA

CONSTITUENTS	Units	Well 05 8/10/04	Well 06 8/10/04
Alkalinity (as CaCO3)	mg/L	200	170
Aluminum (Al) (Primary)	ug/L	< 50.0	< 50.0
Antimony	ug/L	< 6.0	< 6.0
Arsenic (As)	ug/L	3	3
Barium (Ba)	ug/L	140	140
Beryllium	ug/L	< 1.0	< 1.0
Bicarbonate (HCO3)	mg/L	200	170
Cadmium (Cd)	ug/L	< 1.0	< 1.0
Calcium (Ca)	mg/L	55	44
Carbonate Alkalinity(CO3)	mg/L	< 1	< 1
Chloride (Cl)	mg/L +	29	22
Chromium (Total Cr)	ug/L	< 10.0	< 10.0
Color (Unfiltered)	UNITS	< 1	< 1
Copper (Cu)	ug/L	< 50.0	< 50.0
Cyanide	ug/L	< 100.0	< 100.0
Dibromochloropropane (DBCP)	ug/L	0.039	0.19
Fluoride (F) Temp. Depend.	mg/L	0.2	0.1
Hardness (as Ca CO3)	mg/L	220	180
Hydroxide Alkalinity (OH)	mg/L	< 1	< 1
Iron (Fe)	ug/L	< 100.0	< 100.0
Lead (Pb)	ug/L	< 5.0	< 5.0
Magnesium (Mg)	mg/L	20	16
Manganese (Mn)	ug/L	< 20.0	< 20.0
MBAS (Foaming Agents)	ug/L	< 0.05	< 0.05
Mercury (Mn)	ug/L	< 1.0	< 1.0
Nickel	ug/L	< 10.0	< 10.0
Nitrate (NO3)	mg/L	31	26
Odor Threshold at 60° C	TON	1	1
pH (Laboratory)	Std Units	8	8
Potassium (K)	mg/L	4	3
Selenium (Se)	ug/L	< 5.0	< 5.0
Silver (Ag)	ug/L	< 10.0	< 10.0
Sodium (Na)	mg/L	32	30
Specific Conductance (E.C.)	umhos	530	450
Sulfate (SO4)	mg/L +	20	13
Thallium	ug/L	< 1.0	< 1.0
Total Filterable Residue at 180° C (TDS)	mg/L +	360	310
Turbidity	NTU	< 0.1	0.1
Zinc (Zn)	ug/L	< 50.0	< 50.0

TABLE 4-5
CUTLER PUBLIC UTILITY DISTRICT - NITRATE AND DBCP DATA FOR ACTIVE WELLS
WATER SUPPLY STUDY
CUTLER -OROSI AREA

Sample Date	Well No. 5		Well No. 6	
	Nitrate (NO3) (mg/L)	DBCP (ug/L)	Nitrate (NO3) (mg/L)	DBCP (ug/L)
2/10/04	31	0.03		
3/2/04			40	0.16
4/27/04			35	0.16
5/20/04	30	0.3 (1)	46	0.16
6/8/04			36	0.14
7/27/04			43	0.2
8/10/04	31	0.039	26	0.19
8/20/04			40	0.16
9/7/04			48	0.17
9/10/04			28	
9/14/04			49	
10/26/04			35	0.22
11/2/04		0.045	38	0.26
11/23/04				0.16
12/20/04			46	
1/4/05			39	0.2
2/1/05	35	0.061	41	0.18
3/1/05			32	0.21
4/5/05			30	0.24
4/25/05				0.19
5/17/05	40	0.036	33	0.22
6/7/05			48	0.22
6/13/05			26	
7/5/05			30	0.21
8/15/05	31	0.045	48	0.15
8/29/05			48	
9/1/05			25	
9/20/05			27	0.23
10/4/05			46	
10/10/05			31	
12/27/05			39	0.22
12/30/05	31	0.075		
3/14/06	< 2 (1)		36	0.22
4/4/06			34	0.23
5/2/06	38	0.036	29	0.32
6/6/06			26	0.23
7/11/06			32	0.2
8/8/06	33	0.048	31	0.23
Average	33	0.05	37	0.20
Maximum	40	0.08	49	0.32
Minimum	30	0.03	25	0.14
No. of Samples	9	9	34	28

Note:
1. Result is considered not typical when compared to other data.
Potential sampling or analytical error.

exceeded the MCL for nitrate on several occasions. Table 4-6 summarizes nitrate concentrations at CPUD's inactive wells. Like OPUD, the arsenic levels in the CPUD wells are well below the new standard of 10 mg/l.

As evidenced by the testing results, nitrates are impacting the groundwater in the community. Locating a groundwater source in the Cutler-Orosi area that is low in nitrates, has been and will continue to be difficult. The future use of existing wells may also be jeopardized by increasing nitrate levels. Although arsenic levels are well below current regulatory standards, the potential for more stringent standards exist, which may subsequently require a need for treatment.

Surface Water

There is no natural surface water supply in the vicinity of the districts. A surface water supply for domestic purposes will have to be transported to the area through Alta Irrigation District's open channels, the Friant-Kern Canal, a dedicated pipeline or a combination of all three. The Alta Irrigation District surface water supply originates in the Kings River watershed, with their headgate on the Kings River being located downstream of Piedra. Storage of their water supply is provided by Pine Flat Dam.

The districts conducted a short-term surface water testing program to compile preliminary data for consideration in the selection of a treatment process. The samples were collected at the head of the Alta Irrigation District's Tout Ditch which is located near Avenue 120, just northwest of Orosi. Table 4-7 summarizes the testing results for the routine samples. In addition, a detailed analysis for water quality constituents was conducted. Table 4-8 summarizes the detailed water quality results.

TABLE 4-6

CUTLER PUBLIC UTILITY DISTRICT - NITRATE AND DBCP DATA FOR INACTIVE WELI

WATER SUPPLY STUDY

CUTLER-OROSI AREA

Sample Date	Well No. 3	Well No. 4
	Nitrate (NO3) (mg/L)	Nitrate (NO3) (mg/L)
11/27/91	61	
2/13/92	62	
3/7/92	57	
4/7/92	59.5	
9/17/97		44
12/19/97		47
9/23/98		48
12/3/98		49
Average	60	47
Maximum	62	49
Minimum	57	44
No. of Samples	4	4

TABLE 4-7
SURFACE WATER TESTING RESULTS (1)
WATER SUPPLY STUDY
CUTLER-OROSI AREA

PARAMETER	UNITS	SAMPLE TYPE AND DATE														Average	No. of Samples
		Flood 4/6/2006	T22 7/6/2006	7/13/2006	7/20/2006	7/27/2006	8/3/2006	Expanded 8/10/2006	8/17/2006	8/24/2006	8/31/2006	9/7/2006	Expanded 9/14/2006	9/21/2006	9/28/2006		
Turbidity	NTU	67	-	2.2	2.6	2.3	2.0	-	3.1	1.8	1.4	1.8	-	1.4	1.5	2.0	10
Coliform, Total	MPN/100 ml	-	-	-	> 23	-	> 23	Present	> 23	-	-	50	300	-	50	78.2	6
Coliform, Fecal (E. Coli)	MPN/100 ml	-	-	-	> 23	-	16.1	Present	23	-	-	23	No Sample	-	30	23.0	5
Temperature	Deg F	-	-	63	64	65	65	-	-	65	-	69	-	-	66	65.3	7
pH	-	7.9	7.5	-	-	-	-	7.2	-	-	-	-	7.1	-	-	7.3	3
Conductivity (EC)	umho/cm	220	28	-	-	-	-	-	-	-	-	-	-	-	-	28	1
Dissolved Organic Carbon (DOC)	mg/l	9.2	-	-	-	-	-	1.3	-	-	-	-	0.78	-	-	1.0	2
Total Dissolved Solids (TDS)	mg/l	210	32	-	-	-	-	21	-	-	-	-	23	-	-	25.3	3
Total Organic Carbon (TOC)	mg/l	13	-	-	-	-	-	1.3	-	-	-	-	0.95	-	-	1.1	2
Total Suspended Solids (TSS)	mg/l	67	-	-	-	-	-	< 5	-	-	-	-	< 5	-	-	< 5	2
Alkalinity	mg/l	-	29	-	-	-	-	11	-	-	-	-	11	-	-	17	3
Bicarbonate	mg/l	-	29	-	-	-	-	11	-	-	-	-	11	-	-	17	3
Calcium	mg/l	-	3.1	-	-	-	-	2.1	-	-	-	-	2	-	-	2.4	3
Carbonate	mg/l	-	< 1	-	-	-	-	< 1	-	-	-	-	< 1	-	-	< 1	2
Hardness	mg/l	-	10	-	-	-	-	0.9	-	-	-	-	6.6	-	-	5.8	3
Hydroxide	mg/l	-	< 1	-	-	-	-	< 1	-	-	-	-	< 1	-	-	< 1	2
Magnesium	mg/l	-	0.67	-	-	-	-	0.4	-	-	-	-	0.38	-	-	0.5	3

Note:
1. Location: Tout Ditch, Alta Irrigation District; water source - Kings River.

TABLE 4-8
SURFACE WATER CHARACTERIZATION (1)
WATER SUPPLY STUDY
CUTLER-OROSI AREA

Parameter	Units		Date 7/6/2006
Alkalinity	mg/l		29
Aluminum	mg/l		0.19
Antimony	ug/l	<	2
Arsenic	ug/l	<	2
Barium	mg/l	<	0.05
Bicarbonate	mg/l		29
Cadmium	ug/l	<	1
Calcium	mg/l		3.1
Carbonate	mg/l	<	1
Chloride	mg/l	<	1
Chromium - Total	ug/l	<	10
Color	units		15
Conductivity (EC)	umho/cm		28
Copper	ug/l	<	50
Cyanide	ug/l	<	20
Fluoride	mg/l	<	0.1
Hardness	mg/l		10
Hydroxide	mg/l	<	1
Iron	mg/l		0.21
Langlier Index			-1.8
Lead	ug/l	<	5
Magnesium	mg/l		0.67
Manganese	mg/l	<	0.01
MBAS (Surfactants)	mg/l	<	0.05
Mercury	ug/l	<	0.4
Nickel	ug/l	<	10
Nitrate	mg/l	<	1
Nitrite	mg/l	<	0.05
Odor	TON		1.0
pH	-		7.5
Potassium	mg/l	<	2
Selenium	ug/l	<	2
Silver	ug/l	<	10
Sodium	mg/l		1.7
Sulfate	mg/l	<	2
Thallium	ug/l	<	1
Total Dissolved Solids	mg/l		32
Turbidity	NTU		2.5
Zinc	mg/l	<	0.05

NOTES:
(1) Samples collected 7/6/06.
Location: Alta Irrigation District, Tout Ditch.
Source: Kings River.

The water quality of the surface water is good and can be considered typical of summer (post-runoff) high Sierra waters. The water has a low turbidity and solids concentrations. The water's alkalinity is also low which may affect the selection of potential treatment options.

Summary

In general, the groundwater quality in the area is relatively good. Existing and future nitrate concentrations present concerns for both districts. DBCP contamination remains a concern to CPUD.

The water quality of the most convenient surface water supply is excellent. The test results do not reveal any constituent warranting special concerns. The water appears suitable for domestic purposes with standard treatment processes.

TREATMENT ALTERNATIVES

The treatment options available to the districts can be divided into two primary categories: groundwater treatment and surface water treatment.

Groundwater Treatment

There are several alternatives available to accomplish groundwater treatment. One option is to blend high nitrate water with low nitrate water originating from a new water source (i.e., new well). Blending is an acceptable nitrate reduction approach to the Department of Health Services. Based upon the existing groundwater quality data, however, it appears unlikely that a suitable blending source (i.e., an additional well) with a sufficiently low nitrate concentration can be identified. Treatment of an existing source would likely be necessary to facilitate a blending alternative.

Ion exchange and reverse osmosis represent two available treatment technologies for removing nitrates from the groundwater. The ion exchange process utilizes a resin specifically designed for removing a target containment. The resin attracts the contaminant and subsequently removes the contaminant from the water by binding with it. Reverse osmosis is a membrane based process in which contaminants are removed under pressure onto a membrane barrier. Treated water permeates the membrane while the contaminants are rejected by the membrane.

Surface Water Treatment

Due to existing and recently enacted regulations governing surface water treatment, the surface water treatment processes available to the districts will need to demonstrate minimum performance standards. Presently, surface water treatment must accomplish 99.9 percent removal of Giardia lamblia and 99.99 percent removal of viruses through filtration and disinfection. Most conventional treatment processes can accomplish these goals through proper design and operation.

Under the LT2ESWTR, monitoring results for cryptosporidium in the source water can require enhanced treatment requirements. Preliminary research into the presence of giardia and cryptosporidium levels in high Sierra Mountain waters have shown them to be present at low levels. For the purposes of this study, a total of 99.99 percent of giardia and cryptosporidium removal must be achieved for surface water supply. The required removal percentage can be achieved using either conventional treatment on alternative treatment processes. Actual giardia and cryptosporidium concentrations will need to be established through monitoring prior to final design of any surface water treatment process.

Conventional filtration and disinfection generally cannot achieve the anticipated giardia/cryptosporidium removal requirements without process and operational enhancements and controls. An alternate disinfectant, such as ultraviolet (UV) light may also be required in combination with chlorine, to reduce the potential for increased disinfection by-products formation.

An alternate treatment process to conventional filtration is the use of membrane filtration. Micro filtration and ultra filtration membranes can achieve up to 99.9999 percent removal of giardia and cryptosporidium. The reason these processes can achieve the higher removal rates is due to the very small pore openings in the membranes of less than 0.1 micron (μm; 1/25,000th of an inch).

GROUNDWATER TREATMENT CONSIDERATIONS

Three methods of groundwater treatment were identified for consideration as an alternative to developing a surface water supply to meet the districts' projected water demands. The purpose of this section is to present preliminary considerations for each method and identify the groundwater treatment method that will be developed in greater detail.

Blending

Blending of different source water supplies is an acceptable nitrate reduction approach to the Department of Health Services. Several drawbacks exist, however, to implement this approach in the Cutler - Orosi area. First, there have not been any low nitrate groundwater sources identified within the districts, as nitrates have been found throughout the local groundwater at various concentrations. In addition, suitable well sites are not readily available.

Blending does not address the presence of nitrates in the groundwater and its effectiveness will be limited to the nitrate levels of the source groundwater. Blending, therefore, will not be considered further as a permanent groundwater treatment method.

Ion Exchange

Ion exchange represents an alternative that removes nitrates from the water supply. The ion exchange process consists of using resins designed specifically to remove nitrates from the water source. During operation, nitrate laden water contacts the resin on which the nitrates are attached through an electrochemical exchange. Once the resin loses its exchange capability, it is recharged by rinsing with a brine solution to remove the nitrates from the resin. The rinseate can be disposed of in the sanitary sewer if the local wastewater treatment facility has the capability and available capacity. Otherwise, other approved means will be necessary.

Ion exchange presents several advantages. First, nitrates are removed through treatment. In general, variable nitrate levels will have little effect on removal efficiencies. In addition, there exists flexibility in treatment capacities to incorporate a blending approach. The primary disadvantage to the ion exchange process is the resin regeneration by-products. Special handling considerations will be necessary if the by-products cannot be discharged to the sewer system and treated at the regional wastewater facilities.

Reverse Osmosis

Reverse osmosis is another treatment technology that is capable of removing nitrates. Reverse osmosis utilizes a membrane to remove contaminants dissolved in the water. The groundwater is fed into a pressurized vessel in which the water is forced through the membrane. Treated water passes through the membrane as the contaminants are retained at the membrane's surface. The membranes are cleaned periodically to prevent fouling and to maintain their performance.

There are several advantages to reverse osmosis. Nitrates are physically removed from the source water through reverse osmosis. Reverse osmosis will remove other contaminants as well, including dissolved contaminants. Treatment capacities can be adjusted to utilize blending to achieve target nitrate levels, thereby reducing the capital and operational costs of the treatment equipment. There are, however, several disadvantages to a reverse osmosis process. A pretreatment system consisting of ultra-filtration can be required to ensure effective and proper operation of the reverse osmosis process. Due to the complexity of the reverse osmosis process and pretreatment requirements, capital costs are higher when compared to other treatment technologies. Finally, the treatment residuals and associated wastewater may require special handling, including pretreatment, prior to disposal.

For the purpose of this study, the ion exchange process has been selected for detailed consideration as the treatment alternative for nitrate removal from the groundwater. The ion exchange method was selected for the following reasons:

1. The process provides nitrate removal;
2. Blending can be incorporated with the process;
3. The handling of treatment residuals is less problematic due to the selective nature of the resin; and
4. Capital and operational costs for ion exchange will be less than reverse osmosis as a result of a more simplified treatment process.

Surface Water Treatment Considerations

An alternative to groundwater treatment is the use of surface water as a domestic water source. For the purposes of this report and subsequent evaluations, it is assumed that a surface water supply has been identified and can provide an adequate amount of water to meet the districts' water demands.

Surface water treatment will need to be accomplished through a combination of conventional treatment and filtration, membrane filtration and disinfection. Each element has specific considerations that will help formulate the preferred approach for detailed consideration.

Filtration

Conventional treatment and filtration consists of coagulation/flocculation and sedimentation processes followed by single or dual media gravity filters. Chemicals are added during coagulation to improve the settling characteristics of suspended material in the water. The filters are used to remove the very fine suspended material that could not be removed by sedimentation. The primary advantage to this approach is that the process has been proven effective and has been utilized on various surface waters for decades. Design and operation is straightforward. Several disadvantages exist for the conventional treatment process. First, conventional treatment will not achieve the new treatment removal standards as required by the LT2ESWTR without the use of appropriate disinfection practices. Second, the excellent water quality of the proposed surface water supply may prove problematic for efficient conventional treatment processes and result in poor cost effectiveness.

Direct filtration, another surface water treatment process, eliminates the use of the sedimentation process. Untreated surface water flows thrugh the coagulation/flocculation process and then is applied directly to a single or dual media filter either by gravity or under pressure. Direct filtration is primarily used on high quality surface waters. It is a proven treatment process that greatly simplifies treatment operations. Typically, it is less costly than conventional treatment. Direct filtration does not, however, handle significant water quality variations readily. In addition, there are increased treatment removal standards in the LT2ESWTR which are higher than those established for conventional treatment.

Membrane filtration is a comparatively new treatment process. It is becoming more prevalent due to increased treatment regulations and improving cost competitiveness with other treatment processes. The primary advantage of membrane filtration is that this process can fully achieve the cryptosporidium removal requirements of the LT2ESWTR. The removal credit is established by demonstration testing, certification and operational monitoring. Another advantage to membrane filtration is that the technology configuration is packaged in modular units which provide streamlined construction and expansion. Backwash and treatment residuals can be handled in a similar manner to that of conventional treatment. The primary disadvantage to membrane filtration is that variable water quality can adversely impact membrane performance and operation.

For the purpose of this study, membrane filtration has been selected for detailed development of the filtration element of surface water treatment. The selection of membrane filtration as the treatment method of choice was based on the following reasons:

1. Membrane filtration can provide giardia and cryptosporidium removal levels that meet the LT2ESWTR; and

2. Membrane filtration is modular and components are integrally designed making initial construction and future expansion straightforward.

Disinfection

There are several options available to the districts for consideration of disinfection practices. The options consist of chlorination, chloramination, UV disinfection, ozonation and chlorine dioxide.

Chlorination utilizes chlorine to accomplish disinfection. The process can use gaseous or liquid chlorine or sodium hypochlorite. The districts currently use liquid sodium hypochlorite at each of the individual well site. Chlorine is a strong disinfectant and provides a lasting residual in the water for continued disinfection. Its use, however, produces disinfection by-products (DBPs), especially when used with surface waters. Regulations limiting the DBP levels in drinking water will affect the operational practices for chlorination. Liquid and gaseous chlorine also have special safety and handling requirements.

Chloramination combines chlorine and ammonia to form the disinfectant. Chloramines are a weaker disinfectant than chlorine, but provide a longer lasting residual. A common practice is to utilize chlorine as the primary disinfectant at the treatment plant and then combine with ammonia to provide chloramines within the distribution system for residual disinfection. A concern with the use of chloramines is the potential for the formation of nitrates in the distribution system. Utilizing chloramination disinfection also requires the handling and storage of two chemicals.

Ultra-violet (UV) light disinfection is more common in wastewater treatment. Its use, for drinking water, however, is increasingly becoming more prevalent due to germicidal effectiveness and the new regulations regarding DBP formation in the distribution systems. UV disinfection consists of utilizing mercury vapor lamps that produce ultraviolet light which destroys disease causing organisms. UV disinfection has several advantages:

1. UV disinfection provides proven disinfectant effectiveness that exceeds the new disinfection/requirements;
2. UV light does not produce DBPs; and
3. There are also several different configurations of UV disinfection available which provide design and operational flexibility.

UV does not, however, provide a residual disinfection in the water supply, and, therefore, requires a second disinfectant to maintain a disinfection residual in the distribution system. Another disadvantage to UV disinfection is that it requires a large amount of power.

Ozonation is a proven water treatment disinfectant. Ozone is produced by directing oxygen gas between dielectric plates to convert oxygen into ozone. Ozone is a strong disinfectant that dissipates rapidly in water, and, like UV, it does not provide a lasting residual. Although ozone does not produce chlorinated DBPs, it may produce ozonated DBPs when treating certain surface waters. Since ozone does not produce a lasting disinfectant residual, an additional disinfectant is typically required. Another disadvantage in using ozone as a disinfection is that ozone production is a complicated process which utilizes highly technical equipment and requires a large amount of power.

Chlorine dioxide is also a proven water treatment disinfection, although its use is not as common as the other disinfectants. Chlorine dioxide is created by mixing chlorine and sodium chlorite. It is a strong disinfectant that does not produce trihalomethane or haloacetic acid DBPs.

Chlorine dioxide does, however, produce other regulated DBPs. In general, the chlorine dioxide process represents complicated operational considerations, although simplified designs are becoming available.

For the purposes of this study, the selected disinfection practices for detailed development will be UV light for use at the water treatment plant and chlorination for the distribution system disinfection. For chlorination, a liquid sodium hypochorite system will be considered. This combination of disinfection methods were selected for the following reasons:

1. UV disinfection can achieve the required disinfection levels without DBP formation;
2. Design and operation of the UV process is straightforward. It does not involve any complex technologies; and
3. Utilizing chlorine in the distribution system maintains the current practice for the existing groundwater wells. There is little likelihood of taste and odor problems resulting from mixing disinfectants.

SECTION 5
TREATMENT PROCESS COMPARISONS
WATER SUPPLY STUDY
CUTLER-OROSI AREA

GENERAL

Based upon projected water demands and existing groundwater quality issues regarding contaminants, the Cutler Public Utility District (CPUD) and the Orosi Public Utility District (OPUD), additional water supply and treatment will be necessary.

Section 4 described the preliminary review of the feasible treatment of options for the districts. Two options have been identified for further development and comparison:

1. Ion exchange for nitrate removal from existing groundwater resources (wells); and
2. Membrane filtration and UV disinfection of surface water.

This section develops each treatment process in greater detail to facilitate evaluation and comparisons.

GROUNDWATER TREATMENT

An ion exchange process to remove nitrate from the districts' existing groundwater supplies represents the most feasible treatment process for groundwater.

Process Description

A typical process schematic for the ion exchange process is shown on Figure 5-1. Ion exchange utilizes engineered resin material to remove the nitrate from the water. High nitrate water flows through treatment vessels that contain resin. The water contacts the resin within the vessel and flows out of the vessel. Nitrate concentrations in the treated water are very low, typically less than 5 mg/l. The treated water is blended with groundwater to achieve a target nitrate concentration. This blending approach reduces the overall size of the ion exchange process and the quantity of resin per volume of treated water that must be regenerated.

When the resin is no longer removing nitrate as determined by monitoring equipment, the resin must be regenerated. Multiple ion exchange modules are utilized to ensure water production during the resin regeneration process. Resin regeneration consists of pumping a brine solution into the resin modules to remove the nitrates from the resin. The rinseate requires disposal into the sewer or other approved means.

Conceptual Design

The design and configuration of the ion exchange process is straightforward. In general, ion exchange processes are modular package-treatment type systems. Using water quality data, the ion exchange manufacturer sizes and configures equipment to complete an ion exchange system.

The ion exchange process typically includes resin vessels, resin media, distributor and underdrain systems, interconnecting piping, brine make-up system, flow meters, electrical, controls, alarms and appurtenances. The equipment can be skid-mounted to simplify construction. To provide safe year-round access to the equipment and optimal operating conditions, it is proposed that the ion exchange process be installed inside a building structure.

The districts currently use liquid sodium hypochlorite for chlorine disinfection at each of their wells. It is proposed this same type of system be utilized at groundwater treatment locations.

Due to the quantities of brine required to accomplish regeneration and other chemical uses , on-site chemical storage will also be required.

Locations

Each district has unique considerations regarding potential locations for the nitrate removal process. In Cutler, CPUD's inactive wells are located approximately 400 feet apart. CPUD also has set aside a centrally located site for a potential blending project. This site is approximately 900 feet away from the inactive wells. CPUD's active wells (Well Nos. 5 and 6) are within 2,000 feet of the site. Due to the availability of the tentative blending project site, CPUD's ion exchange equipment should be located there. The location is shown in Figure 5-2. A detailed layout of the site is shown in Figure 5-2.

Presently, OPUD has two wells (Well No. 6 and Well No. 9) that are unavailable due to high nitrates. These wells are located on opposite sides of the community. In addition, OPUD's remaining wells are spread throughout the District.

OPUD does not own any property within the central portion of the community that could serve as a treatment system location. Therefore, OPUD's ion exchange treatment process approach will consist of treatment units at each well site for Well Nos. 6 and 9. A typical well site layout is shown in Figure 5-3. Actual site conditions and dimensions will require adjustments to the location of equipment and/or modifications to configuration (design) of the equipment.

Waste Disposal Options

A brine solution is used to regenerate the ion exchange resin. Upon completion of the regeneration process, the nitrate-laden solution must be disposed. Common disposal options are:

1. Discharging to the local sewer for treatment at a wastewater facility;
2. Injection into a deep well;
3. Use of evaporation ponds; and
4. Contract disposal at an approved facility.

The quantity of regeneration rinseate will be a function of nitrate levels, ion exchange resin, process design and flow. Based upon preliminary design concepts proposed by various manufacturers, the regeneration flow could vary between 30,000 gallons per day (gpd) to as high as 76,000 gpd, depending on design and regeneration frequency. Nitrate concentrations in the regeneration byproduct could be as high as 3,300 mg/l. High concentrations of sulfides (1,000 mg/l) and chlorides (10,500 mg/l) will also be present.

Ideally, discharging the regeneration product into the sewer system for subsequent treatment and disposal would represent the solution for handling the ion exchange waste products. The districts however, have discharge limitations established in their respective wastewater ordinances. Pretreatment or dilution prior to discharge will be necessary. Pretreatment to reduce the constituents represents a costly approach as separate processes would be required for each constituent. Dilution of the regeneration product is also not feasible due to the high volume of water needed for blending of the waste product to achieve acceptable discharge concentrations. Sewer discharge of the regeneration product is, therefore, not feasible.

Deep well injection represents another waste disposal approach. This disposal consists of pumping the waste into a deep groundwater aquifer. This approach is not feasible in the Cutler Orosi area since there are no confining soil layers that isolate water bearing layers. This approach also requires state regulatory approvals. No such disposal practices currently exist in the region.

Evaporation ponds provide another method for regeneration product disposal. This approach consists of storing the water in ponds to allow evaporation. The ponds would be designed with liners to prevent percolation and protect the groundwater. This approach is straightforward, however, a significant amount of land would be required. The size of the ponds would be dependent on waste discharge flow, precipitation and evaporation rates. For a waste discharge of 30,000 gallons per day, approximately 7.5 acres of ponds would be required under normal climatic conditions. Larger ponds would be necessary to accommodate "wet" rainfall years. The ponds would have to be cleaned of solids on an intermittent basis. Due to the high levels of nitrates and other degeneration byproducts, pond design and disposal of pond solids may require special permitting from the Regional Water Quality Control Board.

The last option available to the districts for regeneration product disposal is hauling the product to an appropriate disposal site. This option would consist of temporary storage tanks and contracted handling and disposal. An advantage to this approach is the districts do not have to provide and operate disposal facilities. If contract disposal were utilized, the districts would be responsible for all contract conditions, including fee increases. In general, disposal occurs at large wastewater treatment facilities where small quantities of waste do not impact overall wastewater treatment effectiveness. Since there are few large wastewater facilities nearby, it is likely that the total disposal will be impacted by the transportation fees which reflect the distance to the facility.

Considerations for regeneration disposal present serious drawbacks to the ion exchange process. Evaporation ponds and contract work disposal represent the most feasible approaches. Evaporation ponds provide significant capital cost considerations for an ion exchange approach. Contract waste disposal presents annual cost that need to be considered with an ion exchange approach.

Preliminary Cost

Several manufacturers exist that can provide the ion exchange process equipment. This should provide a situation that keeps equipment costs competitive. Some manufacturers utilize proprietary configuration and/or equipment that will have to be accounted for during the design and bidding phases.

Capital costs for ion exchange treatment processes will include costs for:

- Site/location preparation;
- Ion exchange equipment;
- Building enclosure;
- Piping and appurtenances
- Electrical and controls;
- Monitoring equipment; and
- Resin regeneration waste handling facilities.

The capital cost for CPUD's ion exchange approach represents a centralized location that requires additional pipelines to bring the water to the treatment facility. OPUD's capital costs reflect the need to construct satellite facilities at designated wells. A significant contingency exists since these approaches were developed without the completion of a detailed design. If an ion exchange process is selected, detailed design would result in more refined costs.

Two cost alternatives for groundwater treatment were developed. One cost alternative incorporates the construction of disposal ponds for the ion exchange regeneration product. This approach will require the identification, acquisition and development of an offsite location and associated delivery system. Table 5-1 summarizes the estimated capital cost to each district for this approach to nitrate removal. CPUD's cost is estimated to total approximately $6.51 million. The cost for a single well in OPUD is estimated to be approximately $7.8 million. Providing nitrate removal at remaining OPUD wells would increase OPUD's capital costs respectively (i.e., two wells will result in two times the capital cost). A significant portion of the capital cost for each district corresponds to the regeneration water disposal ponds. Larger ponds are necessary for OPUD due to larger regeneration volumes resulting from higher nitrate levels in the groundwater.

The second cost alternative for groundwater treatment is to contract with a waste hauler to transport and dispose of the ion exchange regeneration byproduct. Table 5-2 summarizes the estimated capital cost to each district if contractual waste hauling is implemented. The estimated cost to each district is significantly lower than the pond alternative. CPUD's cost is estimated to total approximately $3.46 million. OPUD's project cost is estimated to be approximately $2.65 million. This approach will, however, require annual operational considerations.

Annual costs are comprised of costs that will be incurred on a regular basis. The districts' ion exchange processes will have annual costs related to the following:

- Labor for operations and maintenance;

TABLE 5-1
PRELIMINARY COST ESTIMATE - GROUNDWATER TREATMENT WITH PONDS
WATER SUPPLY STUDY
CUTLER - OROSI AREA

ITEM	DETAILS		AMOUNT CPUD	OPUD (1)
1.	Site/Location Preparation		$ 81,250.00	$ 100,000.00
	Fencing, paving, etc			
2.	Ion Exchange Equipment			
	Modular, brine regeneration system		$ 325,000.00	$ 400,000.00
	Installation		$ 130,000.00	$ 160,000.00
	Electrical and Controls		$ 97,500.00	$ 120,000.00
3.	Water Treatment Plant Building		$ 400,000.00	$ 440,000.00
	Equipment enclosure			
4.	Piping and Appurtenances			
	Existing site piping modifications, new piping		$ 75,000.00	$ 75,000.00
	Water supply/delivery pipelines and connections		$ 580,000.00	$ -
5.	Electrical and Controls - other equipment, facilities		$ 100,000.00	$ 100,000.00
6.	Monitoring Equipment		$ 30,000.00	$ 30,000.00
	Nitrate analyzers			
7.	Regeneration Waste Recovery/Handling Facilities		$ 1,930,000.00	$ 3,100,000.00
	Off site locations, Lined evaporation ponds, piping			
	SUBTOTAL		$ 3,748,750.00	$ 4,525,000.00
	Contractor Profit, Bonds and Insurance at 10 %		$ 374,875.00	$ 452,500.00
	Contingency at 20 %		$ 749,750.00	$ 905,000.00
	Inflation at 10 %		$ 374,875.00	$ 452,500.00
	TOTAL CONSTRUCTION COST		$ 5,248,250.00	$ 6,335,000.00
	Engineering	7%	$ 367,400.00	$ 443,500.00
	CEQA, Permits, Preliminary Study	2%	$ 105,000.00	$ 126,700.00
	Legal/Administration	2%	$ 105,000.00	$ 126,700.00
	Inspection, Surveying, Testing	11%	$ 577,300.00	$ 696,900.00
	TOTAL PROJECT COST		$ 6,402,950.00	$ 7,728,800.00

Note:
1. Cost for one well. Additional well(s) will increase cost accordingly.

TABLE 5-2
PRELIMINARY COST ESTIMATE - GROUNDWATER TREATMENT WITH CONTRACT DISPOSAL
WATER SUPPLY STUDY
CUTLER - OROSI AREA

ITEM	DETAILS		AMOUNT CPUD	OPUD (1)
1.	Site/Location Preparation		$ 81,250.00	$ 100,000.00
	Fencing, paving, etc			
2.	Ion Exchange Equipment			
	Modular, brine regeneration system		$ 325,000.00	$ 400,000.00
	Installation		$ 130,000.00	$ 160,000.00
	Electrical and Controls		$ 97,500.00	$ 120,000.00
3.	Water Treatment Plant Building		$ 400,000.00	$ 440,000.00
	Equipment enclosure			
4.	Piping and Appurtenances			
	Existing site piping modifications, new piping		$ 75,000.00	$ 75,000.00
	Water supply/delivery pipelines and connections		$ 580,000.00	$ -
5.	Electrical and Controls - other equipment, facilities		$ 100,000.00	$ 100,000.00
6.	Monitoring Equipment		$ 30,000.00	$ 30,000.00
	Nitrate analyzers			
7.	Regeneration Waste Recovery/Handling Facilities		$ 175,000.00	$ 100,000.00
	Storage, pumps and piping			
	SUBTOTAL		$ 1,993,750.00	$ 1,525,000.00
	Contractor Profit, Bonds and Insurance at 10 %		$ 199,375.00	$ 152,500.00
	Contingency at 20 %		$ 398,750.00	$ 305,000.00
	Inflation at 10 %		$ 199,375.00	$ 152,500.00
	TOTAL CONSTRUCTION COST		$ 2,791,250.00	$ 2,135,000.00
	Engineering	7%	$ 195,400.00	$ 149,500.00
	CEQA, Permits, Preliminary Study	2%	$ 55,800.00	$ 42,700.00
	Legal/Administration	2%	$ 55,800.00	$ 42,700.00
	Inspection, Surveying, Testing	11%	$ 307,000.00	$ 234,900.00
	TOTAL PROJECT COST		$ 3,405,250.00	$ 2,604,800.00

Note:
1. Cost for one well. Additional well(s) will increase cost accordingly.

- Chemicals;
- Electrical cost for pumping and equipment; and
- Storage, handling and disposal of waste products.

Operations and maintenance costs consist of the costs associated with the districts' efforts to utilize the process. Costs associated with the storage, handling and disposal of the ion exchange process' waste products will vary depending on the method. Contract disposal of the ion exchange waste will have very routine costs. Evaporation ponds will have intermittent costs as ponds are cleaned and the residuals need disposal. The estimated annual costs to the districts for an ion exchange process are summarized in Tables 5-3 and 5-4.

Table 5-3 summarizes the projected annual operations and maintenance costs for CPUD. Brine and pumping costs represent the largest portions of the annual cost. The high annual cost represents a serious concern regarding ion exchange as a water supply alternative. Contractual disposal of the waste products is not feasible due to its extremely high cost.

Table 5-4 summarizes the projected annual operations and maintenance costs for OPUD. The brine costs represent the largest portion of the annual cost. This situation results from the frequent regeneration of the ion exchange media due to the high nitrate concentrations of OPUD's groundwater supply. As with CPUD, the high annual cost for OPUD's ion exchange alternative is a serious concern to the viability of this alternative. Contract disposal of the regeneration waste product is also not feasible for OPUD.

The total cost for groundwater treatment is summarized in Table 5-5. Table 5-5 provides the costs for each waste disposal alternative for each district. Since the water demand projections utilized a duration of twenty years , the present worth of each district's annual costs have also

TABLE 5-3
ANNUAL OPERATIONS AND MAINTANCE COST - GROUNDWATER TREATMENT FOR CPUD
WATER SUPPLY STUDY
CUTLER-OROSI AREA

CUTLER PUBLIC UTILITY DISTRICT - 1,200 g.p.m. ion exchange system, single location.

COST CATEGORY	DESCRIPTION	AMOUNT	UNITS	UNIT COST ($/unit)	TOTAL COST	NOTES
LABOR						
	Routine operations	520	hrs/yr	$ 40.00	$ 20,800.00	Higher operational certification required.
	Regeneration monitorin;	416	hrs/yr	$ 40.00	$ 16,600.00	Higher operational certification required.
CHEMICALS AND MATERIALS						
	Brine Cost	2,500,000	lbs/yr	$ 0.05	$ 125,000.00	
	Chlorine	3,650	gal/yr	$ 0.75	$ 2,737.50	Liquid chlorine (hypochlorite) proposed.
	Resin Replacement	60	cf/yr	$ 150.00	$ 9,000.00	Resin replaced once every five years.
	Misc. Materials		Lump Sum		$ 20,510.63	
ELECTRICAL						
	Pumping	90	hp	$ 0.15	$ 88,200.00	Wells back on-line. 24 hour operation.
	Equipment	48	kW-hr/day	$ 0.15	$ 17,500.00	
	Misc. Power	6	kW-hr/day	$ 0.15	$ 2,200.00	
ANNUAL OPERATIONS AND MAINTENANCE COST					$ 302,548.13	Cost for onsite disposal of waste products.
	Additional Cost for Waste Disposal:					
	Transportation	18,500,000	gal/yr	$ 0.15	$ 2,775,000.00	Contractual disposal of waste products if on site disposal not utiltized.

TABLE 5-4
ANNUAL OPERATIONS AND MAINTANCE COST - GROUNDWATER TREATMENT FOR OPUD
WATER SUPPLY STUDY
CUTLER-OROSI AREA

OROSI PUBLIC UTILITY DISTRICT - 400 g.p.m., single well site.

COST CATEGORY	DESCRIPTION	AMOUNT	UNITS	UNIT COST ($/unit)	TOTAL COST	NOTES
LABOR						
	Routine operations	260	hrs/yr	$ 40.00	$ 10,400.00	Higher operational certification required.
	Regeneration monitoring	416	hrs/yr	$ 40.00	$ 16,600.00	Higher operational certification required.
CHEMICALS AND MATERIALS						
	Brine Cost	9,900,000	lbs/yr	$ 0.05	$ 495,000.00	
	Chlorine	2,600	gal/yr	$ 0.75	$ 1,950.00	Liquid chlorine (hypochlorite) proposed.
	Resin Replacement	60	cf/yr	$ 150.00	$ 9,000.00	Resin replaced once every five years.
	Misc. Materials		Lump Sum		$ 75,892.50	
ELECTRICAL						
	Pumping	35	hp	$ 0.15	$ 34,300.00	Wells back on-line. 24 hour operation.
	Equipment	24	kW-hr/day	$ 0.15	$ 8,800.00	
	Misc. Power	3	kW-hr/day	$ 0.15	$ 1,100.00	
ANNUAL OPERATIONS AND MAINTENANCE COST					$ 653,042.50	Cost for onsite disposal of waste products.
	Additional Cost for Waste Disposal:					
	Transportation	34,500,000	gal/yr	$ 0.15	$ 5,175,000.00	Contractual disposal of waste products if on site disposal not utiltized.

TABLE 5-5
SUMMARY OF PRELIMINARY COST ANALYSES - GROUNDWATER TREATMENT
WATER SUPPLY STUDY
CUTLER-OROSI AREA

	CPUD		OPUD (one well)	
	with ponds	w/o ponds	with ponds	w/o ponds
PROJECT COST	$ 6,403,000	$ 3,405,300	$ 7,728,800	$ 2,604,800
ANNUAL OPERATIONS COST	$ 302,500	$ 3,077,500	$ 653,000	$ 5,828,000
Present Worth of Annual Cost 6 % interest; term of 20 years	$3,469,700	$35,298,700	$7,489,900	$66,846,700
TOTAL COST (per District)	$ 9,872,700	$ 38,704,000	$ 15,218,700	$ 69,451,500

	TOTAL CUTLER-OROSI AREA COST	
	with waste disposal ponds	utilizing contractual waste disposal
TOTAL CAPITAL COST	$14,131,800	$6,010,100
PRESENT WORTH OF ANNUAL COST	$10,959,600	$102,145,400
TOTAL COST TO CUTLER-OROSI AREA	$25,091,400	$108,155,500

been compiled. The present worth of the contractual disposal of work products further demonstrates the economic infeasibility of this approach for each district.

Subsequently, the most cost effective approach regarding ion exchange for groundwater treatment is to construct local disposal ponds. The total capital cost to provide groundwater treatment and meet the projected water needs is approximately $14.3 million. The overall present worth of this project is about $25.1 million.

SURFACE WATER TREATMENT

Based upon preliminary considerations regarding surface water treatment technologies and processes, membrane filtration followed by ultra-violet (UV) light disinfection presents the best approach.

Process Description

A typical process schematic for the surface water treatment system is shown on Figure 5-4. The primary elements of this approach are membrane filters and UV disinfection components. The membranes will consist of hollow membrane material with pore sizes between $1x10^{-4}$ and $1x10^{-6}$ meter in diameter. Water is forced through the pores. The membranes effectively remove Giardia cysts and cryptosporidium oocysts. Particulates are trapped on the membrane's surface until removed by backwashing.

The membrane process utilizes two backwash modes. The most frequently utilized mode is a standard backwash procedure where water and air are used to scour the surface of the membrane to clean the membrane surface. Periodically, the membrane process needs to undergo an in-place cleaning with weak chemical cleaning solutions. Due to the extent of equipment functions, the membrane process generally operates automatically; manual operation, however, is possible.

After filtration, the treated water will be subjected to UV light to accomplish the necessary degree of disinfection. UV light is a very effective disinfectant. It does not, however, provide any disinfectant residual to be carried throughout the water distribution system. Since the districts utilize chlorine for disinfection of the groundwater, a chlorination system for the distribution system is also necessary.

Location

Several considerations exist regarding potential locations for the surface water treatment facility. Surface water sources in the vicinity are the Kings River and the Friant-Kern Canal. The Friant-Kern Canal represents the closest source; it is approximately 4 miles from Orosi. Irrigation canals bring Kings River water close to the Orosi and Cutler communities. These canals, however, experience local discharges that may significantly alter the water quality. A pipeline to bring Kings River water from Wahtoke Lake would be approximately 13 miles and therefore, cost prohibitive.

Conceptual Design

The surface water treatment approach consists of several components including:

- Intake structure and pump station;
- Transmission pipeline;
- Membrane treatment process;
- UV disinfection system;
- Chlorination system; and

– Treated water storage tank and pump station.

Preliminary design considerations are discussed below.

The Friant-Kern Canal (FKC) represents the closest source of surface water. The distance from the FKC to the districts ranges from 2 to 4 miles. A turnout structure at the FKC would consist of a wet well, vertical turbine pumps and fine mesh screens to prevent debris from entering the turnout structure and damaging the pumps. For 2 MGD, approximately 70 horsepower (hp) pumps and a 15-inch diameter pipeline will be necessary. Multiple pump and/or control arrangements are feasible to provide incremental water supply needs. Refined pumping arrangements can be developed during detailed design. Flow by gravity from the FKC may be possible which would reduce the project cost.

The design and configuration of surface water treatment elements of this approach is straightforward. A general site plan for the surface water facilities is shown on Figure 5-5. A detailed layout of this treatment components is shown on Figure 5-6.

Membrane filters processes are modular units that are packaged with the necessary components and controls. Several options exist regarding membrane process configurations depending on membrane pore size, flow and pressure orientation. Ultra-filtration membranes represent a smaller pore size than micro-filtration membranes and, therefore, a more stringent barrier. Ultra-filtration membranes should be utilized in the treatment process to provide a higher level of removal credit. Membrane systems are configured to operate under pressure or vacuum. Typically, membrane flow and pressure conditions are associated with manufacturer membrane designs which can be determined during detailed design.

Based upon water quality, the raw surface water can be fed directly to the membranes. To increase the capability of the membranes under more variable water conditions, pretreatment elements of coagulation/flocculation and sedimentation can be considered.

Backwash water can be considered typical of residuals originating from conventional under treatment plants. Generally, backwash water has high concentrations of solids. Backwash water will be recovered in on-site ponds for evaporation and percolation. Due to chemical addition, the cleaned-in-place (CIP) backwash rinseate will be neutralized prior to disposal. It is proposed that small lined evaporation ponds be constructed to handle the neutralized CIP waste.

Several configurations exist for UV disinfection. Drinking water applications typically utilize closed-pipe systems that tie directly into treated water piping. UV lamps are positioned inside special pipe fittings. The number of lamps to accomplish disinfection will be established by the treated water quality.

A chlorination system will be necessary to provide a disinfectant residual in the distribution system. Based upon a chlorine dose of 2 mg/l, approximately 33 pounds of chlorine will be required daily to treat 2 MGD. Approximately 1,000 pounds of chlorine is needed to provide 30 days supply. A gaseous chlorine system is recommended due to the significant volume of liquid chlorine (hypochlorite) necessary to provide an equivalent amount of chlorine. Risk management issues can be anticipated and addressed during detail design.

<u>Preliminary Cost</u>

The capital cost to provide a surface water treatment approach will consist of the following costs:

- intake structure and pump station;
- transmission pipeline;
- site/location preparation;

- membrane treatment process;
- UV disinfection process;
- chlorination system;
- building;
- water storage tank and pump stations;
- membrane residual recovery ponds;
- standby generator; and
- delivery system/distribution system piping.

Most, if not all, of the components of surface water treatment plan are represented by multiple manufacturers. Several manufacturers exist for the membrane process and UV disinfection equipment which should provide a cost-competitive situation. These processes, however, can include proprietary features that will need to be addressed during detailed design and project bidding.

Table 5-6 summaries the estimated capital cost for surface water treatment. The project cost is estimated to be approximately $17.4 million.

A surface water treatment plant presents several annual (recurring) cost considerations. Annual operations and maintenance costs will be associated with the following:

- labor;
- chemicals and materials; and
- electrical costs for treatment processes and pumping.

Since the districts do not own surface water rights, the water supply for the facility will need to be purchased. This cost of water represents an additional annual cost.

TABLE 5-6
PRELIMINARY COST ESTIMATE - SURFACE WATER TREATMENT
WATER SUPPLY STUDY
CUTLER - OROSI AREA

ITEM	DETAILS			AMOUNT
1.	Intake Structure and Pump Station		$	280,000.00
	Pumps, Screens, Structure, Modifications			
2.	Transmission Pipeline		$	1,500,000.00
	15-inch diameter, 4 miles long			
3.	Water Treatment Plant Site			
	Land Purchase - 10 acres		$	200,000.00
	Sitework; preparation (fencing, paving, etc.)		$	350,000.00
4.	Membrane Treatment Process			
	2 MGD, modular, clean in place process		$	1,300,000.00
	Installation		$	520,000.00
	Electrical and Controls		$	400,000.00
5.	UV Disinfection System			
	2 MGD		$	250,000.00
	Installation		$	100,000.00
	Electrical and Controls		$	75,000.00
6.	Chlorination System - For Distribution System		$	100,000.00
	Additional chemical processes, treatment appurtenances			
7.	Water Treatment Plant Building		$	720,000.00
	Equipment enclosure, lab area			
8.	Treated Water Storage Tank and Pump Station		$	3,000,000.00
9.	Backwash Recovery Ponds			
	Ponds - (2) one acre ponds, (2) 2,200 sf ponds, piping		$	125,000.00
10.	Standby Generator and Automatic Transfer Switch		$	100,000.00
11.	Distribution System Piping		$	1,000,000.00
	SUBTOTAL		$	10,020,000.00
	Contractor Profit, Bonds and Insurance at 10 %		$	1,002,000.00
	Contingency at 20 %		$	2,004,000.00
	Inflation at 10 %		$	1,002,000.00
	TOTAL CONSTRUCTION COST		$	14,028,000.00
	Engineering	7%	$	982,000.00
	CEQA, Permits, Preliminary Study	2%	$	280,600.00
	Legal/Administration	2%	$	280,600.00
	Inspection, Surveying, Testing	11%	$	1,543,100.00
	TOTAL PROJECT COST		$	17,114,300.00

Table 5-7 summarizes the anticipated annual costs for surface water treatment. Purchasing the new water represents the largest cost due to its local importance and availability. Electrical costs represents the single largest operational cost consideration, primarily due to pumping requirements.

The total cost for surface water treatment is summarized in Table 5-8. Table 5-8 also provides each districts' cost share proportioned according to each districts' water demands. Table 5-8 also presents the present worth of the annual costs over a project duration of 20 years. The total present worth of this potential project is about $22.8 million.

COMPARISON

Ion exchange for groundwater treatment and membrane filtration for surface water treatment represent two very different approaches to address projected water needs in the Cutler - Orosi area. Common considerations exist to each water supply approach. Each treatment approach will require an increased level of operator certification due to the advanced levels of the treatment processes. Also, most of the treatment components are modular which will facilitate faster construction and incremental treatment capacities if desired.

Table 5-9 summarizes the advantages and disadvantages to each approach. Table 5-10 provides a comparison of the potential project costs for each treatment approach.

Groundwater treatment presents the lowest capital cost which results from having existing well sites and fewer disinfection process requirements. A suitable site for surface water treatment facility has not been established. Locations for ion exchange waste disposal ponds, however, also need to be identified.

TABLE 5-7
ANNUAL OPERATIONS AND MAINTANCE COST - SURFACE WATER TREATMENT PLANT
WATER SUPPLY STUDY
CUTLER-OROSI AREA

COST CATEGORY	DESCRIPTION	AMOUNT	UNITS	UNIT COST ($/unit)	TOTAL COST	NOTES
LABOR						
	Routine operations	1,040	hrs/yr	$ 40.00	$ 41,600.00	Higher operational certification required.
	CIP monitoring	416	hrs/yr	$ 40.00	$ 16,600.00	Higher operational certification required.
CHEMICALS AND MATERIALS						
	CIP Process					
	Citric Acid	4,200	lbs/yr	$ 0.50	$ 2,100.00	Acid wash step
	Sodium Hydroxide	1,100	lbs/yr	$ 0.85	$ 935.00	Caustic clean step, acid neutralization.
	Hydrochloric Acid	800	lbs/yr	$ 0.20	$ 160.00	Caustic neutralization.
	Sodium Hypochlorite	2,900	lbs/yr	$ 0.75	$ 2,175.00	Chlorination cleaning, includes amount for dechlorination.
	Chlorine - Disinfection	12,200	lbs/yr	$ 0.75	$ 9,150.00	Gas chlorine proposed due to quantities.
	Misc. Materials		Lump Sum		$ 2,200.00	
ELECTRICAL						
	Pumping - Supply	70	hp	$ 0.15	$ 68,600.00	Supply to WTP. 24 hour operation.
	Backwash Process	25,000	kW-hr/yr	$ 0.15	$ 3,750.00	
	CIP Process	3,800	kW-hr/yr	$ 0.15	$ 570.00	One CIP per unit, per month.
	UV Disinfection	130,000	kW-hr/yr	$ 0.15	$ 19,500.00	24 hour operation.
	Misc. Equipment Power	8,000	kW-hr/yr	$ 0.15	$ 1,200.00	
	Pumping - Delivery	40	hp	$ 0.15	$ 39,200.00	
ANNUAL OPERATIONS AND MAINTENANCE COST					$ 207,740.00	Cost for onsite disposal of waste products.
	Annual Cost of Water	2,300	ac-ft/yr	$ 120.00	$ 276,000.00	
TOTAL ANNUAL COST					$ 483,740.00	

TABLE 5-8
SUMMARY OF PRELIMINARY COST ANALYSES - SURFACE WATER TREATMENT
WATER SUPPLY STUDY
CUTLER-OROSI AREA

	TOTAL COST		DISTRICT SHARE (1)			
			CPUD 70%		OPUD 30%	
PROJECT COST	$	17,114,300	$	11,980,010	$	5,134,290
ANNUAL OPERATIONS COST	$	483,740	$	338,618	$	145,122
Present Worth of Annual Cost 6 % interest; term of 20 years	$	5,548,500	$	3,883,950	$	1,664,550
TOTAL COST	$	22,662,800	$	15,863,960	$	6,798,840

Note:

1. Based upon 2 MGD total flow; 1.4 MGD - CPUD, 0.6 MGD - OPUD.

TABLE 5-9
SUMMARY OF ADVANTAGE AND DISADVANTAGES
WATER SUPPLY STUDY
CUTLER-OROSI AREA

ALTERNATIVE	ADVANTAGES	DISADVANTAGES
Groundwater Treatment	Lowest capital cost Nitrate removal recaptures existing water supply Modular components streamline installation schedule	Highest overall cost Highest annual operations and maintenance costs Multiple locations necessary Waste disposal locations needed; unable to site with ion exchange equipment Well sites may affect ion exchange configuration Increased level of operator certification required Variable water quality in area may affect other wells
Surface water treatment	Lowest overall cost Lowest annual operations maintenance costs Single location needed; fewer operators/hours necessary Provides reliable water supply Modular components can support phased implementation Reduces need for groundwater pumping and subsequent overdraft conditions. Minimal water quality concerns	Highest capital cost No existing rights to surface water supply Final location not yet identified Risk management requirements for gaseous chlorine system Increased level of operator certification required Increased regulatory requirements

TABLE 5-10
COMPARISON OF PRELIMINARY COST ANALYSES
WATER SUPPLY STUDY
CUTLER-OROSI AREA

		GW TREATMENT TOTAL COST		SW TREATMENT TOTAL COST
PROJECT COST	$	14,131,800	$	17,114,300
ANNUAL OPERATIONS COST	$	955,500	$	483,740
Present Worth of Annual Cost 6 % interest; term of 20 years	$	10,959,600	$	5,548,500
TOTAL COST	$	25,091,400	$	22,662,800

The primary advantage to groundwater treatment is that this approach represents the lowest capital cost. Lower costs result from utilizing available well sites and small capacity disinfection systems. Groundwater treatment recaptures existing nitrate laden groundwater supplies. Finally, ion exchange processes are modular packaged units which would streamline implementation.

Groundwater treatment, however, presents several significant disadvantages. This approach result in the highest annual operations and maintenance costs due to chemical (brine) costs associated with resin regeneration. Additional man-hours are also required to monitor multiple locations. Disposal of the ion exchange regeneration by-products will require separate, offsite disposal facilities. Suitable locations for the necessary evaporation ponds have not been identified and may be a considerable distance from the well sites. Finally, nitrate levels in the groundwater have increased and have shown a significant amount of variability in the Cutler - Orosi area. Operational costs will increase as a result of continued increase in nitrate levels and subsequent treatment of the groundwater. Additional wells in the area may also be lost in the future to high nitrate levels, resulting in an additional water quantity that will require nitrate removal. Finally, other contaminants, such as DBCP will require additional treatment processes for removal.

Utilizing surface water provides several advantages to the Cutler - Orosi area. This approach represents the lowest overall cost over the 20-year water demand projection. Although surface water treatment has a high initial cost, the annual operations and maintenance costs are significantly lower than those for groundwater treatment. Lower annual costs result from man-hours necessary for a single treatment facility and lower chemical costs. An additional advantage is that surface water is a reliable water source, if sufficient water rights are obtained. There are no known water quality concerns with the surface waters available to the region. Some water quality variation may be experienced due to storm water runoff. Finally, utilizing surface water reduces the area's use and dependence on the existing groundwater ,subsequently resulting in a reduction in groundwater overdraft conditions.

The most significant disadvantages to surface water treatment are the lack of existing surface water rights and location of the treatment facilities. First, the districts do not presently own any permanent or temporary rights to any quantity of surface water. Permanent rights would be required to ensure a reliable water supply. Purchasing the water for treatment represents over half of the estimated annual costs of the surface water approach. Second, a suitable location for the surface water treatment facilities has not been identified or established. Ideal locations exist, however, the availability of such locations has not been pursued.

An additional disadvantage to surface water treatment is the increased regulatory requirements associated with drinking water treatment. Increase treatment requirements, however, are addressed through the use of the membrane and UV disinfection systems. Chemical handling requirements associated with chlorination can be addressed through risk management plan measures.

CONCLUSION

If a surface water supply can be identified and secured by the districts, the surface water treatment approach represents the most economical and beneficial project. The conclusion is based upon the following:

- lowest total potential project cost;
- lowest estimate annual operations and maintenance cost;
- modular components allowed for phased implementation;
- single location;
- consistent water quality; and
- provides regional groundwater benefits.

The acquisition of surface water represents a significant issue to using surface water treatment to meet the projected water needs. The Friant-Kern Canal represents the closest surface water source for the districts. The Friant-Kern Canal is taken out of service every three years, however, which may require the use of Alta Irrigation District's (AID) water delivery canals. Since AID's canals travel through more developed areas, including the Cutler-Orosi area and receive storm water flow, increased water quality monitoring may be required.

The remaining disadvantages/obstacles to the surface water treatment approach can be addressed through detailed planning and design considerations.

Funding sources and programs have not been identified. Table 5-11 summarizes various funding scenarios for the surface water treatment approach. The funding scenarios represent common conditions of various funding programs. The funding terms directly impact the costs to the districts and their respective customers.

Table 5-11 also presents each district's respective share of overall project costs based upon water demands. CPUD's cost share is significantly greater than OPUD's cost share due to its greater water demand from the project facilities.

TABLE 5-11
FUNDING SCENARIOS - PROPORTIONAL COST SHARE PER DISTRICT (1)
WATER SUPPLY STUDY
CUTLER-OROSI AREA

AMOUNTS	SCENARIO					
	50% Grant / 50% Loan		75% Grant / 25% Loan		75% Grant / 25% Loan	
	Conditions	Amount	Conditions	Amount	Conditions	Amount
Project Cost (2)		$ 17,114,300.00		$ 17,114,300.00		$ 17,114,300.00
Grant Amount	50%	$ 8,557,150.00	75%	$ 12,835,725.00	75%	$ 12,835,725.00
Loan Amount	50%	$ 8,557,150.00	25%	$ 4,278,575.00	25%	$ 4,278,575.00
Annual Repayment Amount (rounded)		$ 465,000.00		$ 232,500.00		$ 171,100.00
Payment term (years)	40		40		25	
Interest Rate	4.50%		4.50%		0.00%	
Required Reserve Amount (Percent)	10%	$ 46,500.00	10%	$ 23,250.00	10%	$ 17,110.00
TOTAL ANNUAL REPAYMENT AMOUNT		$ 511,500.00		$ 255,750.00		$ 188,210.00
Total Monthly Amount		$ 42,625.00		$ 21,312.50		$ 15,684.17
Cutler Public Utility District	70%	$ 29,837.50		$ 14,918.75		$ 10,978.92
Cost Per Connection	1,102	$ 27.08		$ 13.54		$ 9.96
Orosi Public Utility District	30%	$ 12,787.50		$ 6,393.75		$ 4,705.25
Cost Per Connection	1,645	$ 7.77		$ 3.89		$ 2.86

Note:
(1) District share based upon water demand. Reference Table 3-5.
(2) Surface water treatment approach. See Table 5-6 for cost development.

As an alternative to funding the project cost according to each district's water demand, the potential project could be funded equally between the districts. This funding alternative is presented in Table 5-12. This approach would result in additional capacity for OPUD in the surface water treatment plant and subsequent reduce CPUD's share in the surface water treatment plant. CPUD's firm water supply would be reduced by utilizing this approach. Additional water capacity would need to be purchased from OPUD when needed by CPUD to meet projected water demands.

TABLE 5-12
FUNDING SCENARIOS - EQUAL COST SHARE PER DISTRICT (1)
WATER SUPPLY STUDY
CUTLER-OROSI AREA

AMOUNTS	SCENARIO					
	50% Grant / 50% Loan		75% Grant / 25% Loan		75% Grant / 25% Loan	
	Conditions	Amount	Conditions	Amount	Conditions	Amount
Project Cost (2)		$ 17,114,300.00		$ 17,114,300.00		$ 17,114,300.00
Grant Amount	50%	$ 8,557,150.00	75%	$ 12,835,725.00	75%	$ 12,835,725.00
Loan Amount	50%	$ 8,557,150.00	25%	$ 4,278,575.00	25%	$ 4,278,575.00
Annual Repayment Amount (rounded)		$ 465,000.00		$ 232,500.00		$ 171,100.00
Payment term (years)	40		40		25	
Interest Rate	4.50%		4.50%		0.00%	
Required Reserve Amount (Percent)	10%	$ 46,500.00	10%	$ 23,250.00	10%	$ 17,110.00
TOTAL ANNUAL REPAYMENT AMOUNT		$ 511,500.00		$ 255,750.00		$ 188,210.00
Total Monthly Amount		$ 42,625.00		$ 21,312.50		$ 15,684.17
Cutler Public Utility District	50%	$ 21,312.50		$ 10,656.25		$ 7,842.08
Cost Per Connection	1,102	$ 19.34		$ 9.67		$ 7.12
Orosi Public Utility District	50%	$ 21,312.50		$ 10,656.25		$ 7,842.08
Cost Per Connection	1,645	$ 12.96		$ 6.48		$ 4.77

Note:
(1) Project cost divided equal between district without consideration of actual water demand.
(2) Surface water treatment approach. See Table 5-6 for cost development.

TABLE 5-13
TOTAL MONTHLY COST PER CONNECTION - PROPORTIONAL COST SHARE PER DISTRICT (1)
WATER SUPPLY STUDY
CUTLER-OROSI AREA

AMOUNTS (2)	SCENARIO								
	50% Grant / 50% Loan			75% Grant / 25% Loan			75% Grant / 25% Loan		
	Conditions	Amount		Conditions	Amount		Conditions	Amount	
Total Annual Debt Service Cost (3)		$	511,500.00		$	255,750.00		$	188,210.00
Total Annual Operations and Maintenance Cost (4)		$	483,740.00		$	483,740.00		$	483,740.00
Total Annual Cost		$	995,240.00		$	739,490.00		$	671,950.00
Total Monthly Amount		$	82,936.67		$	61,624.17		$	55,995.83
Cutler Public Utility District	70%	$	58,055.67	70%	$	43,136.92	70%	$	39,197.08
Cost Per Connection	1,102	$	52.68	1,102	$	39.14	1,102	$	35.57
Debt Service		$	27.08		$	13.54		$	9.96
O&M		$	25.61		$	25.61		$	25.61
Orosi Public Utility District	30%	$	24,881.00	30%	$	18,487.25	30%	$	16,798.75
Cost Per Connection	1,645	$	15.13	1,645	$	11.24	1,645	$	10.21
Debt Service		$	7.77		$	3.89		$	2.86
O&M		$	7.35		$	7.35		$	7.35

Note:
(1) District share based upon water demand. Reference Table 3-5.
(2) Surface water treatment approach.
(3) See Table 5-11 for cost development.
(4) O&M cost reflects surface water treatment approach only. See Table 5-7 for development.
Does not include existing O&M cost for groundwater well operation.

TABLE 5-14
TOTAL MONTHLY COST PER CONNECTION - PROPORTIONAL COST SHARE PER DISTRICT (1)
WATER SUPPLY STUDY
CUTLER-OROSI AREA

AMOUNTS (2)	SCENARIO								
	50% Grant / 50% Loan			75% Grant / 25% Loan			75% Grant / 25% Loan		
	Conditions	Amount		Conditions	Amount		Conditions	Amount	
Total Annual Debt Service Cost (3)		$	511,500.00		$	255,750.00		$	188,210.00
Total Annual Operations and Maintenance Cost (4)		$	483,740.00		$	483,740.00		$	483,740.00
Total Annual Cost		$	995,240.00		$	739,490.00		$	671,950.00
Total Monthly Amount		$	82,936.67		$	61,624.17		$	55,995.83
Cutler Public Utility District	50%	$	41,468.33	50%	$	30,812.08	50%	$	27,997.92
Cost Per Connection	1,102	$	37.63	1,102	$	27.96	1,102	$	25.41
Debt Service		$	19.34		$	9.67		$	7.12
O&M		$	18.29		$	18.29		$	18.29
Orosi Public Utility District	50%	$	41,468.33	50%	$	30,812.08	50%	$	27,997.92
Cost Per Connection	1,645	$	25.21	1,645	$	18.73	1,645	$	17.02
Debt Service		$	12.96		$	6.48		$	4.77
O&M		$	12.25		$	12.25		$	12.25

Note:
(1) District share based upon water demand. Reference Table 3-5.
(2) Surface water treatment approach.
(3) See Table 5-12 for cost development.
(4) O&M cost reflects surface water treatment approach only. See Table 5-7 for development.
Does not include existing O&M cost for groundwater well operation.

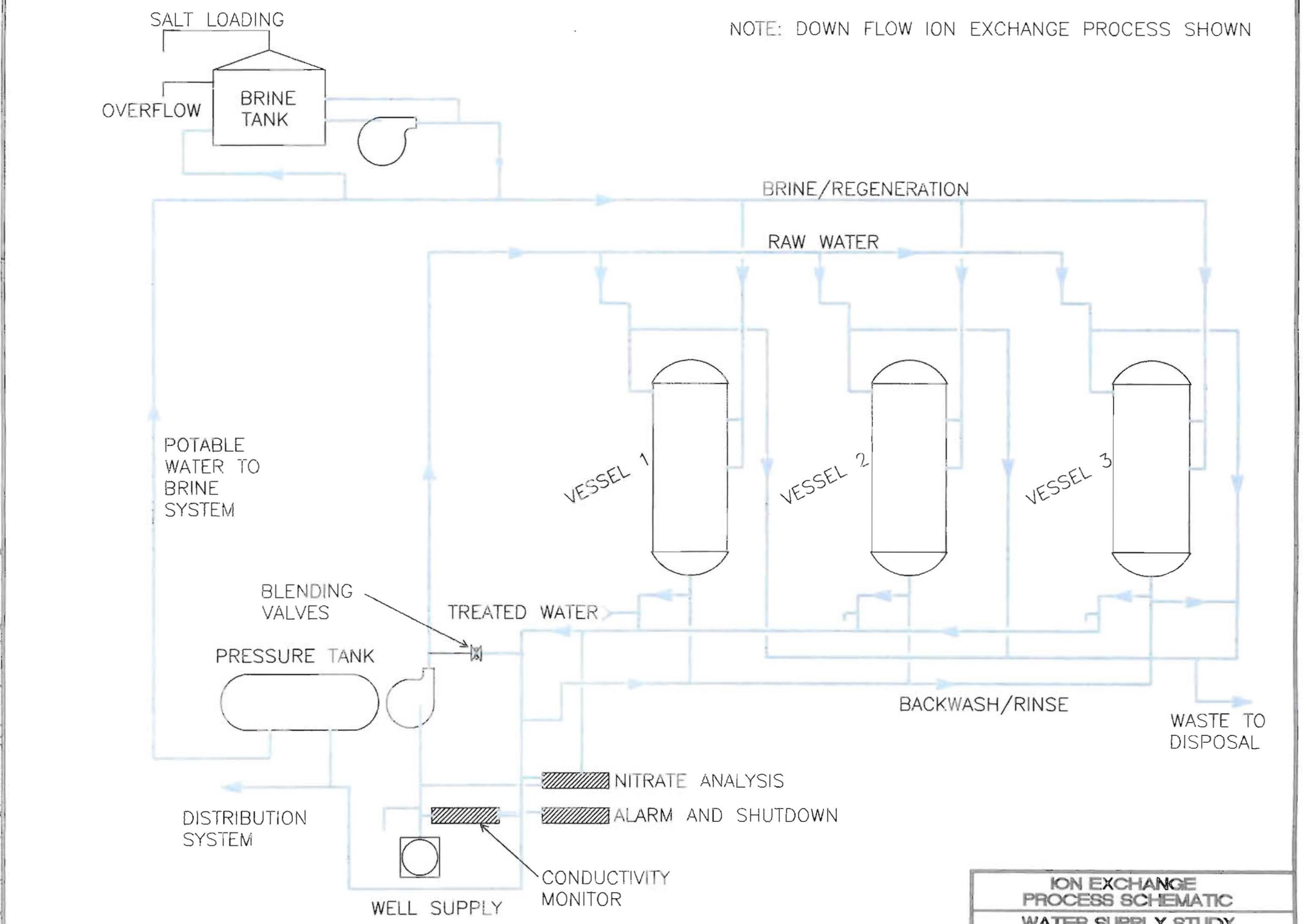
TABLE
PROJECTED WATER CONNECTION FEES
WATER SUPPLY STUDY
CUTLER-OROSI AREA

Total Project Cost $ 17,114,300.00

	CPUD	OPUD
Scenario	70%	30%
Water Capacity (MGD)	1.40	0.60
Water Use (gpcd)	205	150
Population Served by Water Capacity (persons)	6,829	2,927
Population per Existing Connection (1)	4.4	5.5
Available Connections	1,552	532
Total Project Cost Share	$ 11,980,010.00	$ 5,134,290.00
Cost per Connection (Connection Fee)	$ 7,718.55	$ 9,648.19

Note:
1. Based upon the number of connections and estimated 2007 population

	CPUD	OPUD
Number of Connections	1102	1645
Estimated Population	4815	9000
Population per Connection	4.4	5.5



Source: *National Drinking Water Clearinghouse Ion Exchange and Demineralization fact sheet.*

ION EXCHANGE PROCESS SCHEMATIC
WATER SUPPLY STUDY
CUTLER-OROSI AREA

KELLER/WEGLEY

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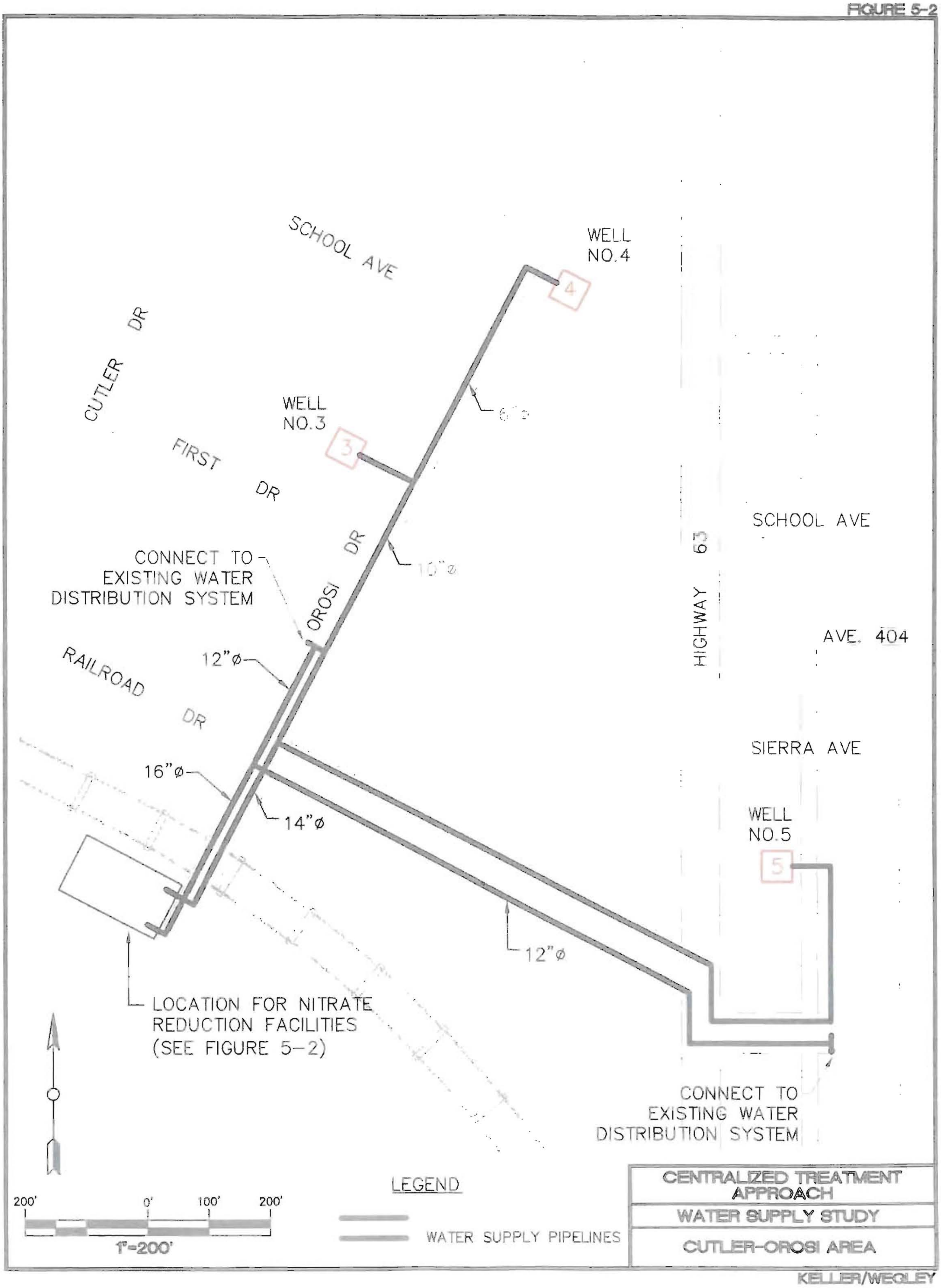
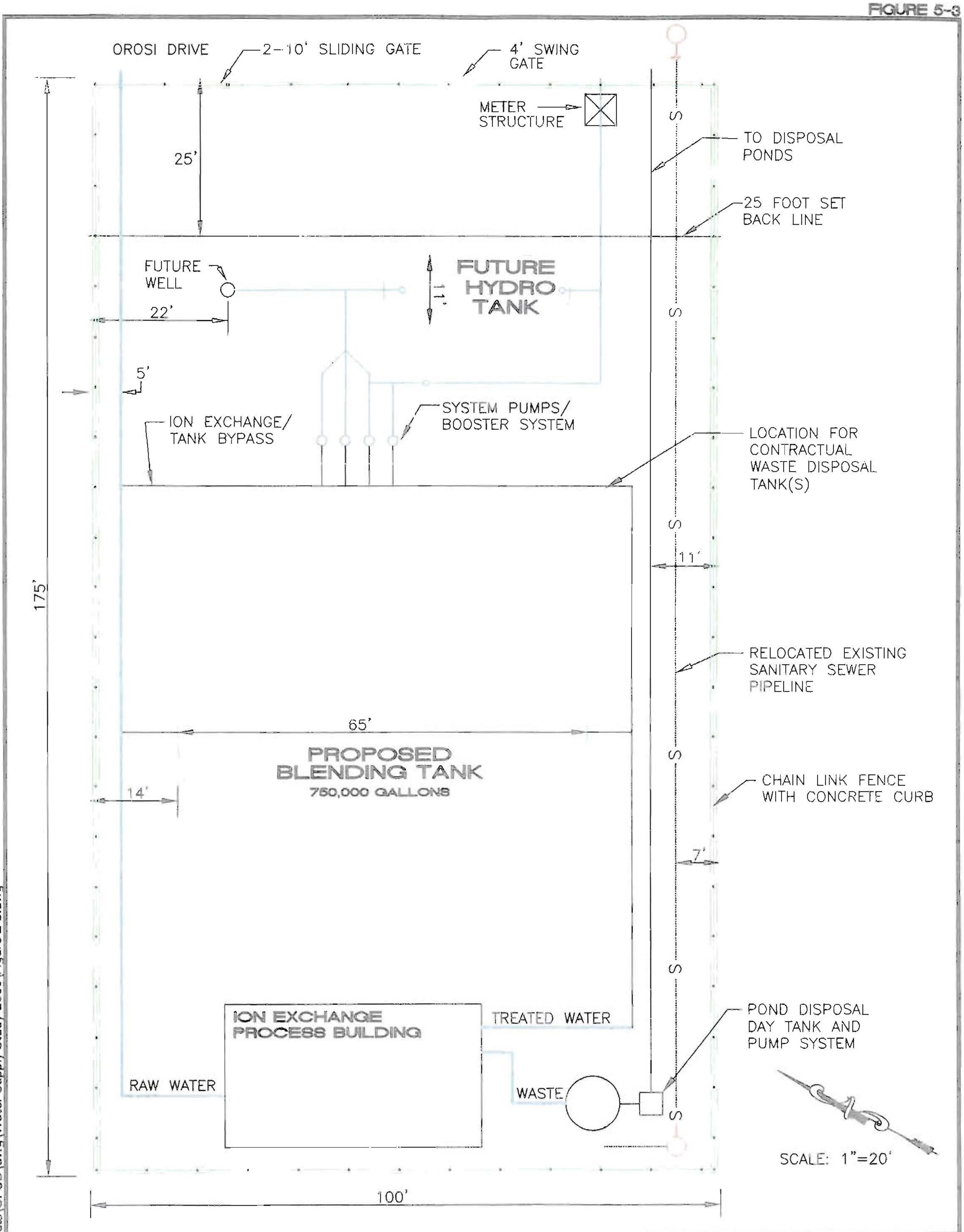
FIGURE 5-2



KELLER/WEGLEY



CPUD ION EXCHANGE LOCATION
WATER SUPPLY STUDY
CUTLER-OROSI AREA

KELLER/WEGLEY

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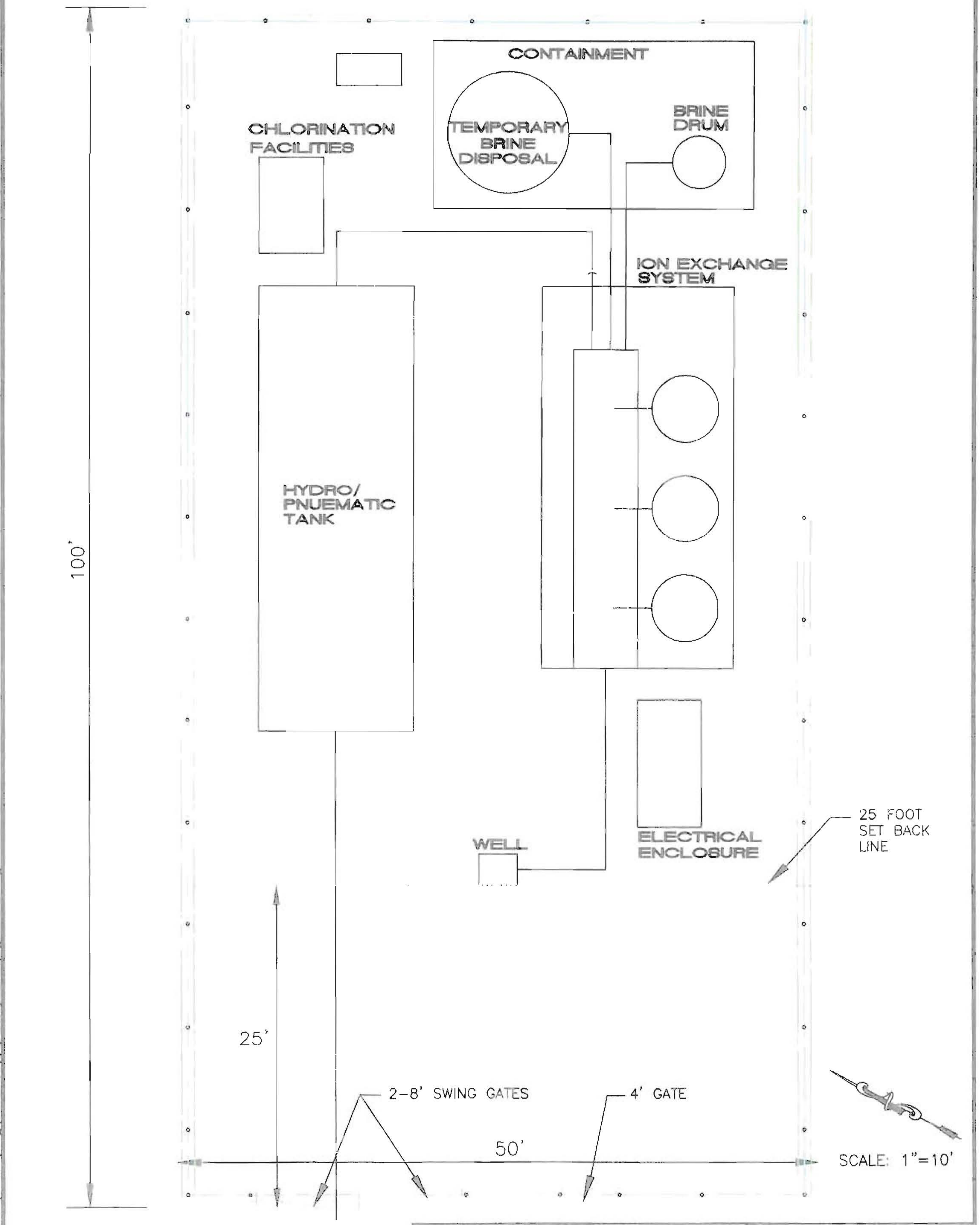

TYPICAL ION EXCHANGE PROCESS LAYOUT - WELL SITE
WATER SUPPLY STUDY
CUTLER-OROSI AREA

KELLER/WEGLEY

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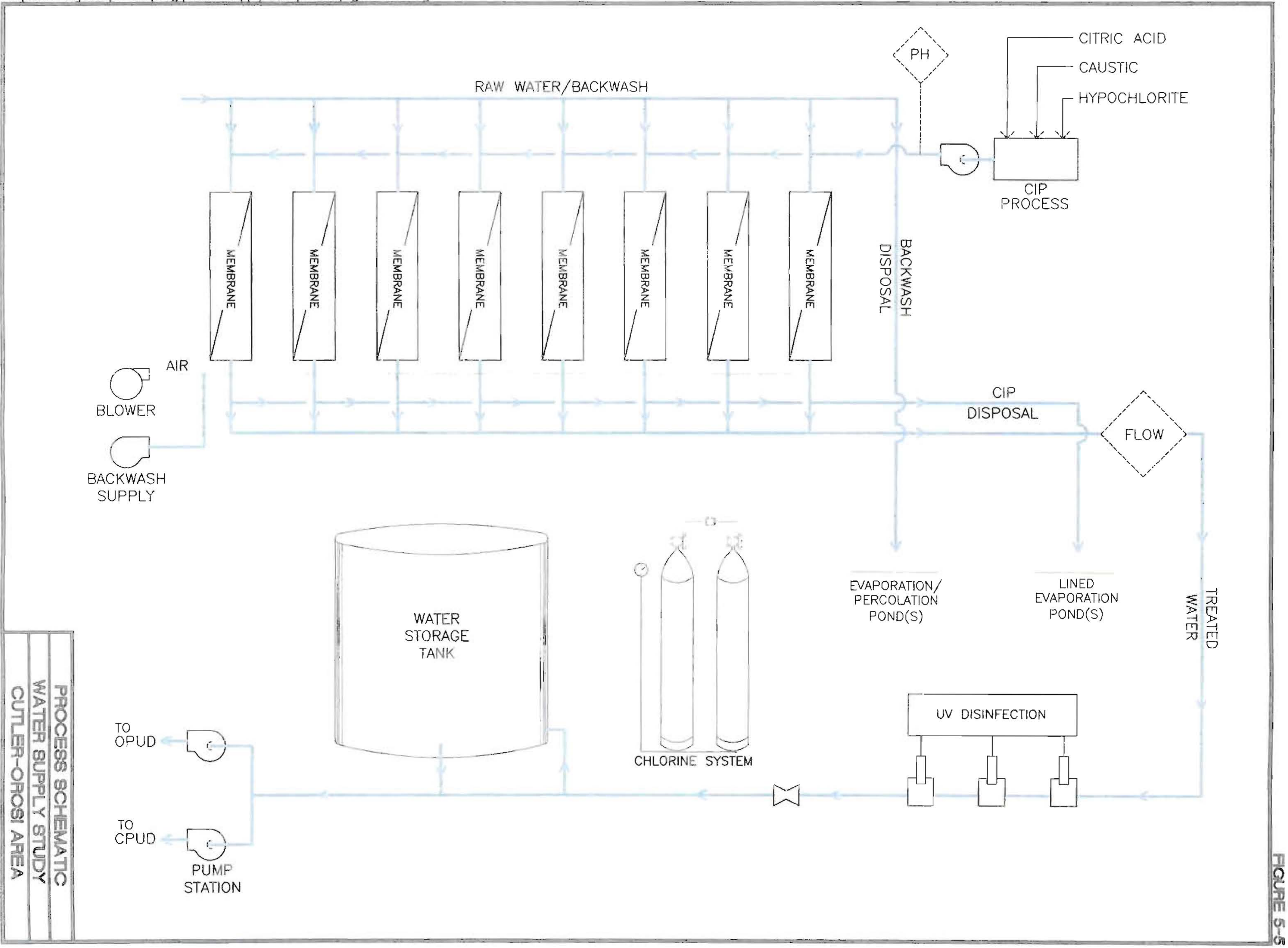
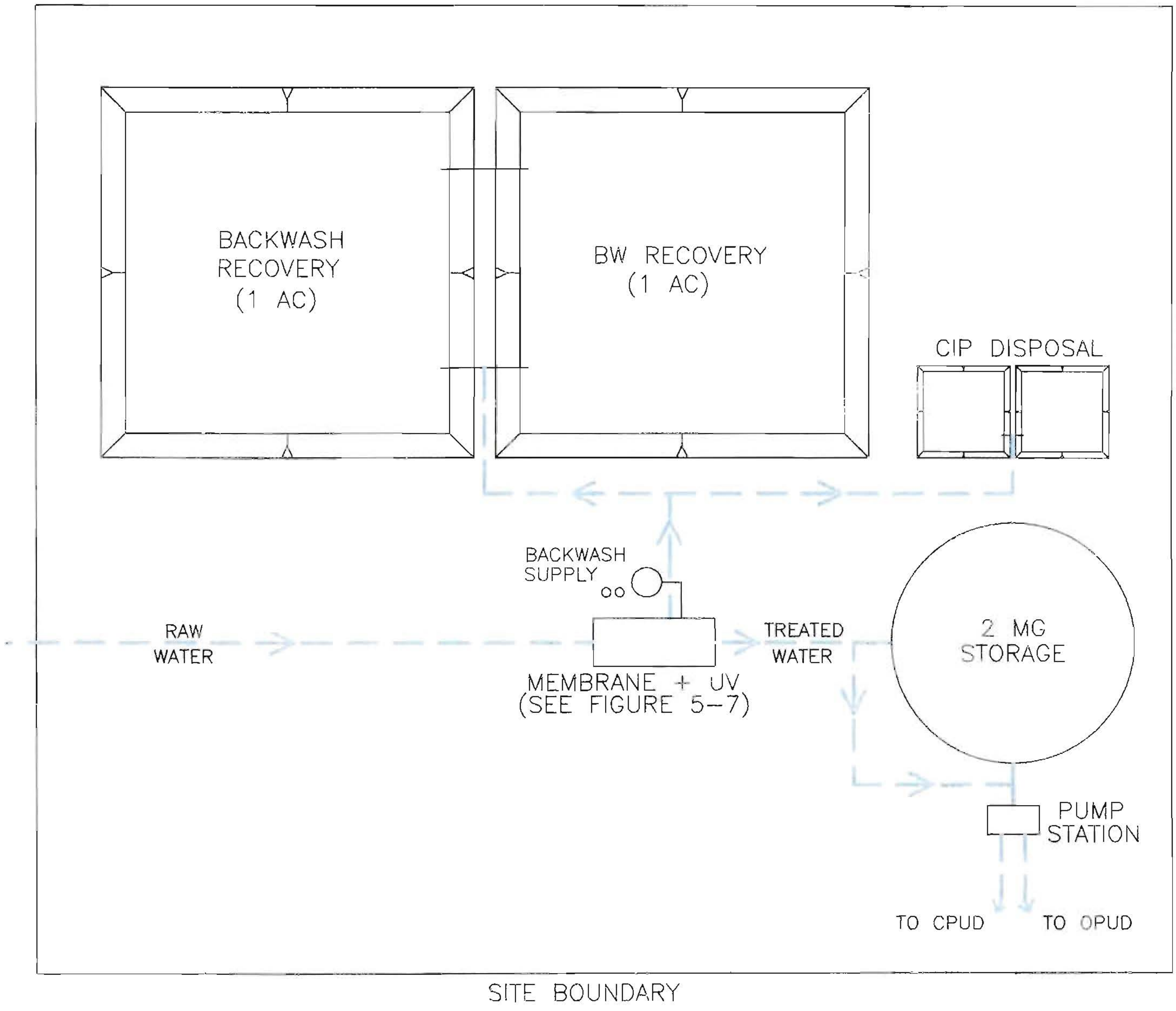


PROCESS SCHEMATIC
WATER SUPPLY STUDY
CUTLER-OROSI AREA
KELLER/WEGLEY

FIGURE 5-5



SCALE: 1"=100'

GENERAL SITE PLAN
WATER SUPPLY STUDY
CUTLER-OROSI AREA

KELLER/WEGLEY

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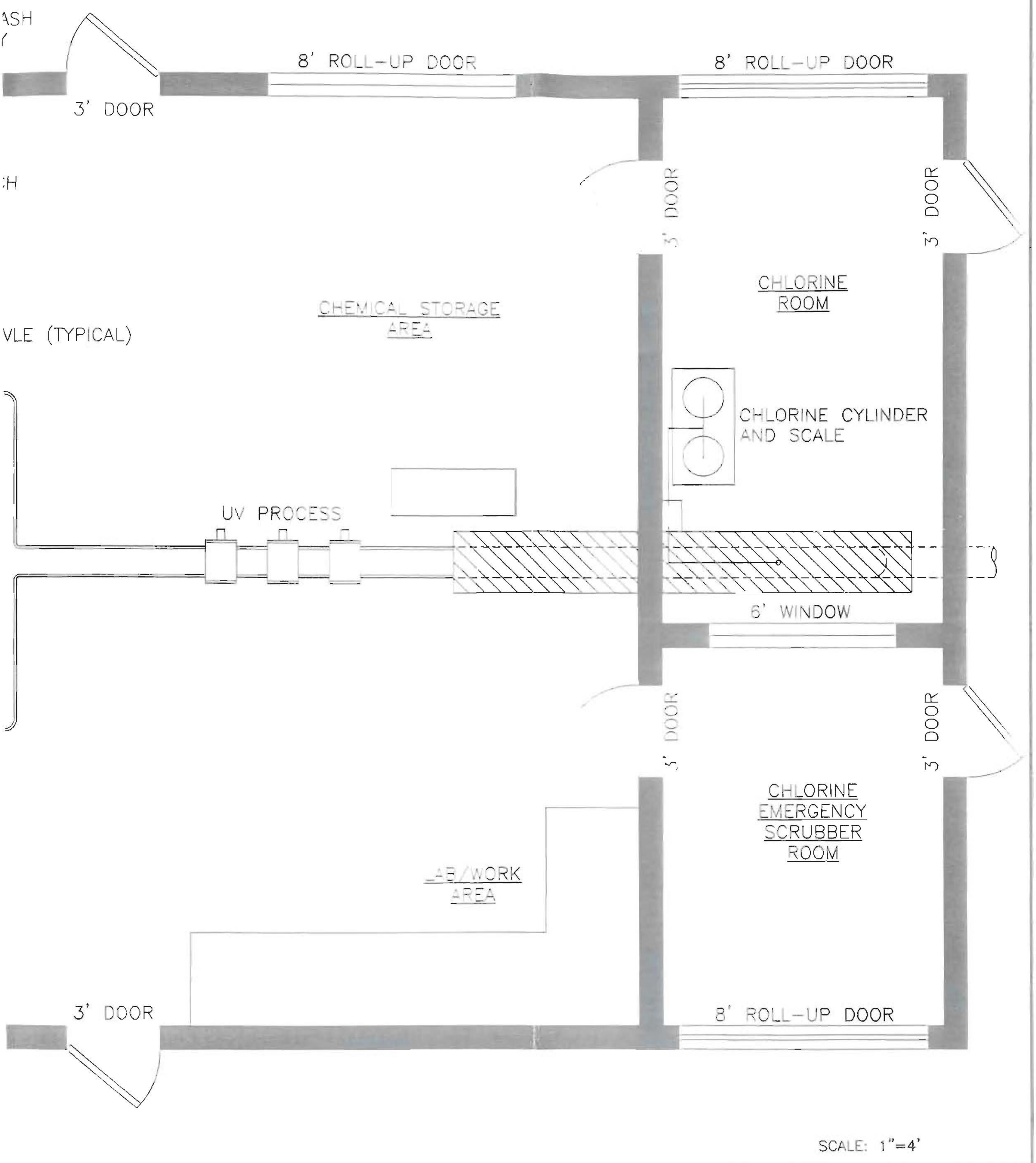
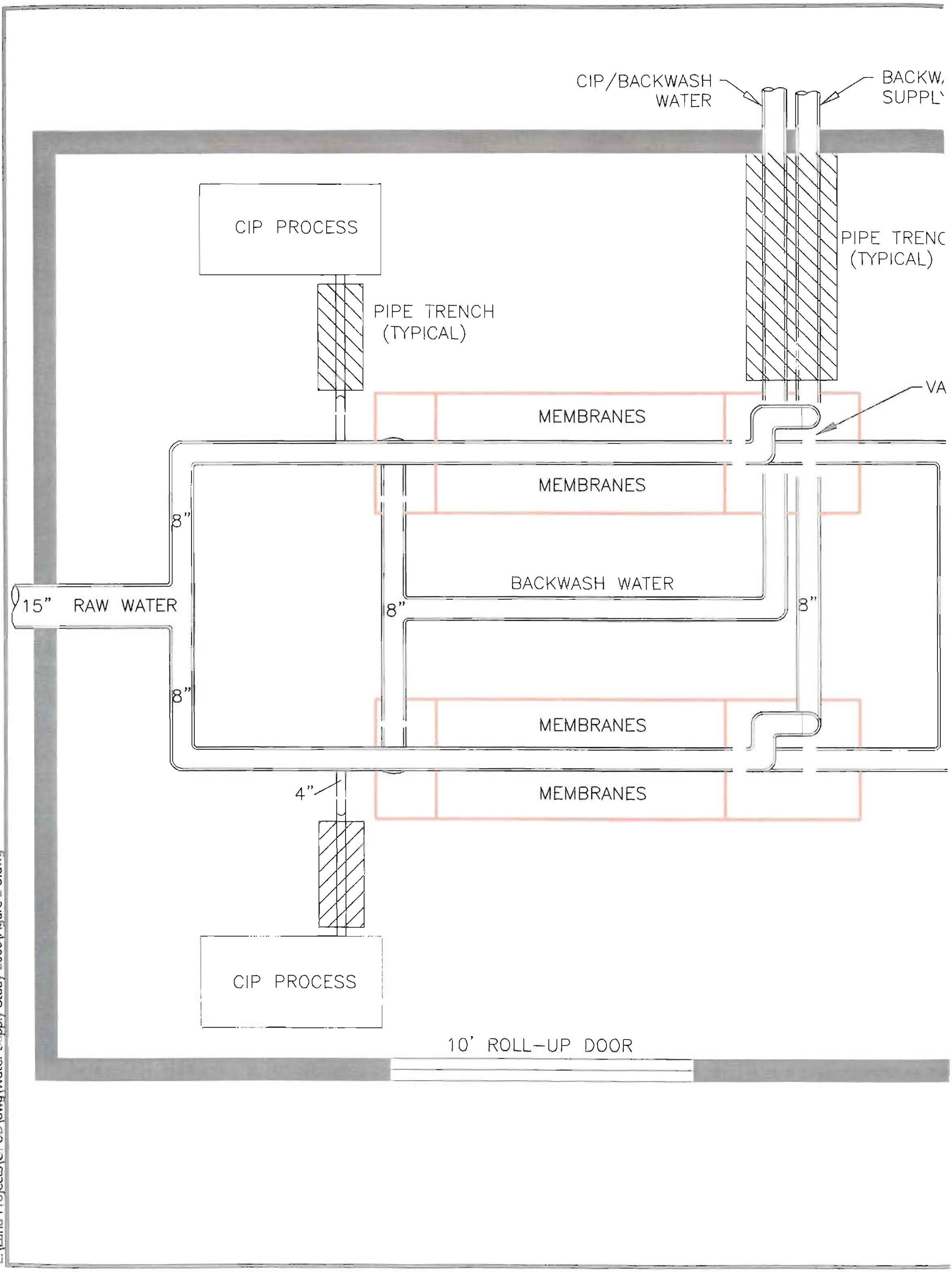


DETAILED EQUIPMENT LAYOUT
WATER SUPPLY STUDY
CUTLER-OROSI AREA

KELLER/WEGLEY



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