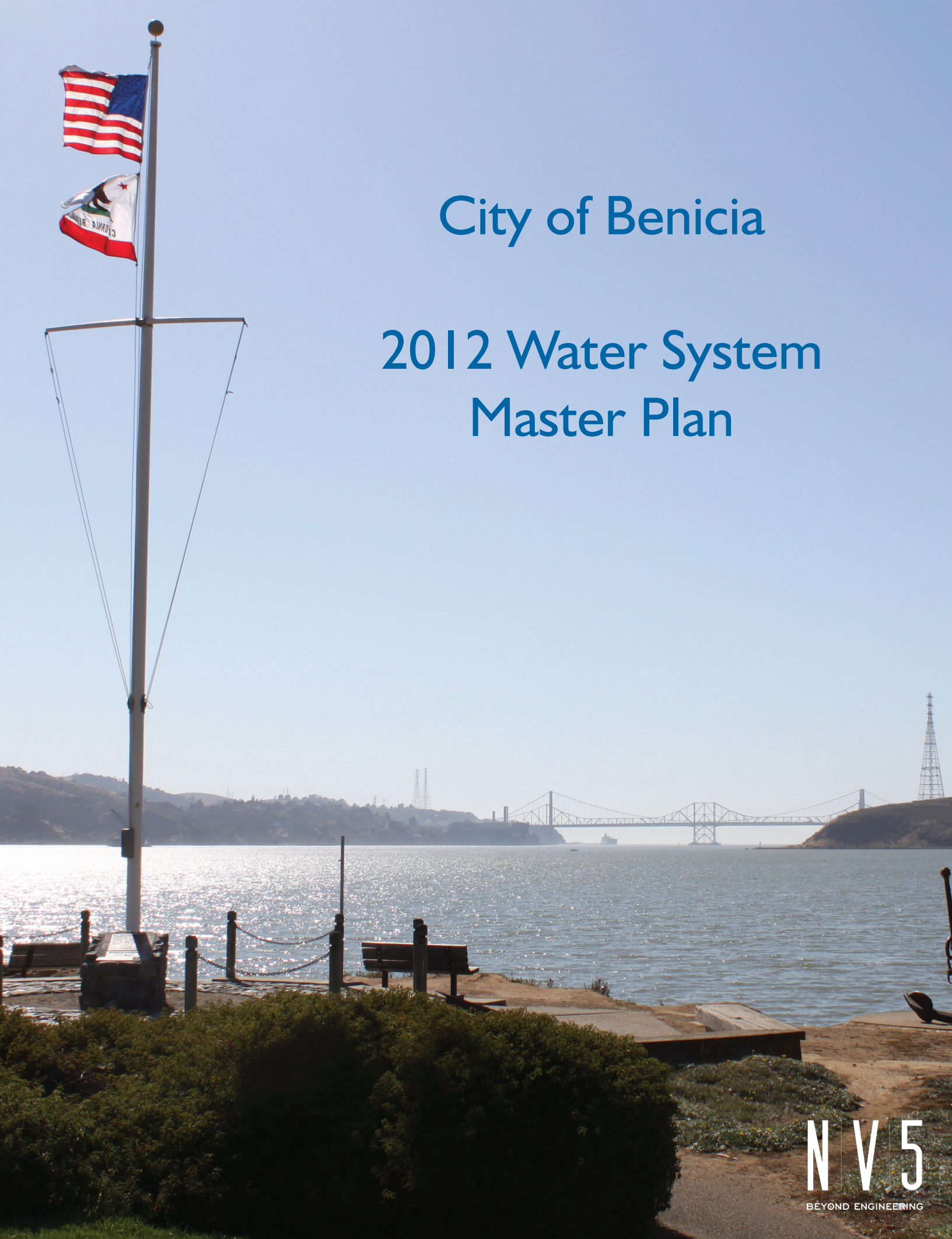

City of Benicia

2012 Water System Master Plan

NV5

BEYOND ENGINEERING

CITY OF BENICIA

2012 Water System Master Plan

THE CITY OF
BENICIA
CALIFORNIA

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APPENDIX A – WATER SUPPLY AGREEMENTS

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APPENDIX B – TECHNICAL MEMORANDUM - REGULATIONS REVIEW

LIST OF ABBREVIATIONS AND ACRONYMS

ABAG .....Association of Bay Area Governments
AC .....alternating current
AF .....acre-foot or acre-feet
AFY .....acre-feet per year
alum .....aluminum sulfate
AWWA .....American Water Works Association
BSPP .....Barker Slough Pumping Plant
CAP .....Climate Action Plan
CCT .....chlorine contact tank
CDPH.....California Department of Public Health
cfs .....cubic feet per second
CIP .....Capital Improvement Program
City .....City of Benicia
cu ft .....cubic feet
CVP .....Central Valley Project
DBPR .....Department of Business and Professional Regulation
DC .....direct current
DHS .....Department of Health Services
du/ac .....dwelling units/acre
DWR .....Department of Water Resource
EPA .....United States Environmental Protection Agency
ft .....feet
FY .....fiscal year
ºF .....degrees Fahrenheit
gal .....gallon
GHG .....greenhouse gas
gpd .....gallons per day
gpm .....gallons per minute
HP .....horsepower
hrs .....hours
in .....inch
IRWMP .....Integrated Regional Water Management Plan
kW .....kilowatt
kWh .....kilowatt-hour
lbs .....pounds
LF .....linear feet
MCC .....motor control centers
MCL .....Maximum Contaminant Level
MDD .....Maximum Day Demand
MG .....million gallons
mgd .....million gallons per day
Mojave .....Mojave Water Agency
MWh .....megawatt-hour
NBA .....North Bay Aqueduct

NPDES .....National Pollutant Discharge Elimination System
NRW .....non-revenue water
NTU .....Nephelometric Turbidity Unit
PG&E .....Pacific Gas and Electric
PLC .....programmable logic controller
PRV .....pressure reducing valves
psi .....pounds per square inch
PSW .....Partnership for Safe Water
PV .....photo voltaic
PVC .....polyvinyl chloride
RFP .....Request for Proposals
RWTL .....Raw Water Transmission Line
SCADA .....Supervisory Control and Data Acquisition
SCWA .....Solano County Water Agency
SID .....Solano Irrigation District
SWA .....Solano Water Authority
SWP .....State Water Project
SWRCB .....State Water Resources Control Board
TOC .....total organic carbon
UFC .....Uniform Fire Code
UWMP .....Urban Water Management Plan
Valero .....Valero Refinery
VFD .....variable frequency drive
WBICs .....weather-based irrigation controllers
WTP .....water treatment plant
WW .....water and wastewater
WWTP .....wastewater treatment plant
yr .....year

CONVERSION FACTORS

Volume
1 AF = 43,560 ft^3 = 325,851 gallons
1 ft^3 = 7.48 gallons
1 million gallons = 3.07 AF

Flow Rate
1 cfs = 450 gpm = 646,320 gallons/day
1,000 gpm = 2.23 cfs = 4.42 AF/day
1 mgd = 1,120 AFY = 3.07 AF/day
1 cfs for 24 hours = 1.983 AF
1 cfs for 30 days = 59.5 AF
1 cfs for 1 year = 724 AF

EXECUTIVE SUMMARY

The City of Benicia (City) has been following a plan outlined in its 1996 Water System Master Plan for maintaining a water system that is reliable with regard to supply and quality. In the past 16 years, significant changes in the economy and regulatory environment have made it clear that an updated planning effort and guide document was required in order to properly maintain and upgrade the City's water system. Preparing an update of the Water System Master Plan will provide a fresh look and solid foundation on which to base future decisions regarding improvements to, and operation and maintenance of treatment, transmission, distribution, and storage facilities.

In particular, the City wishes to account for:

- Growth occurring at a slower pace and in different locations than predicted in the 1996 Water System Master Plan and previous studies
- The need for assessment of existing facilities to improve operational performance
- Changing drinking water regulations, particularly with respect to distribution system water quality
- Reliability of water sources, both in quantity and quality
- Goals of sustainability through the Climate Action Plan (CAP) and impacts associated with climate change

WATER DEMAND FORECASTS

The water demand forecasts were developed based on land use projections and water use factors. The land use projection methodology ties the forecasts to actual planned land use as designated by the City’s Community Development Department.

Existing (2010) consumption and production data were obtained from the City’s meter data records and raw water flow meter at the water treatment plant (WTP). These data were used as an existing condition basis upon which the baseline projections were built.

Separate water forecasts were developed for: (1) treated water production; (2) Raw water demands for the Valero Refinery (Valero); and (3) the City's total water supply needs, which is equivalent to the sum of treated water production and Valero's raw water demands. For each of the three forecasts, three water use projections--high, baseline, and low--were developed to provide a probable range of future water use.

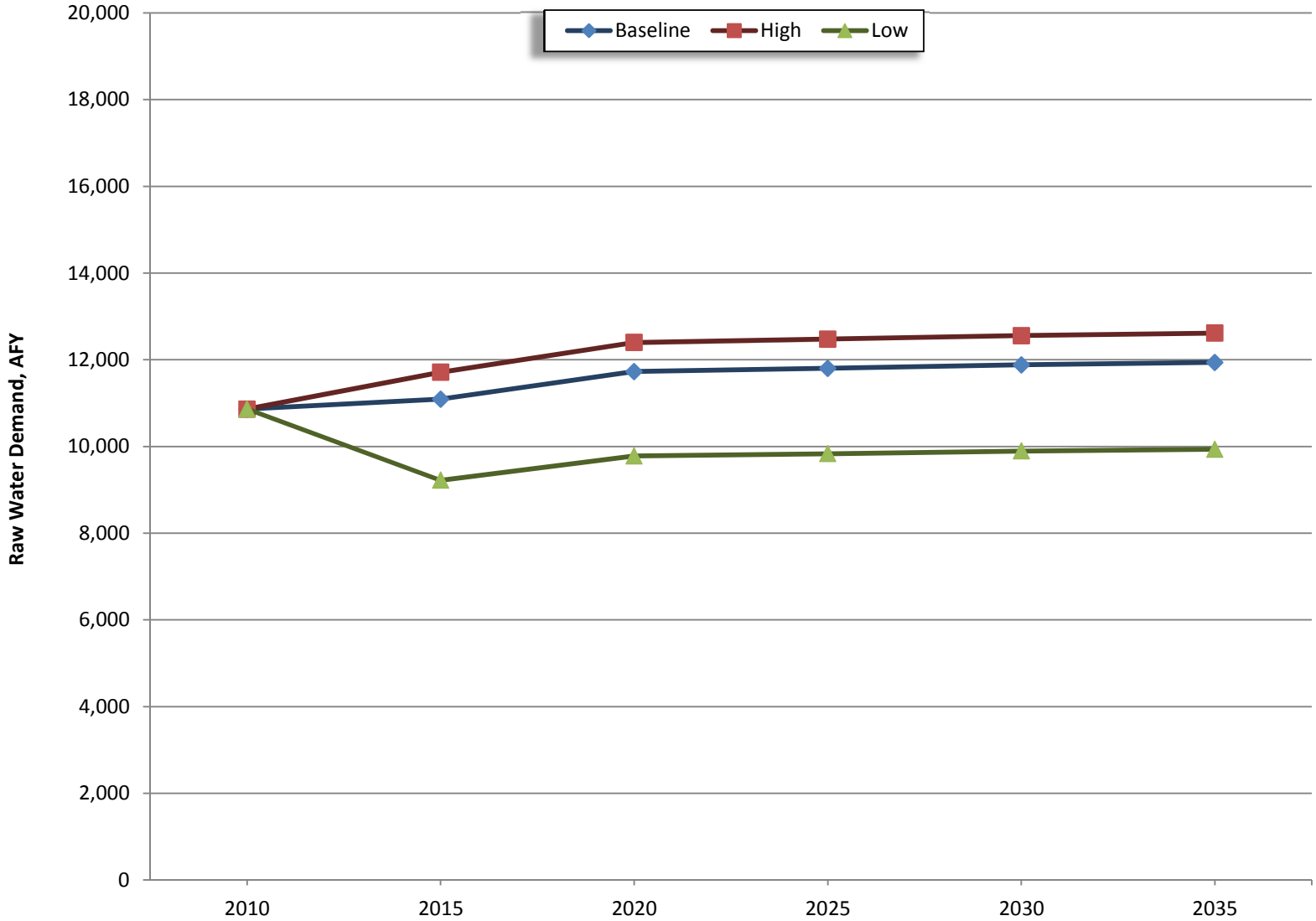
High, baseline, and low raw water demand projections were developed to examine the City's supply needs for water (Table E-1 and Figure E-1). These projections include both production demands and Valero's raw water demands. The high demand curve assumes industrial treated water use is twice that in baseline conditions, no significant savings from conservation programs occur, and the projected Valero raw water demand is 10 percent over baseline values for treated water demand. The baseline case is from the 2010 UWMP, assuming current levels of conservation and 100 percent planned buildout as phased; with Valero's raw water demand curve remaining relatively flat at levels extrapolated from historical use data.

The low demand assumes that additional conservation activities cause a decrease from the baseline demands by ten percent and that buildout for treated water supply is 80 percent of

baseline construction; which is equivalent to a total of 18 percent reduction in treated water demand, and a ten percent reduction in non-potable demands.

TABLE E-1
TOTAL RAW WATER DEMAND FORECASTS

	Annual Demand, AFY					
	2010	**2015**	**2020**	**2025**	**2030**	**2035**
Baseline Scenario						
Treated Water Demand	4,183	4,247	4,315	4,382	4,455	4,505
Valero Raw Water Demand	4,792	5,296	5,800	5,800	5,800	5,800
Operations & Emergency Demand	441	441	441	441	441	441
Unaccounted For Water	1,447	1,109	1,173	1,180	1,188	1,194
Total Demand	10,863	11,093	11,729	11,803	11,884	11,940
High Demand Scenario						
Treated Water Demand	4,272	4,337	4,407	4,475	4,550	4,601
Valero Raw Water Demand	5,271	5,826	6,380	6,380	6,380	6,380
Operations & Emergency Demand	441	441	441	441	441	441
Unaccounted For Water	1,447	1,109	1,173	1,180	1,188	1,194
Total Demand	11,431	11,713	12,401	12,476	12,559	12,616
Low Demand Scenario						
Treated Water Demand	3,012	3,058	3,107	3,155	3,208	3,244
Valero Raw Water Demand	4,313	4,766	5,220	5,220	5,220	5,220
Operations & Emergency Demand	441	441	441	441	441	441
Unaccounted For Water	1,302	998	1,056	1,062	1,069	1,075
Total Demand	9,024	9,219	9,779	9,834	9,894	9,935



CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

RAW WATER DEMAND FORECAST

FIGURE E-1

WATER SUPPLY SOURCES

The City has contracts for water through agreements with the Solano County Water Agency (SCWA) for State Water Project (SWP) water and with the California Department of Water Resources (DWR) for Settlement Water. The City also has contracts for water from the Solano Project through agreements with the City of Vallejo and the Solano Irrigation District (SID). These contracted water supplies are summarized in Table E-2.

TABLE E-2
CONTRACTED WATER SUPPLY

Source	Contract Amount (AFY)
State Water Project	16,075
Settlement Water	10,500
Vallejo Agreement	1,100
SID Agreement	2,000
Lake Herman	500[a]
	30,175

[a] Note: Water Supply available from Lake Herman is based on historical observation.

Water supplies can be stored at Lake Herman reservoir. Lake Herman is located in the hills between Benicia and Vallejo and has an approximate storage capacity of 1,400 AF.

The City currently has an active water purchase agreement with the City of Vallejo. The agreement was executed in 1962 and has been amended twice. The second amendment extended the expiration date of the agreement to February 28, 2025. It is assumed that this agreement will be renewed at its expiration. In the agreement, the City will purchase 1,100 AFY of Vallejo's Solano Project water from Lake Berryessa.

In March 2009, the City entered into a purchase agreement with the SID to provide 2,000 AFY. SID is the holder of a contractual right to receive allotments from the Solano Project as a Participating Agency of the SCWA under the terms of a Participating Agency Contract providing for the delivery of and allotment of 141,000 AFY from the Solano Project to SID.

Based on the review of Benicia's contracted water supplies, supply reliabilities, and water demands, the City has confirmed water supplies to meet its demands. However, Benicia is at the end of long conveyance facilities subject to negative impacts caused by regulatory, judicial, and equipment disruptions. For instance, in order to protect the Longfin Smelt, flow in the NBA is reduced from 130 cubic feet per second (cfs) to 50 cfs. Therefore, Benicia must be vigilant to ensure reliable long and short-term water supplies. Past efforts include a Settlement Water Agreement with DWR for "Area of Origin" water, extension of water supply agreement with Vallejo and a new water agreement with SID. Future efforts will consider methods to maximize the use of Settlement Water to provide increased reliability.

EXISTING WATER SYSTEM FACILITIES

The City's existing water system consists of raw water supply and transmission, treatment, storage, and distribution facilities. The water distribution system delivers potable water to the residential, commercial, and industrial land uses within the existing City limits. The distribution system facilities consist of pipelines, pump stations, pressure reducing valves, and storage reservoirs.

Water Distribution System

The existing distribution system is separated into three main pressure (or service) zones: Zone I, Zone II, and Zone III. Storage reservoirs are located in each of the main pressure zones to provide potable water during peak demand periods and to provide fire and emergency storage capacity. There are currently six water storage reservoirs in the distribution system, with a total capacity of 12.8 million gallons. Water is delivered to Pressure Zones II and III by three pump stations. The P-1 Pump Station located north of the City's Corporation Yard, delivers water to Zone II from Zone I. The P-2 Pump Station located across from the Corporation Yard approximately 1,200 feet west of East 2nd Street and north of Tenny's Drive conveys water from Zone II to Zone III. Similarly, the P-3 Pump Station located at the corner of Rose Drive and East 2nd Street delivers water directly from Zone I to Zone III.

Because of the variance in ground elevation within Zone III, several pressure reducing valve stations are located to provide an adequate level of service. In addition, in 1996 the City installed an additional pressure reducing valve station to supply all of Zone II from Zone III when the Zone II R-2 Reservoir is out of service.

The water distribution system pipelines range in diameter from 4-inch to 30-inch. Most of the larger pipelines are steel; the majority of the pipelines 12-inch in diameter or less are constructed of ductile iron.

Raw Water Transmission System

Raw water is delivered to the City via the raw water transmission system, which is comprised of two pump stations and approximately 75,000 feet of 24-, 30-, and 36-inch diameter pipelines.

The primary raw water source for the City is the State Water Project (SWP). This water is delivered from Barker Slough on the Sacramento-San Joaquin River Delta via the North Bay Aqueduct. Additional water comes through the Putah South Canal to the Terminal Reservoir. Water is then conveyed from either the NBA Pump Station or Cordelia Pump Station through the 36-inch Raw Water Transmission Main (RWTL) to a diversion structure located at the City’s water treatment plant. Flows in excess of the daily demand at the plant are diverted by gravity to Lake Herman through a 24-inch pipeline. Raw water is also provided to Valero’s Benicia Oil Refinery from the 24-inch pipeline. The City has the ability to convey raw water from Lake Herman to the water treatment plant for when supplies from the RWTL are interrupted.

Water Treatment Plant

The existing City water treatment plant was constructed in 1971. The plant was originally designed for a capacity of 6 mgd. In 1989, the plant was expanded to 12 mgd, and reliability/redundancy improvements occurred in 2006.

DISTRIBUTION SYSTEM EVALUATION

The water distribution system was analyzed and evaluated with use of a hydraulic model. Based on the evaluation improvement projects detailed in Table E-3 are recommended to mitigate existing and future deficiencies in the distribution system.

The hydraulic network model of the existing water supply and distribution system was developed based on the City's water system base maps. The calibrated hydraulic model was utilized to evaluate the performance of the water distribution system under existing demand conditions and buildout demand conditions.

Each of the existing pressure zones has a surplus of storage capacity under existing demand conditions, and no additional storage capacity is necessary. The future proposed development (Seeno Property) will require a separate pressure zone with specific pumping, piping, and storage facilities. The storage capacity for new developments should be reviewed and approved by the City at the time development planning commences.

The results of the pumping capacity evaluation indicate that the existing pump stations have adequate firm capacity to provide maximum day demand conditions to each pressure zone, even under circumstances when the P-3 Pump Station is out of service. A new pump station will most likely be required to convey water from Zone I to the future Seeno Property development. This new development will require separate pumping, storage, and piping facilities.

Several pipeline projects have been identified through the hydraulic evaluation and are necessary to correct hydraulic deficiencies and/or improve operational reliability and performance. Table E-3 is a summary of the total project costs for the recommended projects grouped by facility type.

TABLE E-3
RECOMMENDED DISTRIBUTION SYSTEM IMPROVEMENTS

Project Description	Quantity	Units	Baseline Construction Cost[a]	Contingency Cost[b]	Engineering/ Admin/Legal /CM Costs[c]	Total Cost
Distribution System						
1. New 18-inch pipeline in Park Road for Zone I for Arsenal area	2,500	LF	$350,000	$70,000	$84,000	$504,000
2. New 24-inch transmission main in Park Road for Zone I - Reliability	1,550	LF	$247,000	$50,000	$60,000	$357,000
3. Replace 6-inch DIP in Jefferson Street from Grant Street to Park Road	850	LF	$77,000	$15,000	$18,000	$110,000
4. New 12-inch main in Adams Street from Grant Street to Bayshore Road	500	LF	$55,000	$11,000	$13,000	$79,000
5. New 12-inch pipeline in Military West for Zone I	4,175	LF	$459,000	$92,000	$110,000	$661,000
6. New 8-inch water main to loop Drolette Way with Corrigan Court	250	LF	$23,000	$5,000	$6,000	$34,000
7. New 12-inch Zone III pipeline to serve Pressure Zone 3-A	1,200	LF	$132,000	$26,000	$32,000	$190,000
8. New 36-inch Reliability Transmission Main	2,800	LF	$504,000	$101,000	$121,000	$726,000
9. New 12-inch Vallejo-Benicia Inter-tie Connection	8,200	LF	$2,440,000	$480,000	$580,000	$3,500,000
10. P-2 Pump station MCC Replacement	1	LS	$208,000	$42,000	$50,000	$300,000
11. Recoating of R-1 Reservoir (interior & exterior)	1	LS	$208,000	$42,000	$50,000	$300,000
12. Recoating of R-2 Reservoir (interior & exterior)	1	LS	$208,000	$42,000	$50,000	$300,000
Raw Water Transmission System						
36-inch RWTL CP Improvements	1	LS	$280,000	$55,000	$65,000	$400,000
36-inch RWTL Improvements - Valve Replacement	1	LS	$140,000	$28,000	$32,000	$200,000

[a] Construction costs based on an ENR Index of 9291 for June 2012 (20 cities average).
[b] Contingency at 20% of baseline construction costs.
[c] Engineering/Admin/Legal/Construction Management Costs at 20% of sum of baseline construction cost and contingency.

WATER TREATMENT PLANT

The City of Benicia's Water Treatment Plant was evaluated on six levels, including: 1) plant capacity; 2) regulatory compliance and safety; 3) treatment process performance, 4) sludge treatment and disposal; 5) electrical systems and controls; and 6) operations. The treatment plant evaluation included the following tasks:

- Reviewing updated water demand projections and determining whether plant capacity will need to increase
- Determining regulatory compliance status
- Assessing treatment process performance as compared to established standards, operational goals, and voluntary targets
- Evaluating sludge treatment and disposal facilities and operations
- Conducting an electrical engineering review of existing electrical panels, switchgear, and control systems
- Identifying necessary operational improvements
- Recommending capital improvement projects

Recommended improvement projects are summarized in Table E-4**.** The table was developed from evaluations of the water treatment plant facilities and operations, discussions with City staff, and review of previous City master plans and capital improvement plans. The total project costs include baseline construction cost, a 20 percent construction contingency, and a 20 percent project contingency for engineering, administrative, legal, and construction management costs.

TABLE E-4
WATER TREATMENT PLANT IMPROVEMENT PROJECTS TO BE CONSIDERED

Project Description	Baseline Construction Cost	Contingency Cost[a]	Engineering/Admin/ Legal/CM Costs[c]	Total Cost
WTP PLC Replacement	$140,000	$28,000	$32,000	$200,000
Chemical Building Electrical Systems and Controls	$480,000	$95,000	$115,000	$690,000
Chemical Tank Farm Improvements	$590,000	$118,000	$142,000	$850,000
Magnetic Ion Exchange System (6 mgd)	$2,440,000	$485,000	$585,000	$3,510,000
Convert from Chlorine Gas to Sodium Hypochlorite Solution	$208,000	$42,000	$50,000	$300,000
Conversion to Polyorthophosphate	$105,000	$20,000	$25,000	$150,000
Re-Line Sludge Lagoons	$1,111,000	$222,000	$267,000	$1,600,000
Replace Backwash Tank 1	$295,000	$60,000	$70,000	$425,000
Re-Coating of Chlorine Contact Tank (Interior and Exterior)	$210,000	$40,000	$50,000	$300,000

[a] Contingency at 20% of baseline construction costs.
[b] Engineering/Admin/Legal/Construction Management Costs at 20% of sum of baseline construction cost and contingency

SUSTAINABILITY AND CLIMATE CHANGE

Incorporating sustainability into the water master plan ensures that the City of Benicia remains a good steward of their water resources.

The City has continuously implemented a water conservation program for more than 20 years. The City's on-going commitment to address sustainability and reduce global warming impacts related to the Water System Master Plan is addressed in this chapter. Effects of climate change resulting from operation of the City water supply system can be influenced in three general areas 1) reducing the operation of facilities by reducing demand; 2) increasing the efficiency of facilities that use energy; and 3) obtaining energy from renewable sources.

The City has a very detailed and goal oriented Climate Action Plan (CAP). The plan inventoried City energy users and concluded that almost 25 percent of the City Government's greenhouse gas (GHG) emissions result from the electricity required to pump, treat, and deliver clean potable water (the subject of this water master plan) and to collect and treat wastewater (see Wastewater System Master Plan).

The CAP established the following three objectives for the City water and wastewater systems (WW). Each objective has several strategies and those are also noted throughout this chapter as they apply:

- Objective WW-1: Reduce the Amount of Water Consumed 20% by 2020
- Objective WW-2: Reduce the Amount of Emissions Resulting from Pumps and Lift Stations
- Objective WW-3: Reduce the Amount of Emissions Resulting from Water and Wastewater Plant Operations 95% by 2020

Climate change and other impacts that occur as a result of global warming present potential challenges for water supply. The City is committed to meet the challenges of climate change by preparing for potential future changes. The City supported the passage of AB 32, the Global Warming Solutions Act, which requires California to cut its greenhouse gas emissions by 25 percent by 2020 and has adopted its own Climate Action Plan. To help mitigate global climate change, the City has aggressive goals to save energy by increasing water facility efficiency, reducing demand with water conservation measures, and reducing the City's role in global warming by considering energy sources that are renewable. To meet future challenges of diminished supplies, the City must prepare for both emergency situations, as well as long term goals. Suggestions and recommendations for further implementing City objectives have been addressed in Section 7 – Sustainability and Climate Change.

CAPITAL IMPROVEMENT PROGRAM

Based on the analysis of the water transmission, distribution, and treatment systems the recommended projects have been developed into a 10-year Capital Improvement Program (CIP) to represent the staged implementation of water system improvements in the distribution system and at the water treatment plant.

Water Distribution System

The recommended improvement projects and cost estimates resulting from the analysis of the water distribution system are shown in Tables E-5 and E-6. Most of the recommended improvement projects are necessary to correct current deficiencies or will immediately improve system operation, performance, and reliability (redundancy), if implemented.

Table E-5 shows the projects that will benefit existing customers, to be funded by the existing general fund. Table E-6 shows the projects that will benefit new customers, to be funded by connection fees. These connection fee project costs are shared with existing customers, and therefore the costs are split between Tables E-5 and E-6. The projects identified in the CIP resulted from the most recent budget preparation concluded prior to completion of this master plan update. The projects are listed in detail in Section 5, and have been staggered over the 10 year period to spread costs to each fiscal year in an effort to balance annual costs. The timing of projects may change as priorities shift, or funding is impacted.

Water Treatment Plant

The water treatment plant projects identified in Table E-7 resulted from the most recent budget preparation concluded prior to completion of this Master Plan update. Projects not completed from the previous CIP were either deleted (no longer necessary) or re-entered into this current list of projects. Electrical and instrumentation upgrades take a high priority in FYs 2013-2015. In subsequent years 2015-2017, conversion from chlorine gas to liquid sodium hypochlorite is planned along with improvements to the chemical tank farm. The major project slated for the treatment plant is construction of the magnetic ion exchange system (MIEX) expected to begin in FY 2017.

The remaining projects are staggered over the 10-year period to spread costs in each fiscal year as much as possible. The timing of projects may change as priorities shift, or funding is impacted. On a 20-year horizon, several projects are listed including large maintenance items such as reservoir recoating and relining of the sludge lagoons.

TABLE E-5
WATER DISTRIBUTION SYSTEM
10-YEAR CAPITAL IMPROVEMENT PROGRAM
OPERATIONS FUND

Project Number	Project	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-32	Total
Distribution System											
1	New 18-inch transmission main in Park Road for Zone 1 (Armory to Oak Road)	$504,000									$504,000
2	New 24-inch DIP in Park Road for Zone I (Reliability)					$357,000					$357,000
3	Replace 6-inch DIP in Jefferson Street (Grant Street to Park Road)		$110,000								$110,000
4	New 12-inch DIP in Adams Street (Grant Street to Bayshore Road)		$39,500[a]								$39,500
5	New 12-inch DIP in Military West (West 6th Street to Plaza de Oro)			$330,500[a]							$330,500
6	New 8-inch DIP to loop Drolette Way with Corrigan Court				$17,000[a]						$17,000
7	New 12-inch DIP in Zone III to serve Pressure Zone 3-A				$95,000[a]						$95,000
8	New 36-inch transmission main (Reliability from WTP to East 2nd Street)					$726,000					$726,000
9	Benicia-Vallejo Inter-tie									$3,500,000	$3,500,000
10	P-2 Pump Station MCC Replacement				$300,000						$300,000
11	Recoating of R-1 Reservoir (interior & exterior)									$300,000	$300,000
12	Recoating of R-2 Reservoir (interior & exterior)									$300,000	$300,000
Raw Water Transmission System											
	36-inch RWTL CP Improvements	$200,000	$200,000								$400,000
	36-inch RWTL Improvements	$200,000									$200,000
	Totals	**$904,000**	**$349,500**	**$330,500**	**$412,000**	**$1,083,000**	**$0**	**$0**	**$0**	**$4,100,000**	**$7,179,000**

[a] This cost represents half of the total project cost. The project cost is shared equally with the Connection Fee Fund (see Table E-6)

TABLE E-6
WATER DISTRIBUTION SYSTEM
10-YEAR CAPITAL IMPROVEMENT PROGRAM
CONNECTION FEE FUND[a]

Project Number	Project	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-32	Total
4	New 12-inch DIP in Adams Street (Grant Street to Bayshore Road)		$39,500[b]								$39,500
5	New 12-inch DIP in Military West (West 6th Street to Plaza de Oro)			$330,500[c]							$330,500
6	New 8-inch DIP to loop Drolette Way with Corrigan Court				$17,000[d]						$17,000
7	New 12-inch DIP in Zone III to serve Pressure Zone 3-A				$95,000[e]						$95,000
	Totals	**$0**	**$39,500**	**$330,500**	**$112,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$482,000**

[a] The cost for each of these projects represents half of the total project cost. The project cost is shared equally with the Operations Fund (see Table E-5)
[b] Total project cost is estimated at $79,000.
[c] Total project cost is estimated at $661,000.
[d] Total project cost is estimated at $34,000.
[e] Total project cost is estimated at $190,000.

TABLE E-7
WATER TREATMENT PLANT
10-YEAR CAPITAL IMPROVEMENT PROGRAM
OPERATIONS FUND

Project	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-32	Total
WTP PLC Replacement	$200,000									$200,000
Chemical Building Electrical Systems and Controls		$690,000								$690,000
Chemical Tank Farm Improvements			$250,000	$600,000						$850,000
Magnetic Ion Exchange System (6 mgd)					$800,000	$2,710,000				$3,510,000
Conversion from Chlorine Gas to Sodium Hypochlorite			$300,000							$300,000
Conversion to Polyorthophosphate							$150,000			$150,000
Re-Line Sludge Lagoons									$1,600,000	$1,600,000
Replace Backwash Tank 1									$425,000	$425,000
Recoating of Chlorine Contact Tank (interior & exterior)									$300,000	$300,000
Totals	**$200,000**	**$690,000**	**$550,000**	**$600,000**	**$800,000**	**$2,710,000**	**$150,000**	**$0**	**$2,325,000**	**$8,025,000**

The City of Benicia (City) has been following a plan outlined in its 1996 Water System Master Plan for maintaining a water system that is reliable with regard to supply and quality. In the past 16 years, significant changes in the economy and regulatory environment have made it clear that an updated planning effort and guide document was required in order to properly maintain and upgrade the City's water system. Preparing an update of the Water System Master Plan will provide a fresh look and solid foundation on which to base future decisions regarding improvements to, and operation and maintenance of treatment, transmission, distribution, and storage facilities.

In particular, the City wishes to account for:

- Growth occurring at a slower pace and in different locations than predicted in the 1996 Water System Master Plan and previous studies
- The need for assessment of existing facilities to improve operational performance
- Changing drinking water regulations, particularly with respect to distribution system water quality
- Reliability of water sources, both in quantity and quality
- Goals of sustainability through the Climate Action Plan (CAP) and impacts associated with climate change

WATER DEMAND FORECASTS

The water demand forecasts were developed based on land use projections and water use factors. The land use projection methodology ties the forecasts to actual planned land use as designated by the City’s Community Development Department.

Existing (2010) consumption and production data were obtained from the City’s meter data records and raw water flow meter at the water treatment plant (WTP). These data were used as an existing condition basis upon which the baseline projections were built.

Separate water forecasts were developed for: (1) treated water production; (2) Raw water demands for the Valero Refinery (Valero); and (3) the City's total water supply needs, which is equivalent to the sum of treated water production and Valero's raw water demands. For each of the three forecasts, three water use projections--high, baseline, and low--were developed to provide a probable range of future water use.

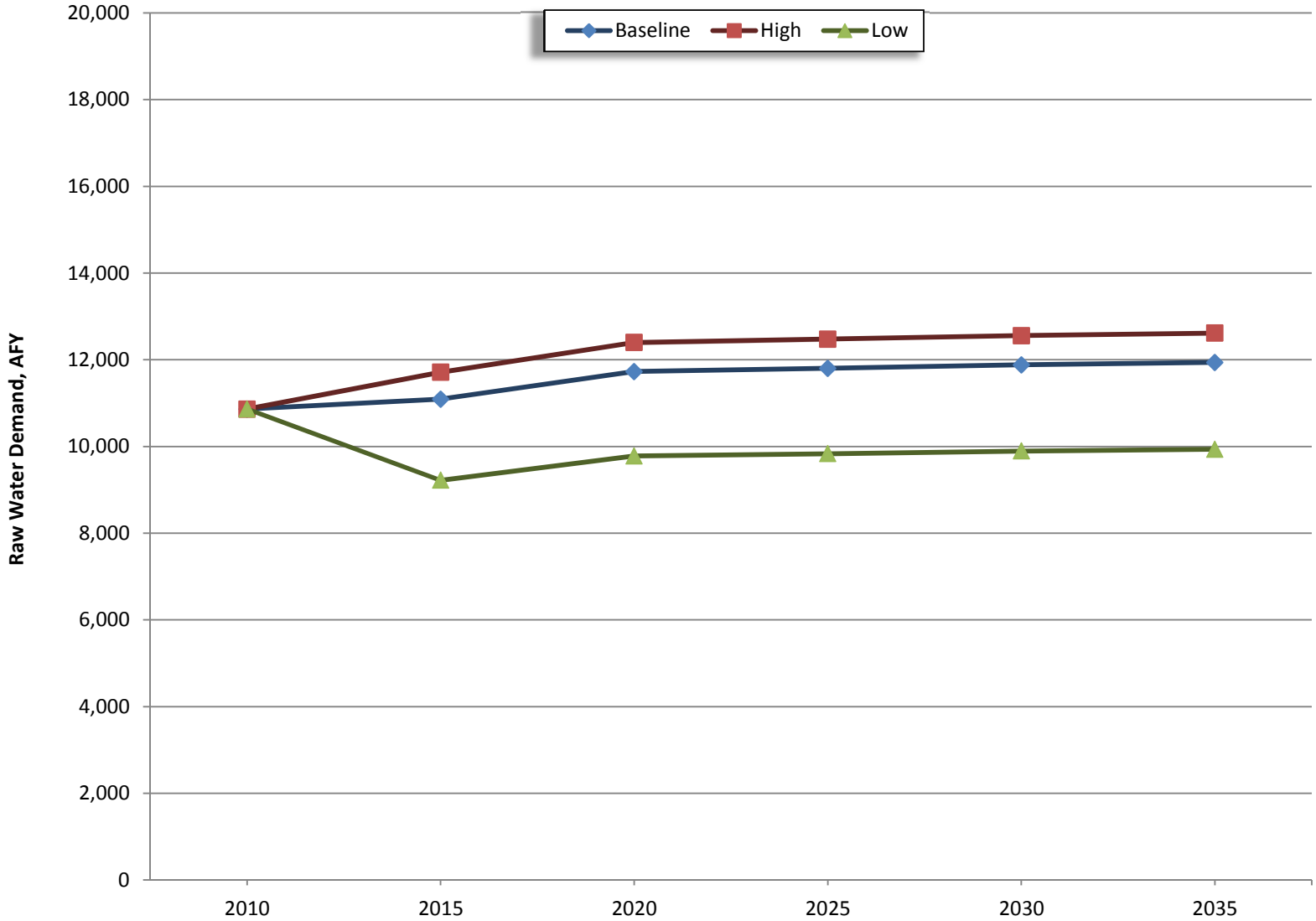
High, baseline, and low raw water demand projections were developed to examine the City's supply needs for water (Table E-1 and Figure E-1). These projections include both production demands and Valero's raw water demands. The high demand curve assumes industrial treated water use is twice that in baseline conditions, no significant savings from conservation programs occur, and the projected Valero raw water demand is 10 percent over baseline values for treated water demand. The baseline case is from the 2010 UWMP, assuming current levels of conservation and 100 percent planned buildout as phased; with Valero's raw water demand curve remaining relatively flat at levels extrapolated from historical use data.

The low demand assumes that additional conservation activities cause a decrease from the baseline demands by ten percent and that buildout for treated water supply is 80 percent of

baseline construction; which is equivalent to a total of 18 percent reduction in treated water demand, and a ten percent reduction in non-potable demands.

TABLE E-1
TOTAL RAW WATER DEMAND FORECASTS

	Annual Demand, AFY					
	2010	**2015**	**2020**	**2025**	**2030**	**2035**
Baseline Scenario						
Treated Water Demand	4,183	4,247	4,315	4,382	4,455	4,505
Valero Raw Water Demand	4,792	5,296	5,800	5,800	5,800	5,800
Operations & Emergency Demand	441	441	441	441	441	441
Unaccounted For Water	1,447	1,109	1,173	1,180	1,188	1,194
Total Demand	10,863	11,093	11,729	11,803	11,884	11,940
High Demand Scenario						
Treated Water Demand	4,272	4,337	4,407	4,475	4,550	4,601
Valero Raw Water Demand	5,271	5,826	6,380	6,380	6,380	6,380
Operations & Emergency Demand	441	441	441	441	441	441
Unaccounted For Water	1,447	1,109	1,173	1,180	1,188	1,194
Total Demand	11,431	11,713	12,401	12,476	12,559	12,616
Low Demand Scenario						
Treated Water Demand	3,012	3,058	3,107	3,155	3,208	3,244
Valero Raw Water Demand	4,313	4,766	5,220	5,220	5,220	5,220
Operations & Emergency Demand	441	441	441	441	441	441
Unaccounted For Water	1,302	998	1,056	1,062	1,069	1,075
Total Demand	9,024	9,219	9,779	9,834	9,894	9,935



CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

RAW WATER DEMAND FORECAST

FIGURE E-1

WATER SUPPLY SOURCES

The City has contracts for water through agreements with the Solano County Water Agency (SCWA) for State Water Project (SWP) water and with the California Department of Water Resources (DWR) for Settlement Water. The City also has contracts for water from the Solano Project through agreements with the City of Vallejo and the Solano Irrigation District (SID). These contracted water supplies are summarized in Table E-2.

TABLE E-2
CONTRACTED WATER SUPPLY

Source	Contract Amount (AFY)
State Water Project	16,075
Settlement Water	10,500
Vallejo Agreement	1,100
SID Agreement	2,000
Lake Herman	500[a]
	30,175

[a] Note: Water Supply available from Lake Herman is based on historical observation.

Water supplies can be stored at Lake Herman reservoir. Lake Herman is located in the hills between Benicia and Vallejo and has an approximate storage capacity of 1,400 AF.

The City currently has an active water purchase agreement with the City of Vallejo. The agreement was executed in 1962 and has been amended twice. The second amendment extended the expiration date of the agreement to February 28, 2025. It is assumed that this agreement will be renewed at its expiration. In the agreement, the City will purchase 1,100 AFY of Vallejo's Solano Project water from Lake Berryessa.

In March 2009, the City entered into a purchase agreement with the SID to provide 2,000 AFY. SID is the holder of a contractual right to receive allotments from the Solano Project as a Participating Agency of the SCWA under the terms of a Participating Agency Contract providing for the delivery of and allotment of 141,000 AFY from the Solano Project to SID.

Based on the review of Benicia's contracted water supplies, supply reliabilities, and water demands, the City has confirmed water supplies to meet its demands. However, Benicia is at the end of long conveyance facilities subject to negative impacts caused by regulatory, judicial, and equipment disruptions. For instance, in order to protect the Longfin Smelt, flow in the NBA is reduced from 130 cubic feet per second (cfs) to 50 cfs. Therefore, Benicia must be vigilant to ensure reliable long and short-term water supplies. Past efforts include a Settlement Water Agreement with DWR for "Area of Origin" water, extension of water supply agreement with Vallejo and a new water agreement with SID. Future efforts will consider methods to maximize the use of Settlement Water to provide increased reliability.

EXISTING WATER SYSTEM FACILITIES

The City's existing water system consists of raw water supply and transmission, treatment, storage, and distribution facilities. The water distribution system delivers potable water to the residential, commercial, and industrial land uses within the existing City limits. The distribution system facilities consist of pipelines, pump stations, pressure reducing valves, and storage reservoirs.

Water Distribution System

The existing distribution system is separated into three main pressure (or service) zones: Zone I, Zone II, and Zone III. Storage reservoirs are located in each of the main pressure zones to provide potable water during peak demand periods and to provide fire and emergency storage capacity. There are currently six water storage reservoirs in the distribution system, with a total capacity of 12.8 million gallons. Water is delivered to Pressure Zones II and III by three pump stations. The P-1 Pump Station located north of the City's Corporation Yard, delivers water to Zone II from Zone I. The P-2 Pump Station located across from the Corporation Yard approximately 1,200 feet west of East 2nd Street and north of Tenny's Drive conveys water from Zone II to Zone III. Similarly, the P-3 Pump Station located at the corner of Rose Drive and East 2nd Street delivers water directly from Zone I to Zone III.

Because of the variance in ground elevation within Zone III, several pressure reducing valve stations are located to provide an adequate level of service. In addition, in 1996 the City installed an additional pressure reducing valve station to supply all of Zone II from Zone III when the Zone II R-2 Reservoir is out of service.

The water distribution system pipelines range in diameter from 4-inch to 30-inch. Most of the larger pipelines are steel; the majority of the pipelines 12-inch in diameter or less are constructed of ductile iron.

Raw Water Transmission System

Raw water is delivered to the City via the raw water transmission system, which is comprised of two pump stations and approximately 75,000 feet of 24-, 30-, and 36-inch diameter pipelines.

The primary raw water source for the City is the State Water Project (SWP). This water is delivered from Barker Slough on the Sacramento-San Joaquin River Delta via the North Bay Aqueduct. Additional water comes through the Putah South Canal to the Terminal Reservoir. Water is then conveyed from either the NBA Pump Station or Cordelia Pump Station through the 36-inch Raw Water Transmission Main (RWTL) to a diversion structure located at the City’s water treatment plant. Flows in excess of the daily demand at the plant are diverted by gravity to Lake Herman through a 24-inch pipeline. Raw water is also provided to Valero’s Benicia Oil Refinery from the 24-inch pipeline. The City has the ability to convey raw water from Lake Herman to the water treatment plant for when supplies from the RWTL are interrupted.

Water Treatment Plant

The existing City water treatment plant was constructed in 1971. The plant was originally designed for a capacity of 6 mgd. In 1989, the plant was expanded to 12 mgd, and reliability/redundancy improvements occurred in 2006.

DISTRIBUTION SYSTEM EVALUATION

The water distribution system was analyzed and evaluated with use of a hydraulic model. Based on the evaluation improvement projects detailed in Table E-3 are recommended to mitigate existing and future deficiencies in the distribution system.

The hydraulic network model of the existing water supply and distribution system was developed based on the City's water system base maps. The calibrated hydraulic model was utilized to evaluate the performance of the water distribution system under existing demand conditions and buildout demand conditions.

Each of the existing pressure zones has a surplus of storage capacity under existing demand conditions, and no additional storage capacity is necessary. The future proposed development (Seeno Property) will require a separate pressure zone with specific pumping, piping, and storage facilities. The storage capacity for new developments should be reviewed and approved by the City at the time development planning commences.

The results of the pumping capacity evaluation indicate that the existing pump stations have adequate firm capacity to provide maximum day demand conditions to each pressure zone, even under circumstances when the P-3 Pump Station is out of service. A new pump station will most likely be required to convey water from Zone I to the future Seeno Property development. This new development will require separate pumping, storage, and piping facilities.

Several pipeline projects have been identified through the hydraulic evaluation and are necessary to correct hydraulic deficiencies and/or improve operational reliability and performance. Table E-3 is a summary of the total project costs for the recommended projects grouped by facility type.

TABLE E-3
RECOMMENDED DISTRIBUTION SYSTEM IMPROVEMENTS

Project Description	Quantity	Units	Baseline Construction Cost[a]	Contingency Cost[b]	Engineering/ Admin/Legal /CM Costs[c]	Total Cost
Distribution System						
1. New 18-inch pipeline in Park Road for Zone I for Arsenal area	2,500	LF	$350,000	$70,000	$84,000	$504,000
2. New 24-inch transmission main in Park Road for Zone I - Reliability	1,550	LF	$247,000	$50,000	$60,000	$357,000
3. Replace 6-inch DIP in Jefferson Street from Grant Street to Park Road	850	LF	$77,000	$15,000	$18,000	$110,000
4. New 12-inch main in Adams Street from Grant Street to Bayshore Road	500	LF	$55,000	$11,000	$13,000	$79,000
5. New 12-inch pipeline in Military West for Zone I	4,175	LF	$459,000	$92,000	$110,000	$661,000
6. New 8-inch water main to loop Drolette Way with Corrigan Court	250	LF	$23,000	$5,000	$6,000	$34,000
7. New 12-inch Zone III pipeline to serve Pressure Zone 3-A	1,200	LF	$132,000	$26,000	$32,000	$190,000
8. New 36-inch Reliability Transmission Main	2,800	LF	$504,000	$101,000	$121,000	$726,000
9. New 12-inch Vallejo-Benicia Inter-tie Connection	8,200	LF	$2,440,000	$480,000	$580,000	$3,500,000
10. P-2 Pump station MCC Replacement	1	LS	$208,000	$42,000	$50,000	$300,000
11. Recoating of R-1 Reservoir (interior & exterior)	1	LS	$208,000	$42,000	$50,000	$300,000
12. Recoating of R-2 Reservoir (interior & exterior)	1	LS	$208,000	$42,000	$50,000	$300,000
Raw Water Transmission System						
36-inch RWTL CP Improvements	1	LS	$280,000	$55,000	$65,000	$400,000
36-inch RWTL Improvements - Valve Replacement	1	LS	$140,000	$28,000	$32,000	$200,000

[a] Construction costs based on an ENR Index of 9291 for June 2012 (20 cities average).
[b] Contingency at 20% of baseline construction costs.
[c] Engineering/Admin/Legal/Construction Management Costs at 20% of sum of baseline construction cost and contingency.

WATER TREATMENT PLANT

The City of Benicia's Water Treatment Plant was evaluated on six levels, including: 1) plant capacity; 2) regulatory compliance and safety; 3) treatment process performance, 4) sludge treatment and disposal; 5) electrical systems and controls; and 6) operations. The treatment plant evaluation included the following tasks:

- Reviewing updated water demand projections and determining whether plant capacity will need to increase
- Determining regulatory compliance status
- Assessing treatment process performance as compared to established standards, operational goals, and voluntary targets
- Evaluating sludge treatment and disposal facilities and operations
- Conducting an electrical engineering review of existing electrical panels, switchgear, and control systems
- Identifying necessary operational improvements
- Recommending capital improvement projects

Recommended improvement projects are summarized in Table E-4**.** The table was developed from evaluations of the water treatment plant facilities and operations, discussions with City staff, and review of previous City master plans and capital improvement plans. The total project costs include baseline construction cost, a 20 percent construction contingency, and a 20 percent project contingency for engineering, administrative, legal, and construction management costs.

TABLE E-4
WATER TREATMENT PLANT IMPROVEMENT PROJECTS TO BE CONSIDERED

Project Description	Baseline Construction Cost	Contingency Cost[a]	Engineering/Admin/ Legal/CM Costs[c]	Total Cost
WTP PLC Replacement	$140,000	$28,000	$32,000	$200,000
Chemical Building Electrical Systems and Controls	$480,000	$95,000	$115,000	$690,000
Chemical Tank Farm Improvements	$590,000	$118,000	$142,000	$850,000
Magnetic Ion Exchange System (6 mgd)	$2,440,000	$485,000	$585,000	$3,510,000
Convert from Chlorine Gas to Sodium Hypochlorite Solution	$208,000	$42,000	$50,000	$300,000
Conversion to Polyorthophosphate	$105,000	$20,000	$25,000	$150,000
Re-Line Sludge Lagoons	$1,111,000	$222,000	$267,000	$1,600,000
Replace Backwash Tank 1	$295,000	$60,000	$70,000	$425,000
Re-Coating of Chlorine Contact Tank (Interior and Exterior)	$210,000	$40,000	$50,000	$300,000

[a] Contingency at 20% of baseline construction costs.
[b] Engineering/Admin/Legal/Construction Management Costs at 20% of sum of baseline construction cost and contingency

SUSTAINABILITY AND CLIMATE CHANGE

Incorporating sustainability into the water master plan ensures that the City of Benicia remains a good steward of their water resources.

The City has continuously implemented a water conservation program for more than 20 years. The City's on-going commitment to address sustainability and reduce global warming impacts related to the Water System Master Plan is addressed in this chapter. Effects of climate change resulting from operation of the City water supply system can be influenced in three general areas 1) reducing the operation of facilities by reducing demand; 2) increasing the efficiency of facilities that use energy; and 3) obtaining energy from renewable sources.

The City has a very detailed and goal oriented Climate Action Plan (CAP). The plan inventoried City energy users and concluded that almost 25 percent of the City Government's greenhouse gas (GHG) emissions result from the electricity required to pump, treat, and deliver clean potable water (the subject of this water master plan) and to collect and treat wastewater (see Wastewater System Master Plan).

The CAP established the following three objectives for the City water and wastewater systems (WW). Each objective has several strategies and those are also noted throughout this chapter as they apply:

- Objective WW-1: Reduce the Amount of Water Consumed 20% by 2020
- Objective WW-2: Reduce the Amount of Emissions Resulting from Pumps and Lift Stations
- Objective WW-3: Reduce the Amount of Emissions Resulting from Water and Wastewater Plant Operations 95% by 2020

Climate change and other impacts that occur as a result of global warming present potential challenges for water supply. The City is committed to meet the challenges of climate change by preparing for potential future changes. The City supported the passage of AB 32, the Global Warming Solutions Act, which requires California to cut its greenhouse gas emissions by 25 percent by 2020 and has adopted its own Climate Action Plan. To help mitigate global climate change, the City has aggressive goals to save energy by increasing water facility efficiency, reducing demand with water conservation measures, and reducing the City's role in global warming by considering energy sources that are renewable. To meet future challenges of diminished supplies, the City must prepare for both emergency situations, as well as long term goals. Suggestions and recommendations for further implementing City objectives have been addressed in Section 7 – Sustainability and Climate Change.

CAPITAL IMPROVEMENT PROGRAM

Based on the analysis of the water transmission, distribution, and treatment systems the recommended projects have been developed into a 10-year Capital Improvement Program (CIP) to represent the staged implementation of water system improvements in the distribution system and at the water treatment plant.

Water Distribution System

The recommended improvement projects and cost estimates resulting from the analysis of the water distribution system are shown in Tables E-5 and E-6. Most of the recommended improvement projects are necessary to correct current deficiencies or will immediately improve system operation, performance, and reliability (redundancy), if implemented.

Table E-5 shows the projects that will benefit existing customers, to be funded by the existing general fund. Table E-6 shows the projects that will benefit new customers, to be funded by connection fees. These connection fee project costs are shared with existing customers, and therefore the costs are split between Tables E-5 and E-6. The projects identified in the CIP resulted from the most recent budget preparation concluded prior to completion of this master plan update. The projects are listed in detail in Section 5, and have been staggered over the 10 year period to spread costs to each fiscal year in an effort to balance annual costs. The timing of projects may change as priorities shift, or funding is impacted.

Water Treatment Plant

The water treatment plant projects identified in Table E-7 resulted from the most recent budget preparation concluded prior to completion of this Master Plan update. Projects not completed from the previous CIP were either deleted (no longer necessary) or re-entered into this current list of projects. Electrical and instrumentation upgrades take a high priority in FYs 2013-2015. In subsequent years 2015-2017, conversion from chlorine gas to liquid sodium hypochlorite is planned along with improvements to the chemical tank farm. The major project slated for the treatment plant is construction of the magnetic ion exchange system (MIEX) expected to begin in FY 2017.

The remaining projects are staggered over the 10-year period to spread costs in each fiscal year as much as possible. The timing of projects may change as priorities shift, or funding is impacted. On a 20-year horizon, several projects are listed including large maintenance items such as reservoir recoating and relining of the sludge lagoons.

TABLE E-5
WATER DISTRIBUTION SYSTEM
10-YEAR CAPITAL IMPROVEMENT PROGRAM
OPERATIONS FUND

Project Number	Project	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-32	Total
Distribution System											
1	New 18-inch transmission main in Park Road for Zone 1 (Armory to Oak Road)	$504,000									$504,000
2	New 24-inch DIP in Park Road for Zone I (Reliability)					$357,000					$357,000
3	Replace 6-inch DIP in Jefferson Street (Grant Street to Park Road)		$110,000								$110,000
4	New 12-inch DIP in Adams Street (Grant Street to Bayshore Road)		$39,500[a]								$39,500
5	New 12-inch DIP in Military West (West 6th Street to Plaza de Oro)			$330,500[a]							$330,500
6	New 8-inch DIP to loop Drolette Way with Corrigan Court				$17,000[a]						$17,000
7	New 12-inch DIP in Zone III to serve Pressure Zone 3-A				$95,000[a]						$95,000
8	New 36-inch transmission main (Reliability from WTP to East 2nd Street)					$726,000					$726,000
9	Benicia-Vallejo Inter-tie									$3,500,000	$3,500,000
10	P-2 Pump Station MCC Replacement				$300,000						$300,000
11	Recoating of R-1 Reservoir (interior & exterior)									$300,000	$300,000
12	Recoating of R-2 Reservoir (interior & exterior)									$300,000	$300,000
Raw Water Transmission System											
	36-inch RWTL CP Improvements	$200,000	$200,000								$400,000
	36-inch RWTL Improvements	$200,000									$200,000
	Totals	**$904,000**	**$349,500**	**$330,500**	**$412,000**	**$1,083,000**	**$0**	**$0**	**$0**	**$4,100,000**	**$7,179,000**

[a] This cost represents half of the total project cost. The project cost is shared equally with the Connection Fee Fund (see Table E-6)

TABLE E-6
WATER DISTRIBUTION SYSTEM
10-YEAR CAPITAL IMPROVEMENT PROGRAM
CONNECTION FEE FUND[a]

Project Number	Project	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-32	Total
4	New 12-inch DIP in Adams Street (Grant Street to Bayshore Road)		$39,500[b]								$39,500
5	New 12-inch DIP in Military West (West 6th Street to Plaza de Oro)			$330,500[c]							$330,500
6	New 8-inch DIP to loop Drolette Way with Corrigan Court				$17,000[d]						$17,000
7	New 12-inch DIP in Zone III to serve Pressure Zone 3-A				$95,000[e]						$95,000
	Totals	**$0**	**$39,500**	**$330,500**	**$112,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$482,000**

[a] The cost for each of these projects represents half of the total project cost. The project cost is shared equally with the Operations Fund (see Table E-5)
[b] Total project cost is estimated at $79,000.
[c] Total project cost is estimated at $661,000.
[d] Total project cost is estimated at $34,000.
[e] Total project cost is estimated at $190,000.

TABLE E-7
WATER TREATMENT PLANT
10-YEAR CAPITAL IMPROVEMENT PROGRAM
OPERATIONS FUND

Project	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-32	Total
WTP PLC Replacement	$200,000									$200,000
Chemical Building Electrical Systems and Controls		$690,000								$690,000
Chemical Tank Farm Improvements			$250,000	$600,000						$850,000
Magnetic Ion Exchange System (6 mgd)					$800,000	$2,710,000				$3,510,000
Conversion from Chlorine Gas to Sodium Hypochlorite			$300,000							$300,000
Conversion to Polyorthophosphate							$150,000			$150,000
Re-Line Sludge Lagoons									$1,600,000	$1,600,000
Replace Backwash Tank 1									$425,000	$425,000
Recoating of Chlorine Contact Tank (interior & exterior)									$300,000	$300,000
Totals	**$200,000**	**$690,000**	**$550,000**	**$600,000**	**$800,000**	**$2,710,000**	**$150,000**	**$0**	**$2,325,000**	**$8,025,000**

SECTION 1 – INTRODUCTION

The City of Benicia (City) has been following a plan outlined in its 1996 Water System Master Plan for maintaining a water system that is reliable with regard to supply and quality. In the past 16 years, significant changes in the economy and regulatory environment have made it clear that an updated planning effort and guide document was required in order to properly maintain and upgrade the City's water system. Preparing an update of the Water System Master Plan will provide a fresh look and solid foundation on which to base future decisions regarding improvements to, and operation and maintenance of treatment, transmission, distribution, and storage facilities.

In particular, the City wishes to account for:

- Growth occurring at a slower pace and in different locations than predicted in the 1996 Water System Master Plan and previous studies
- The need for assessment of existing facilities to improve operational performance
- Changing drinking water regulations, particularly with respect to distribution system water quality
- Reliability of water sources, both in quantity and quality

The City has identified key objectives for the 2012 Water System Master Plan update. These objectives are to:

- Address water quality concerns of the City's system for meeting existing and future requirements of the California Department of Public Health (CDPH)
- Identify sources and facilities required to meet future drinking water demands of the City for the next 20 years
- Consider sustainability and the potential for meeting the objectives of the City's Climate Action Plan for water facilities
- Develop a Capital Improvement Program

PREVIOUS STUDIES

The City has historically undertaken master planning studies to plan for future development and guide expansion and improvement of the water transmission, distribution and treatment facilities. Water System Master Plans were prepared in 1977, 1990, and most recently in 1996. This 2012 Water System Master Plan update will provide the City with a comprehensive guide to providing reliable, high quality, and reasonably priced drinking water to its customers.

Previous reports reviewed for incorporation into this document include the following:

Water System Master Plan, Camp Dresser & McKee, November 1990
Water System Master Plan, Montgomery Watson, September 1996
Urban Water Management Plan, Camp Dresser & McKee, June 2011
Benicia Climate Action Plan, City of Benicia, September, 2009

OBJECTIVE

The primary objective of this Water System Master Plan update is development of a comprehensive plan for expansion and implementation of the water system improvements required to meet current and future projected water demands. This plan extends through the estimated ultimate (buildout) development of the City. Improvement projects have been outlined for the next ten years, with additional projects identified through 2032. The following major scope tasks were performed in this study:

- Establish planning and engineering criteria
- Update the City's water demand forecasts and water supply projections
- Develop a hydraulic network model and analyze the water distribution system
- Investigate water treatment options
- Evaluate the feasibility of reclamation
- Address sustainability and climate change
- Prepare the water system master plan report

OUTLINE OF REPORT

This master plan report includes the following sections:

- Executive Summary
- Section 1 - Introduction
- Section 2 - Water Demand Forecasts
- Section 3 - Water Supply Sources
- Section 4 - Existing Water System
- Section 5 - Distribution System Evaluation
- Section 6 - Water Treatment Plant Evaluation
- Section 7 - Sustainability and Climate Change
- Section 8 - Capital Improvement Program
- Appendix A - Water Supply Agreements
- Appendix B - Technical Memorandum – Regulations Review

SECTION 2 – WATER DEMAND FORECASTS

The existing and projected water demands for the City of Benicia water system are presented in this section. Water demands are projected in five-year increments through buildout in the year 2035.

STUDY AREA CHARACTERISTICS

Founded in 1847, the City of Benicia is a waterfront city containing historic buildings and military establishments, industry, and new residential developments upon a backdrop of rolling hills. Bordering the Carquinez Strait and Suisun Bay, Benicia's neighbors include the City of Vallejo to the west and the City of Martinez across the Carquinez Strait to the south. Demographic characteristics and climate both affect water use and are thus discussed herein.

Study Area

The current City water service area is within the city limits. The city limits roughly include the borders the Vallejo city limit line (west of Rose Drive) to the west, Lake Herman to the north, Carquinez Strait to the south, and Suisun Bay to the east, as shown in Figure 2-1. The future service area boundary is the sphere of influence boundary shown in the 2003 Benicia General Plan Land Use map.

Demographic Characteristics

Benicia's historical growth, presented in Table 2-l, has been somewhat sporadic with the largest influx occurring in the 1940s and again in the 1970s. The 1980s showed a decline in the growth rate. The first half of the 1990s has seen renewed growth in the area, which have stalled somewhat in the 2000s. The population projections presented in Table 2-2 are from the Association of Bay Area Governments (ABAG) Projections and Priorities 2009, and are consistent with population projections presented in the 2010 Urban Water Management Plan.

TABLE 2-1
HISTORICAL POPULATION

Year	Population
1940[a]	2,419
1950[a]	7,284
1960[a]	6,070
1970[a]	7,352
1980[a]	15,376
1990[a]	25,342
2000[b]	26,865
2010[b]	28,086

[a] Benicia General Plan, 1993
[b] Benicia Urban Water Master Plan, 2010

LEGEND

- BENICIA CITY LIMITS BOUNDARY
- LOT/PROPERTY LINE
- STREET/ROAD/HIGHWAY RIGHT-OF-WAY LINE
- SHORE LINE/EDGE OF WATER BODY
- INTERSTATE HIGHWAYS

N

0 3700 7400

1" = 3700'

FIGURE 2-1

CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

SERVICE AREA

NV5 BEYOND ENGINEERING

TABLE 2-2
POPULATION AND HOUSEHOLD FORECASTS[a]

	2010	2015	2020	2025	2030	2035
Population	28,086	28,515	28,943	29,372	29,800	30,100
Households	10,522	10,805	11,065	11,330	11,600	11,680
Population Growth %	--	1.5	1.5	1.5	1.5	1.0

[a] From Association of Bay Area Governments, Projections and Priorities, 2009

Climate

Benicia has an inland coastal maritime climate typified by cool, wet winters with significant periods of fog and warm, dry summers with frequent cooling sea breezes from the west. Water demand in the City service area increases in the summer months due to outdoor irrigation. Total precipitation in Benicia averages about 20 inches per year and falls mostly between December and April. Typically, July and August are the hottest months of the year with an average high temperature of 87 degrees Fahrenheit. December and January are the coolest months with an average low temperature of 39 degrees Fahrenheit, as shown in Table 2-3. Evapotranspiration (ET) follows a similar trend as temperature, peaking in July and decreasing in January.

TABLE 2-3
CLIMATE DATA

Month	Monthly Average Maximum Temperature[a], ºF	Monthly Average Minimum Temperature[a], ºF	Monthly Average Precipitation[a], in	Monthly Average Evapotranspiration[b], in
January	54	39	4.25	1.3
February	60	42	3.81	1.4
March	64	44	3.24	2.7
April	71	46	1.04	3.8
May	78	50	0.46	4.9
June	84	54	0.12	5.0
July	87	55	0.02	6.4
August	87	55	0.08	5.5
September	83	54	0.24	4.4
October	75	49	0.94	2.9
November	63	43	2.59	1.2
December	55	39	2.79	0.7
Annual	72	48	19.58	40.3

[a] Average Weather for Benicia, CA, www.weather.com
[b] California Code of Regulations, Title 23, Chapter 2.7, Model Water Efficient Landscape Ordinance

WATER DEMAND DEVELOPMENT METHODOLOGY

The water demand forecasts described and presented below were developed based on land use projections and water use factors. The land use projection methodology ties the forecasts to actual planned land use as designated by the City's Community Development Department. The

December 2011 Zoning Map, provided by the Community Development Department, is used throughout this section. The land use designations presented in the zoning map are subject to long-range planning decisions made by the City Council which involve public scrutiny to reduce perceived growth-inducing conflicts.

Separate water forecasts were developed for: (1) treated water production; (2) Raw water demands for the Valero Refinery (Valero); and (3) the City's total water supply needs, which is equivalent to the sum of treated water production and Valero's raw water demands. For each of the three forecasts, three water use projections--high, baseline, and low--were developed to provide a probable range of future water use.

Existing (2010) consumption and production data were obtained from the City's meter data records and raw water flow meter at the water treatment plant (WTP). These data were used as an existing condition basis upon which the baseline projections were built. The City's consumption and production data were reconciled with data provided in the 2010 Urban Water Management Plan (UWMP). Future water demands in five year increments through 2035 presented in the 2010 UWMP are used to predict future water demands. The UWMP water demand projections are based on the population predictions presented in Table 2-2. Baseline raw water demand forecast for the Valero refinery, was extrapolated from historic demands. The refinery was previously operated by Exxon. The baseline projection for the City's total water supply needs was the summation of the baseline forecasts for the treated water demands plus Valero's raw water demands.

The high water use curve was developed by assuming that the industrial water use increases to twice the water use forecasted in the baseline projection, and the Valero raw water used increases by ten percent over the baseline water use.

Low curves were developed by assuming that planned development occurs to only 80 percent of that projected at baseline conditions and that water conservation contributes to a 10 percent reduction in water demands for both treated water and Valero's raw water. This results in a total treated water reduction of 72 percent. Raw water use is assumed to be reduced by ten percent.

HISTORICAL WATER USE

The City contracts to receive raw water from the North Bay Aqueduct (NBA) through agreements with the Solano County Water Agency (SCWA) for State Water Project (SWP) water and with the California Department of Water Resources (DWR) for Settlement Water. The City also receives water from the Solano Water Project through agreements with the City of Vallejo and the Solano Irrigation District (SID). These raw water supplies are delivered to the City's WTP. Roughly half of the City's raw water demand is for Valero. The refinery has an onsite treatment plant for producing water for their own industrial water uses. The remaining raw water is treated at the City's WTP. Water supplies can be stored at Lake Herman, which has an approximate capacity of 1,400 AF. Water stored in Lake Herman is captured through storm water runoff or impounded from excess raw water diversion from the WTP. The City's water supply sources are detailed in Section 3.

Historical Treated Water Demands

Historical water production and consumption data were analyzed to determine appropriate peaking factors, system losses, and other parameters to estimate and allocate existing and projected future water demands. Treated water production data are based on flow meter records of raw water delivered to the water treatment plant. Consumption data were compiled from customer billing records based on water meter readings. Raw water demands are discussed in the final paragraphs of Section 2.

From 2002 to 2011, the annual production of the water treatment plant ranged from 1,783.5 to 2,175.8 million gallons per year (MG/year), corresponding to annual average day demands of 4.89 million gallons per day (mgd) and 5.96 mgd, respectively. Historical annual water production totals from the Benicia WTP are presented in Table 2-4. Historical monthly water production is presented in Table 2-5.

TABLE 2-4
HISTORICAL ANNUAL WATER PRODUCTION

Year	Total Production, MG/yr	Average Total Production, mgd
2002	2,136.8	5.85
2003	2,034.0	5.57
2004	2,176.5	5.95
2005	1,973.7	5.41
2006	1,930.4	5.29
2007	2,175.8	5.96
2008	2,127.0	5.81
2009	1,919.6	5.26
2010	1,783.5	4.89
2011	1,833.5	5.02

TABLE 2-5
HISTORICAL MONTHLY PRODUCTION

	Monthly Production (MG)									
Month	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
January	103.8	111.3	108.0	100.9	104.4	120.5	107.4	110.4	101.0	100.5
February	98.0	100.6	99.3	90.7	96.8	104.3	102.9	97.6	87.2	93.5
March	121.7	118.9	139.9	99.2	98.7	143.9	145.2	114.7	108.4	99.9
April	166.5	131.1	194.3	128.7	99.1	173.2	191.9	159.2	113.9	130.7
May	206.2	177.6	237.7	171.7	182.6	221.5	222.9	185.3	155.3	188.5
June	239.5	233.5	248.4	220.6	219.5	244.1	228.9	207.8	201.9	182.2
July	261.4	261.6	261.0	254.6	245.0	261.6	243.7	229.2	226.2	216.0
August	250.8	238.9	250.8	248.2	211.8	258.6	243.6	225.8	216.5	215.6
September	230.2	216.6	236.0	217.7	223.9	223.9	213.1	205.8	201.1	200.3
October	206.5	206.4	173.9	192.9	199.2	169.7	190.1	156.2	157.1	165.5
November	134.8	129.8	115.2	139.2	132.4	138.2	125.4	122.2	110.4	122.9
December	117.4	107.7	112.0	109.3	117.0	116.3	111.9	105.3	104.4	117.9
Total	2,136.8	2,034.0	2,176.5	1,973.7	1,930.4	2,175.8	2,127.0	1,919.6	1,783.5	1,833.5
Monthly Average, MG	178.1	169.5	181.4	164.5	160.9	181.3	177.3	160.0	148.6	152.8
Annual Average, mgd	5.85	5.57	5.95	5.41	5.29	5.96	5.81	5.26	4.89	5.02

Large Treated Water Users

Billing data for 2011 was tabulated to provide a list of the City's largest users of treated water. The top ten water users include industrial refineries, homeowners associations, and school districts. The list will be used to target point sources where necessary while calibrating the hydraulic model. The top ten water users consumed 737 acre-feet per year (AFY), or 40 percent of treated water in 2011. The ten largest users of treated water in 2011 are shown in Table 2-6.

TABLE 2-6
LARGE TREATED WATER USERS

		2011 Demand	
Rank	**Customer Name**	**gpd**	**AFY**
1	City of Benicia[a]	293,021	328.25
2	Valero Refining Company	79,198	88.72
3	Club Pacifica	42,458	47.56
4	Bay Vista Homeowners Association	41,232	46.19
5	Benicia Unified School District	39,287	44.01
6	Water View PMG	38,482	43.11
7	The Terrace Townhouse	34,560	38.71
8	Hillsboro Properties	31,574	35.37
9	Benicia Highland Homeowners Association	31,363	35.13
10	Bayview Villas	26,524	29.71
Total			736.76

[a] City of Benicia demand includes all City accounts.

Non-Revenue Water

Non-Revenue Water (NRW) accounts for system losses at the treatment plant and throughout the distribution system. NRW is determined by comparing the amount of water produced at the WTP with the amount of metered water delivered during the same time period. NRW was calculated for years 2000 through 2011, and is presented in Table 2-7.

TABLE 2-7
NON-REVENUE WATER

Year	Treated Water Volume, AFY	Total Metered Deliveries, AFY	Non-Revenue Water, AFY	Non-Revenue Water, %
2000	5,703	4,990	713	12.5%
2001	5,848	5,230	618	10.6%
2002	5,645	5,454	191	3.4%
2003	5,889	5,077	812	13.8%
2004	6,271	5,619	652	10.4%
2005	5,883	5,000	883	15.0%
2006[a]	5,641	4,989	652	12.1%
2007[a]	6,412	4,661	1,285	23.4%
2008[a]	6,251	4,777	1,161	22.2%
2009	5,777	4,517	1,260	21.8%
2010	5,500	4,183	1,317	23.9%
2011	5,608	4,195	1,413	25.2%

[a] Supply volume adjusted to account for faulty meter readings.

As seen in Table 2-7, NRW ranged from 3.4 to 25.2 percent of the total water treated. NRW averaged 16.2 percent. In 2007, the flow meter probe was found to be too short for the diameter of pipe carrying water from the WTP. Flows measured prior to 2007 were underestimated due to the faulty flow meter probe. As seen in Table 2-7, the highest percentages of NRW are observed from 2007 to the present, with an average of 23.3 percent. The typical water conservation goal for California cities is to keep NRW below 10 percent. All water systems have some level of non-revenue water, typically between 10 to 20 percent of total demand.

PEAKING FACTORS

Peaking factors represent the increase above the average annual demands and are used to calculate the water demands expected under varying demand conditions. The resulting demand conditions are used in the hydraulic analysis of the distribution system. Typical peaking factors necessary for the hydraulic evaluation and sizing of improvements include maximum day to average day demand, peak hour to maximum day demand (MDD), and maximum month to average month demand. Peaking factors are obtained from a review of historical data and experiences from neighboring water systems.

Average Day of Maximum Month

Average Day of Maximum Month is defined as the average day demand for the month of highest water demand during the year, expressed as a multiplier of average daily annual demand. This factor is used primarily in the evaluation of supply capabilities. Review of the City's monthly water production data indicate an average day in the maximum month to average annual demand ratio ranging from 1.3 to 1.5.

Maximum Day Demand

The MDD peaking factor is the ratio of the maximum flowrate into the plant to the average daily flowrate for the year. Water transmission, treatment, and pumping facilities are typically sized for MDD. Water flow records from 2007 through 2011 were obtained from the City and reviewed to determine the maximum daily raw water flowrate entering the plant. Records prior to 2007 were not considered due to the underestimation of flow caused by a faulty flow meter probe. The average annual and maximum daily flowrates are shown in Table 2-8. The maximum day peaking factor ranges from 1.4 to 1.5. To be conservative, the average peaking factor during this time period is 1.5, which is used in the hydraulic model. This factor is within the American Water Works Association (AWWA) criterion of 1.2 to 2.5 times average day demand for similar water systems with gravity storage capacity.

TABLE 2-8
MAXIMUM DAY PEAKING FACTORS

Year	Month of Maximum Day Demand	Production, mgd: Peak Month Maximum Day Demand	Production, mgd: Annual Average Day Demand	Maximum Day Peaking Factor
2007	July	6.9	4.9	1.4
2008	August	6.2	4.7	1.4
2009	July	7.3	5.2	1.4
2010	July	7.4	4.9	1.5
2011	August	6.9	5.0	1.4

Peak Hour Demand

The peak hour demand factor is the ratio of the highest hourly flowrate into the plant to the maximum daily flowrate, and represents the highest diurnal flowrate. Peak hour demands are typically met by utilizing water in water storage facilities. Based on discussions with City staff, comparison with similar water systems, previous studies, and the maximum day diurnal flow records, a peak hour factor of 1.6 will be used in the hydraulic evaluation. AWWA criteria indicate that peak hour demands generally range from 1.3 to 2.0 times the MDD.

Maximum Month Demand

An indicator of the seasonal fluctuation of raw water flows entering the plant is the ratio of the maximum monthly flow to the average monthly flow for the year, as shown in Table 2-9. These ratios ranged from a low of 1.35 in 2008 to a high of 1.53 in 2010. Data prior to 2007 was not considered due to an underestimation of flow caused by a faulty flow meter probe. The average maximum month flow demand factor from 2007 to 2011 is 1.43.

TABLE 2-9
MAXIMUM MONTH PEAKING FACTORS

Year	Month of Maximum Day Demand	Production, mgd: Maximum Month Total Flow	Production, mgd: Average Annual Monthly Flow	Maximum Month Peaking Factor
2007	July	214	149	1.44
2008	August	192	142	1.35
2009	July	226	157	1.44
2010	July	228	149	1.53
2011	August	215	152	1.41
Average				1.43

FUTURE LAND USES

Future land use information was obtained from the City's General Plan and the December 2011 Zoning Map. Land use categories were used for compiling future land use acreages, and are described in Table 2-10.

TABLE 2-10
LAND USE DESCRIPTIONS

Land Use Designation	Description
Open Space	Includes urban open space (publicly-owned open space land dedicated for permanent open space in residential subdivisions); open space for public health and safety (hillsides with slopes over 30 percent); rural open space (space for managed production of resources); and open space for conservation of natural resources (Lake Herman watershed).
Park	Publicly-owned neighborhood, community, and regional parks; golf courses.
Public & Quasi-Public	Includes variety of public services, such as education (schools), police, fire, water, and sewer facilities.
Low Density Family Residential	Single family homes (0-7 dwelling units per acre (du/ac))
Medium Density Residential	Multifamily residences (8-14 du/ac)
High Density Residential	Multifamily residences (15-21 du/ac)
Community Commercial	Convenience commercial centers, limited in size (formerly Neighborhood Commercial).
Office Commercial	Small scale offices intended to serve as a buffer between residential uses and more intensive commercial areas. This category typically generates lower traffic volumes than offices in other commercial or industrial districts (formerly Business and Professional Offices).
General Commercial	Primary shopping centers, auto service and parts shops, retail sales, offices, and shops.
Downtown Commercial (Town Core)	First Street Corridor between Solano Square and Historic Triangle. Relatively intense commercial development while providing pedestrian and historical orientation.
Waterfront Commercial	Pedestrian-scale commercial and residential area with both water orientation and historic character. Commercial component restricted to retail shops and services that directly support marina and boating activities or restaurants overlooking the water.
Limited Industrial	Manufacturing, assembly, and packaging of goods primarily from previously prepared materials; wholesale, distribution, and storage facilities; research and development facilities; and related industrial and commercial services.
General Industrial	Manufacturing, assembly, and packaging of goods and products from extracted, raw, and previously prepared materials and related industrial and commercial services. Least restrictive of industrial categories to allow flexibility.
Water Related Industrial	Includes port terminals and water-dependent, related industrial uses such as warehousing and storage; supporting transportation services; and ship maintenance and repair.
Industrial Park	Landscaped settings for industrial office centers, research and development facilities, limited industrial activities, and small-scale warehousing distribution.
Town Core – Open	Currently open space, planned for future Town Center land use development.
Valero Buffer	Open space area to provide a buffer between the Valero refinery and other development in the City. The buffer is zoned as Light Industrial and General Industrial in the December 2011 Zoning Map; however, this area has not been included in previous water demand estimates.
Neighborhood General	This is a zoning designation intended to protect the integrity and quality of the downtown residential neighborhoods.
Neighborhood General - Open	Currently open space, planned for future Neighborhood General land use development.

Future growth is based on the population projections in ABAG's Projections and Priorities 2009. Figure 2-2 indicates the location of planned future development. Future growth includes small infill projects throughout the City as well as the 500-acre Benicia Business Park (Seeno Property). The business park is proposed to include 35-acres of commercial uses, 150 acres of limited industrial uses and 315 acres of open space. The Benicia Business Park is currently on hold.

Year 2035 is the General Plan buildout date and extent of the Water System Master Plan and UWMP planning horizons. Demands resulting from this methodology are approximately phased; demands could occur earlier or later in the planning horizon but ultimately reflect full buildout of General Plan land use.

In addition, Figure 2-2 shows a Valero buffer zone which has General Plan land uses of general and light industrial, but is assumed to remain open space as a buffer between Valero's refinery and residential and other community development. This land is not included in expected buildout.

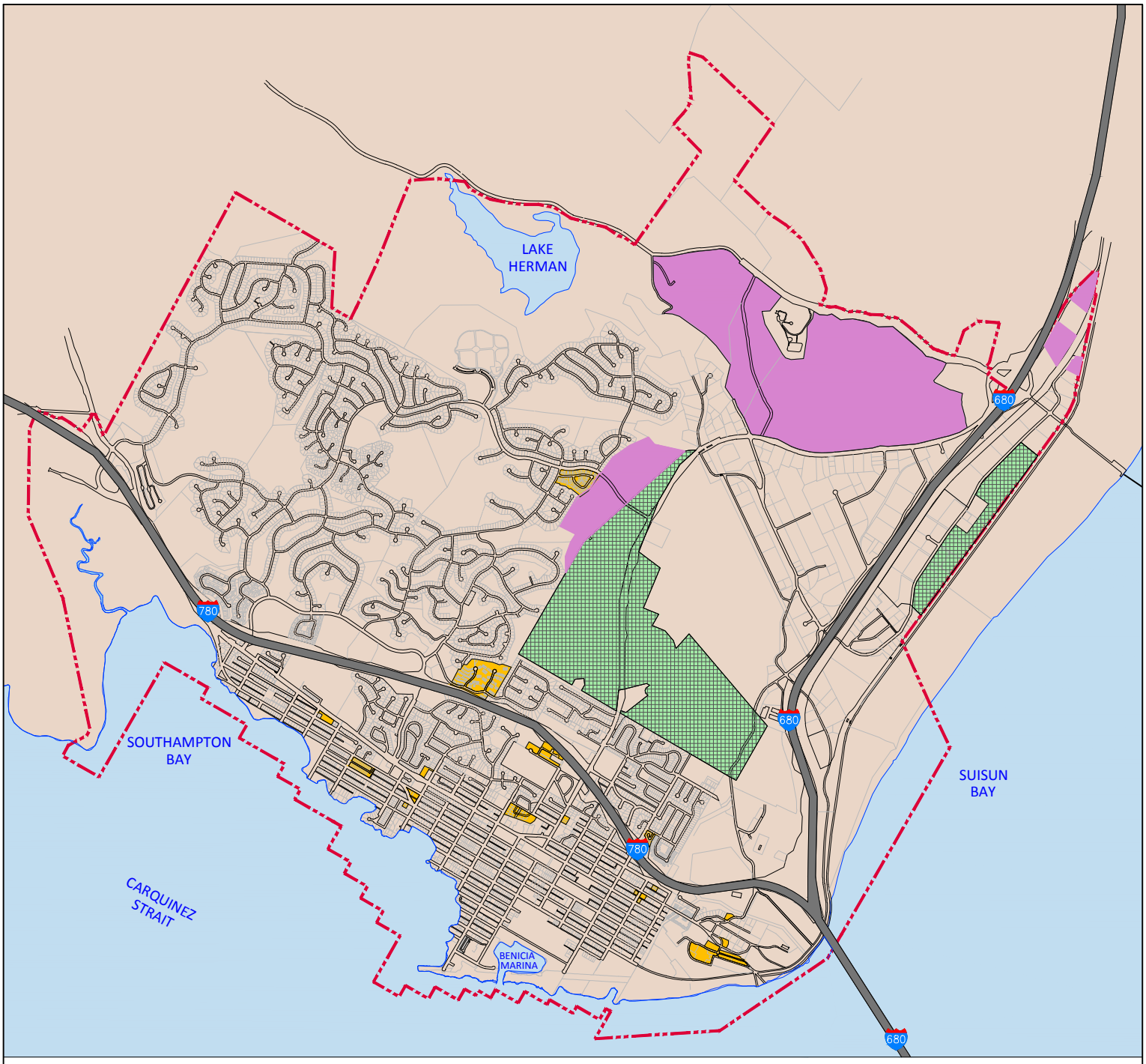
The land use categories used in the December 2011 Zoning Map are largely the same as described in the 1999 General Plan. Exceptions include the Town Center, Industrial Park, and Neighborhood General land uses shown in the December 2011 Zoning Map. Town Center land use is assumed to be equivalent to Downtown Commercial described in the General Plan. The Industrial Park land use is assumed to be more concentrated than other industrial land uses. The Neighborhood General land use is used in the Downtown Mixed Use Master Plan Zoning District shown on the December 2011 Zoning Map, and is assumed to be similar to the Community General land use described in the General Plan.

The Valero Buffer land use is not shown on the December 2011 Zoning Map or described in the 1999 General Plan. The Valero Buffer is located in land use shown as Limited Industrial and General Industrial on the December 2011 Zoning Map; however, no development will be permitted within the area to provide a buffer between the Valero refinery and other development in the City.

WATER USE FACTORS

Water use factors were developed for the future land use categories based on historical use in Benicia and experience with water service areas with similar study area characteristics. Industrial use is quite variable and is described in greater detail herein. The water use factors will be used as the basis for accurately developing the future water use factors.

Water use factors for existing land uses, shown in Table 2-11, were estimated using water consumption data provided by the City. Residential demand factors were determined by isolating a land use area, identifying the water consumption data for that sample area, and then dividing the water consumption by the number of units in the sample area. Other demand factors (non-residential) were determined by dividing water consumption by the acreage within that sample area. After calculating the City demands, we reviewed demand factors used in other Cities within the county. The calculated demand factors are similar to demand factors used in nearby Cities.



LEGEND

- BENICIA CITY LIMITS BOUNDARY
- LOT/PROPERTY LINE
- STREET/ROAD/HIGHWAY RIGHT-OF-WAY LINE
- SHORE LINE/EDGE OF WATER BODY
- INTERSTATE HIGHWAYS
- PD PLANNED DEVELOPMENT
- UB BUFFER/UNDEVELOPABLE
- IL LIMITED INDUSTRIAL

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0 3700 7400

1" = 3700'

FIGURE 2-2

CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

PLANNED FUTURE LAND USE

NV5 BEYOND ENGINEERING

TABLE 2-11
BASELINE WATER USE FACTORS

	Demand Factor	
Land Use	**gpd/du**	**gpd/ac**
Open Space (OS)	--	0
Park (PK)	--	1,700
Public & Semi-Public (PS)	--	700
Single Family Residential (RS)	300	--
Medium Density Residential (RM)	240	--
High Density Residential (RH)	--	2,750
Planned Development (PD)	--	0
Community Commercial (CC)	--	1,300
Office Commercial (CO)	--	775
General Commercial (CG)	--	1,850
Downtown Commercial (Town Core, CD)	--	2,500
Waterfront Commercial (CW)	--	1,450
Limited Industrial (IL)	--	200
General Industrial (IG)	--	425
Water Related Industrial (IW)	--	200
Industrial Park (IP)	--	2,500
Town Core – Open (TC-O)	--	0
Valero Buffer (VB)	--	0
Neighborhood General (NG)	--	1,400
Neighborhood General – Open (NG-O)	--	0

WATER DEMANDS

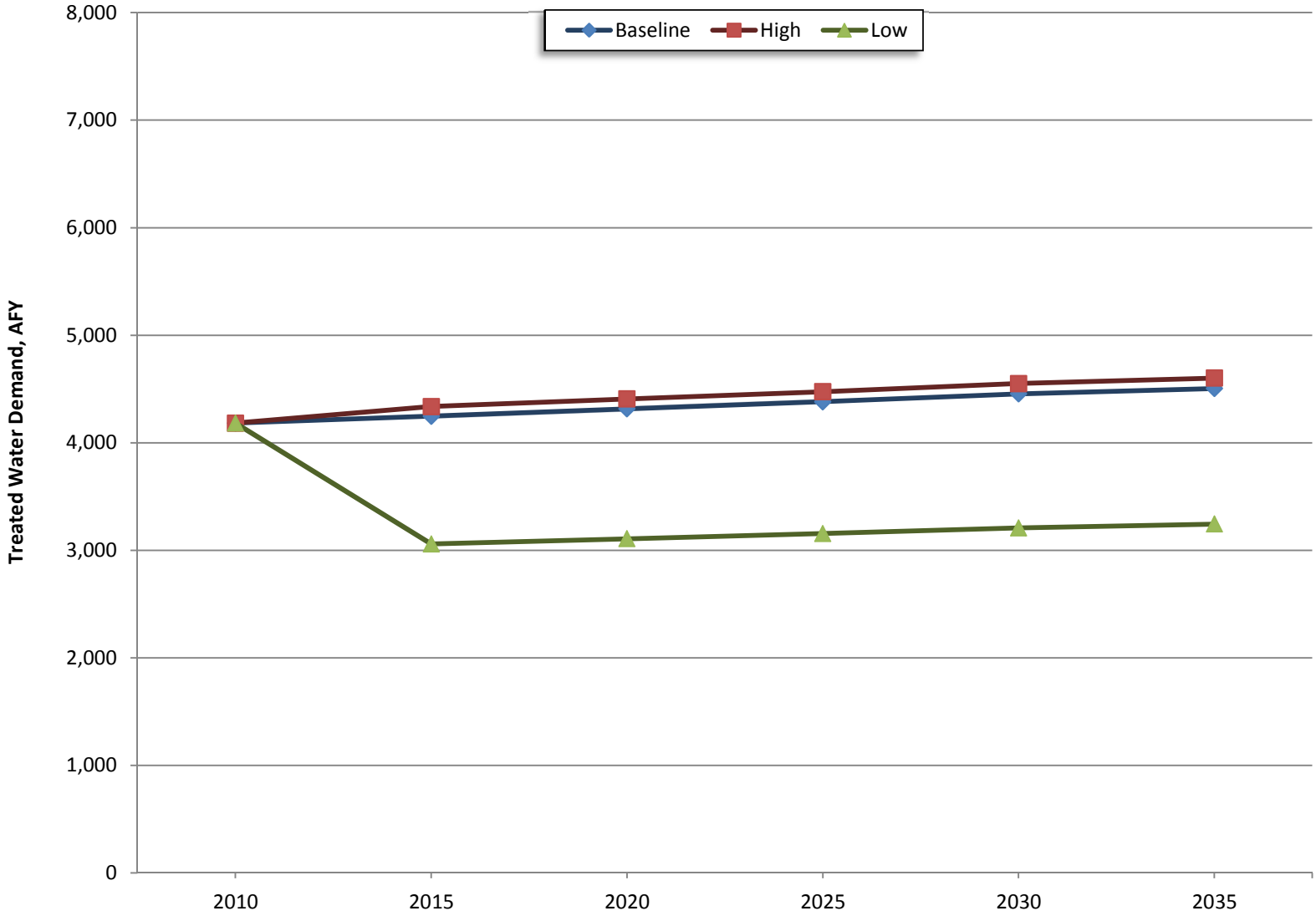
Production and consumption data for October 2009 through August 2011 was obtained from the City and was used to develop existing treated water demands. Treated water production data and Valero's raw water demand data were used to develop existing raw water supply needs.

Treated Water Demands

Treated water demands are necessary for preparation of the Urban Water Management Plan, for water supply planning purposes, and for development of the hydraulic model. Three treated water production demand curves have been developed as a result of the information and methodology described previously to meet the analysis needs of these three efforts. Comparisons of the forecasts are provided in Table 2-12 and Figure 2-3.

TABLE 2-12
TREATED WATER DEMAND FORECAST COMPARISON

Year	2010		2015		2020		2025		2030		2035	
	mgd	AFY	mgd	AFY	mgd	AFY	mgd	AFY	mgd	AFY	mgd	AFY
High	3.73	4,183	3.87	4,337	3.93	4,407	3.99	4,475	4.06	4,550	4.11	4,601
Baseline	3.73	4,183	3.79	4,247	3.85	4,315	3.91	4,382	3.98	4,455	4.02	4,505
Low	3.73	4,183	2.73	3,058	2.77	3,107	2.82	3,155	2.86	3,208	2.90	3,244



CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

TREATED WATER DEMAND FORECAST

FIGURE 2-3

Baseline Treated Water Demands. A baseline forecast was developed assuming no additional conservation from 2009-11 levels would occur in the future. Baseline water demand forecasts presented in the 2010 UWMP were used for the water demand. Forecast consumption for the various land use categories were summarized to provide the baseline treated production projection shown in Table 2-13.

TABLE 2-13
BASELINE TREATED WATER DEMAND FORECAST BY CATEGORY

	Water Consumption, AFY					
Water Use Category	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Single Family Residential	2,701	2,743	2,786	2,830	2,876	2,909
Multi-Family Residential	467	474	482	489	497	503
Commercial/Institutional	381	387	393	399	406	410
Industrial	89	90	92	93	95	96
Irrigation	536	544	553	562	571	577
Other	9	9	9	9	10	10
Total	**4,183**	**4,247**	**4,315**	**4,382**	**4,455**	**4,505**

The projected water consumption shown in Table 2-13 includes increased water demands from the infill projects and the Benicia Business Park project (Seeno Property). Because of the uncertainty in the phasing of the future projects, water consumption is assumed to increase proportionately to the population growth.

High Treated Water Demands. The high treated water demand scenario is developed to capture the variability of water use at industrial land uses. The high treated water demand assumes that industrial water use is twice the baseline industrial water use.

Low Treated Water Demands. The third demand estimate assumes a future conservation effort that would save ten percent of baseline production as a result of a proactive water conservation program and assumes that actual City buildout will only be 80 percent of estimated baseline buildout. The combination of the conservation and buildout reduction results in a 72 percent reduction in water use. This estimate is important to consider for the hydraulic model evaluation and facilities planning.

Valero's Benicia Refinery - Raw Water Demands

In addition to the demands for treated water, the City provides a significant portion of its raw water supply to meet the raw water needs of the Valero Refinery. Valero has a contractual agreement of up to 5,800 AFY maximum annual delivery (5.2 mgd), which theoretically can be requested with one month's notice. Since 2002, raw water demand for the refinery has ranged from 4,528 AFY to 4,849.9 AFY. Valero's historic and baseline projected raw water demands are shown in Table 2-14. Water use for the Valero refinery projected in the 2010 UWMP Update is used for future water demand at the refinery.

TABLE 2-14
VALERO REFINERY HISTORICAL AND PROJECTED RAW WATER DEMAND

Year Historical	Demand, AFY
2002	4,695.2
2003	4,717.1
2004	4,528.1
2005	4,849.9
2006	4,701.1
2007	4,672.1
2008	4,777.4
2009	4,738.3
2010	4,792.1
2011	4,570.6
Projected	
2015	5,296
2020	5,800
2025	5,800
2030	5,800
2035	5,800

Total Raw Water Demands

The total amount of raw water supply the City is projected to need, based on treated water demands and raw water projections at the baseline level, and is shown in Table 2-15. Raw water projections include raw water for the Valero refinery and operations raw water used for treatment processes at the WTP and surplus raw water supply that bypasses the treatment plant and is stored in Lake Herman for future emergency use. The projected total raw water demands are expected to increase from approximately 10,863 AFY in 2010 to 11,940 AFY in 2035, an increase of over 1,077 AFY.

TABLE 2-15
BASELINE RAW WATER DEMANDS

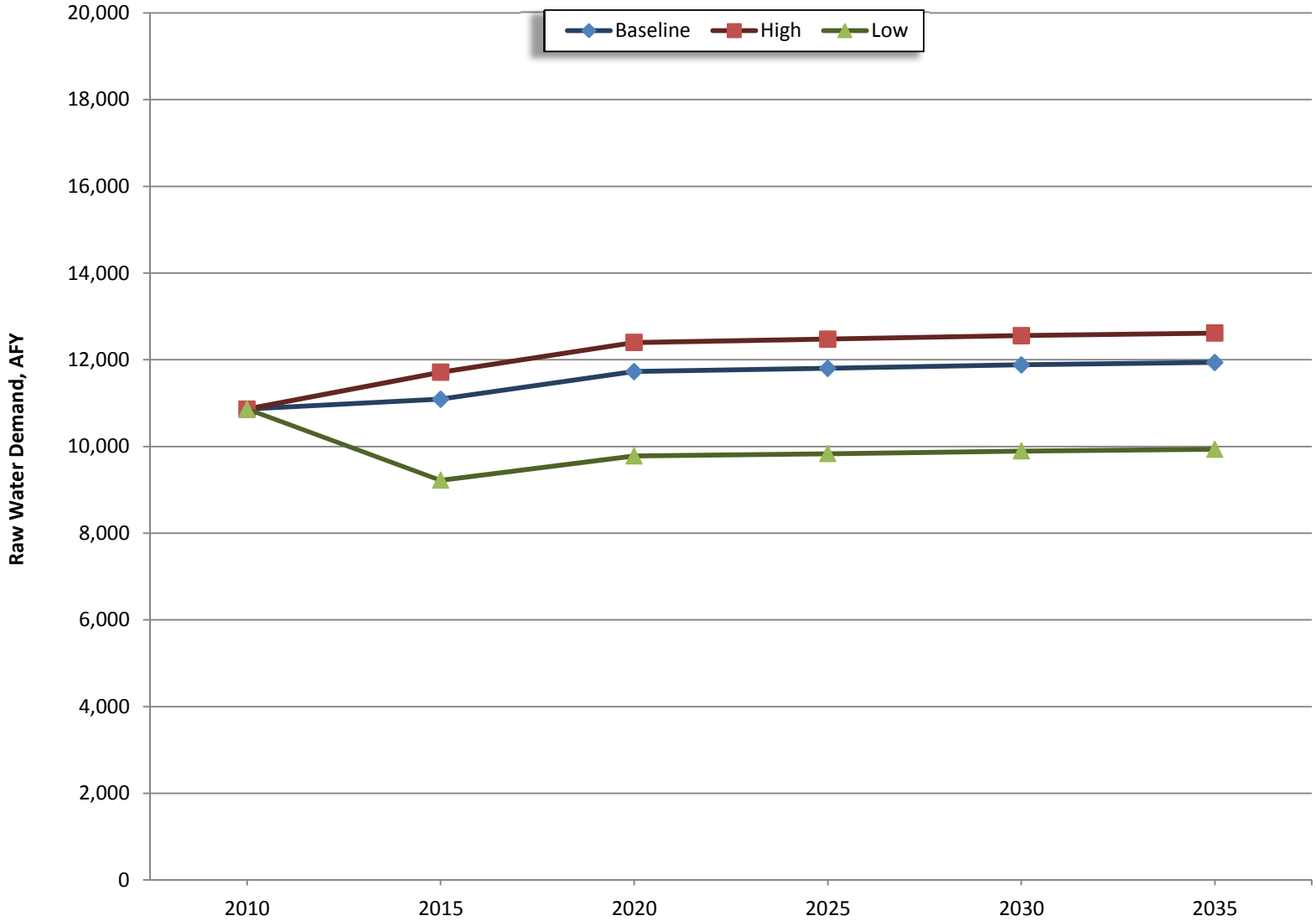
	Raw Water Demands (AFY)					
	2010	**2015**	**2020**	**2025**	**2030**	**2035**
Treated Water	4,183	4,247	4,315	4,382	4,455	4,505
Valero Raw Water	4,792	5,296	5,800	5,800	5,800	5,800
Operations and Emergency Raw Water	441	441	441	441	441	441
Unaccounted For Water	1,447	1,109	1,173	1,180	1,188	1,194
Total Raw Water Demand	10,863	11,093	11,729	11,803	11,884	11,940

High, baseline, and low raw water demand projections were developed to examine the City's supply needs for water (Table 2-16 and Figure 2-4). These projections include both production demands and Valero's raw water demands. The high demand curve assumes industrial treated water use is twice that in baseline conditions, no significant savings from conservation programs occur, and the projected Valero raw water demand is 10 percent over baseline values shown in Table 2-13. The baseline case is the same as that in Table 2-14, assuming current levels of conservation and 100 percent planned buildout as phased; with Valero's raw water demand curve remaining relatively flat at levels extrapolated from historical use data.

The low demand assumes that additional conservation activities cause a decrease from the baseline demands by ten percent and that buildout for treated water supply is 80 percent of baseline construction; which is equivalent to a total of 18 percent reduction in treated water demand, and a ten percent reduction in non-potable demands.

TABLE 2-16
TOTAL RAW WATER DEMAND FORECASTS

	Annual Demand, AFY					
	2010	**2015**	**2020**	**2025**	**2030**	**2035**
Baseline Scenario						
Treated Water Demand	4,183	4,247	4,315	4,382	4,455	4,505
Valero Raw Water Demand	4,792	5,296	5,800	5,800	5,800	5,800
Operations & Emergency Demand	441	441	441	441	441	441
Unaccounted For Water	1,447	1,109	1,173	1,180	1,188	1,194
Total Demand	10,863	11,093	11,729	11,803	11,884	11,940
High Demand Scenario						
Treated Water Demand	4,272	4,337	4,407	4,475	4,550	4,601
Valero Raw Water Demand	5,271	5,826	6,380	6,380	6,380	6,380
Operations & Emergency Demand	441	441	441	441	441	441
Unaccounted For Water	1,447	1,109	1,173	1,180	1,188	1,194
Total Demand	11,431	11,713	12,401	12,476	12,559	12,616
Low Demand Scenario						
Treated Water Demand	3,012	3,058	3,107	3,155	3,208	3,244
Valero Raw Water Demand	4,313	4,766	5,220	5,220	5,220	5,220
Operations & Emergency Demand	441	441	441	441	441	441
Unaccounted For Water	1,302	998	1,056	1,062	1,069	1,075
Total Demand	9,024	9,219	9,779	9,834	9,894	9,935



CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

RAW WATER DEMAND FORECAST

FIGURE 2-4

SECTION 3 – WATER SUPPLY SOURCES

This section summarizes the current long-term water supply sources for the City, describes the availability of these sources through different hydrologic conditions, and summarizes ongoing efforts to ensure continued and reliable long-term water supplies for the City.

EXISTING WATER SUPPLIES

The City has contracts for water from the NBA through agreements with the SCWA [1] for SWP water and with the California DWR [2] for Settlement Water. The City also has contracts for water from the Solano Project through agreements with the City of Vallejo [3] and the SID [4]. In addition, local and other water supplies can be stored at Lake Herman reservoir, which has a current capacity of 1,390 AF based on a bathymetric survey performed by Clean Lakes in 2008. These contracted water supplies are summarized in Table 3-1.

TABLE 3-1
CONTRACTED WATER SUPPLY

Source	Contract Amount (AFY)
State Water Project	16,075
Settlement Water	10,500
Vallejo Agreement	1,100
SID Agreement	2,000
Lake Herman	500[a]
	30,175

[a] Note: Water supply available from Lake Herman is based on historical observation.

Each of these water supplies is discussed in more detail in the following subsections. The City's water supply system is illustrated in Figure 3-1 and a schematic representation is shown in Figure 3-2.

State Water Project

The City receives SWP water through an agreement with SCWA. SCWA contracts with the DWR for the SWP water (called Table A water), and in turn contracts with cities in Solano County to provide this supply. The water supply for the SWP comes from Lake Oroville and water rights for flows in the Sacramento and San Joaquin River systems. The SWP contract runs to year 2035 and is renewable. DWR diverts water under an appropriative right that allows diversion of water that is not needed to meet in-Delta needs or outflow needs.

The City's current SWP contract amount is 17,200 AFY. In 1985, the Cities of Benicia, Fairfield, and Vallejo agreed to reduce their annual allotment in order to provide SWP water to the Cities of Rio Vista and Dixon. Although it is not known when or if, Rio Vista and Dixon will receive SWP water; the City's SWP allotment should be reduced by 1,125 AF [1] to reflect this obligation. Therefore, the City's SWP allotment is an adjusted supply of 16,075 AF.

FIGURE 3-1

CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

WATER SUPPLY SYSTEM

NV5
BEYOND ENGINEERING

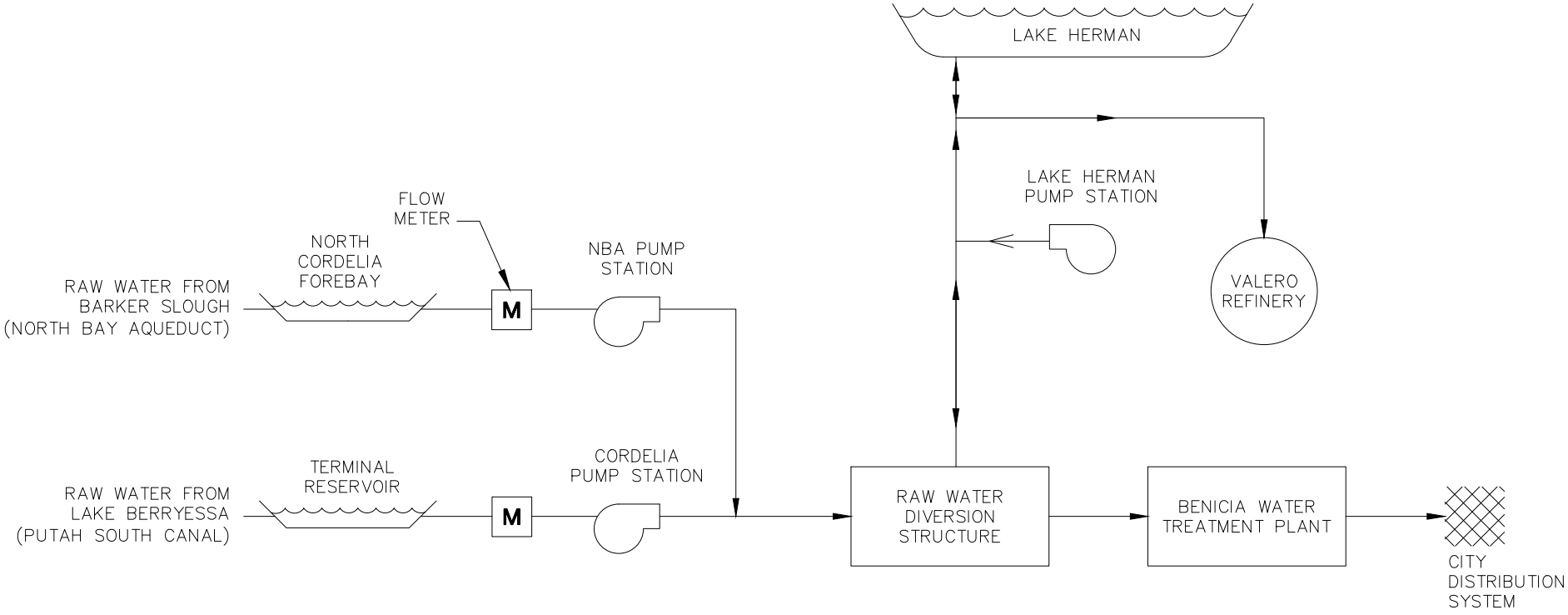


FIGURE 3-2

CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

WATER SUPPLY SCHEMATIC

NV5
BEYOND ENGINEERING

Water Rights Settlement

The City of Benicia, along with the Cities of Fairfield and Vacaville, asserted a priority right with the State of California for water from the Sacramento-San Joaquin Delta pursuant to the Watershed-of-Origin Statute. The purpose of the statute, in part, is to reserve for the areas where water originates a right to such water for future needs that is preferential to the right of outside (export) areas. DWR filed a protest on the cities' applications with the State Water Resources Control Board (SWRCB). Prior to the SWRCB hearing, DWR and the cities negotiated a comprehensive settlement that would provide water to the cities. The subsequent settlement and conveyance agreements define the basis on which water is made available to SCWA for use in the cities' service areas and how the existing DWR facilities would be used to convey the water to the cities.

DWR diverts water under an appropriative right that allows diversion of water that is not needed to meet in-Delta needs or outflow needs. In California, courts have held that appropriative water rights may be limited under the Public Trust Doctrine.

The "Area of Origin" Water Rights Settlement with DWR provides the City with 10,500 AFY of water from the Sacramento River that is not SWP water. Although it is non-Project water as defined by the settlement agreement, the source of the water is DWR's appropriative right. This is a permanent allocation of water supply based on Critical Dry Year. The amount of water was based on projected water needs to meet the City's General Plan demands during a drought. The Settlement Agreement allows the City to apply in the future to the SWRCB for a Watershed of Origin appropriation higher than the Settlement Agreement amount if demands exceed those upon which the Agreement was based. The Settlement Agreement runs through 2035 and is renewable under the same terms as the SWP contract.

Settlement Water is conveyed through the NBA when capacity is available and delivered to the City in the same manner as SWP water. The City can preferentially use Settlement Water during the periods when it is available and capacity is available. The City typically uses its Settlement Water in the spring and fall when it is most often available.

Settlement Water is restricted or not available when Standard Water Right Term 91 is in effect. Term 91 is declared by the SWRCB when it is determined that the SWP and U.S. Bureau of Reclamation's Central Valley Project (CVP) are required to release stored water in excess of low natural flow to meet Sacramento Valley in-basin uses plus export demands. Natural flow is the flow that would have been in existence if the dams were not there. Term 91 is declared in the summer of all but very wet years.

Settlement Water can be taken when the Delta is in excess conditions or when the Delta is in balanced conditions as long as Term 91 is not in effect. Balanced conditions in the Delta are defined as the periods when releases from upstream SWP and CVP reservoirs plus unregulated flow approximately equal the water supply needed to meet all Sacramento Valley in-basin uses plus export demands. During balanced conditions, the SWP and CVP are releasing water from reservoir storage to meet their water delivery obligations.

Lake Herman

Lake Herman is located in the hills between Benicia and Vallejo and has an approximate storage capacity of 1,400 AF. The dam that created Lake Herman was constructed in 1905 and raised in 1943 to its current height. Lake Herman is part of the Sulphur Spring Creek watershed. The average yield of its watershed is 500 AFY to 1,000 AFY, with no yield in dry years. The lake serves as terminal storage for excess supply delivered to the City through the NBA.

Pumped raw water from the NBA or Putah South Canal is delivered to the City's treatment facility at a diversion structure. Since the pump stations operate at a fixed speed, surplus flow not needed at the plant is diverted by gravity to Lake Herman through a 24-inch diameter pipeline. The City has the ability to pump water from Lake Herman back to the treatment facility through the Lake Herman Pump Station. This is typically done during emergencies when supply from the NBA or Putah South Canal is not available. The pump station has a total pumping capacity of 9.6 mgd.

Vallejo Agreement (Solano Project Water)

The City currently has an active water purchase agreement with the City of Vallejo. The agreement was executed in 1962 and has been amended twice. The second amendment extended the expiration date of the agreement to February 28, 2025. It is assumed that this agreement will be renewed at its expiration.

In the agreement, the City will purchase 1,100 AFY of Vallejo's Solano Project water from Lake Berryessa. The agreement also provides that the City can receive up to 3 mgd of the water as treated water, in lieu of raw water, by means of an inter-connection between the Benicia and Vallejo treated water systems, which does not currently exist. Currently the City can only receive raw water from Vallejo by means of the Cordelia Pump Station and Cordelia Pipeline. In order to receive treated water, a new interconnection would be required. The agreement provides that shortages (reductions) experienced by Vallejo may be passed on to Benicia.

The City previously had a second agreement with Vallejo for purchase of 4,400 AFY from various sources. This agreement was seldom exercised and was terminated in 2004.

Solano Irrigation District

Solano Irrigation District (SID) is the holder of a contractual right to receive allotments from the Solano Project as a Participating Agency of the SCWA under the terms of a Participating Agency Contract providing for the delivery of and allotment of 141,000 AFY from the Solano Project to SID. In March 2009, the City entered into a purchase agreement with the SID to provide 2,000 AFY. Water will be provided through water deliveries from Lake Berryessa and the Putah South Canal of the Solano Project. There is no specified date of termination of the agreement as long as SID maintains the adequate water rights from SCWA, and payments to SID are met. The agreement is subject to a reduction in supply based on drought conditions.

The SID water was purchased to improve drinking water quality when the water drawn from the Delta through the NBA is high in total organic carbon. This water source can be counted towards the total water available, but was not intended to increase availability for future growth. Any new water use of any significance would have to be analyzed in this context.

RELIABILITY OF EXISTING WATER SUPPLY

In California, actual amount of water delivered on a year-to-year basis is affected by various factors, including:

- Precipitation
- Reservoir levels
- Environmental impacts
- Court decisions

State law requires that water agencies take these factors into consideration and forecast the reliability of water supplies for three specific hydrologic conditions:

- Normal Year
- Single Dry Year
- Multiple Day Year

The City's recently adopted 2010 Urban Water Management Plan used reliability factors for State Water Project [5] and Solano Project [6] generated by the respective water supplier (DWR and SCWA). Settlement Water will be provided whenever Term 91 Condition is not in effect. Historical observation indicates that Term 91 Condition is not in effect for at least 6 months per year during Single Dry Year and Multiple Dry Year Conditions [7].

Therefore, Benicia should expect Settlement Water availability as follows:

$$26.6\ \text{cfs}^* \times \frac{1.98\ \text{AF/Day}}{\text{cfs}} \times \frac{30\ \text{Days}}{\text{Month}} = 1{,}580\ \text{AF/Month}$$

$$1{,}580\ \text{AF/Month} \times 6\ \text{Months} = 9{,}480/\text{Year}$$

$$\text{Percent Reliability} = \frac{9{,}480\ \text{AF}}{10{,}500\ \text{AF}} = 90\%$$

*Benicia's share of NBA capacity at reduced flow rate of 130 cubic feet per second (cfs) [8].

Based on these provided and calculated reliability factors Benicia water supply for the three conditions is shown in Table 3-2.

TABLE 3-2
ANNUAL WATER SUPPLY PER HYDROLOGIC CONDITION

Source	Contract Amount (AFY)	Normal Year		Single Dry Year		Multiple Dry Year	
		Reliability	Amount	Reliability	Amount	Reliability	Amount
State Water Project	16,075	64%	10,288	46%	7,395	31%	4,983
Settlement Water	10,500	100%	10,500	90%	9,450	90%	9,450
Vallejo Agreement	1,100	99%	1,084	98%	1,078	89%	979
SID Agreement	2,000	99%	1,980	98%	1,960	89%	1,780
Lake Herman	500	100%	500	0	0	0	0
	30,175		24,352		19,883		17,192

Mojave Banking and Water Exchange

The City, as member of the SCWA, is entitled to participate in a banking and water exchange program with the Mojave Water Agency (Mojave), another SWP contractor. Mojave serves a portion of the high desert region north of the San Gabriel Mountains in Southern California. It overlies a large groundwater basin that can meet nearly all of its demands in dry years. This allows Mojave to operate the basin conjunctively with surface water supplies from the SWP. Available surface water is stored in the groundwater basin.

SCWA had an agreement with Mojave to exchange wet weather SWP water for dry year SWP water. Mojave and SCWA also have agreements with DWR to transport the exchange water through SWP facilities. According to the agreement, SCWA (or its members) can exchange two units of SWP water for a future return of one unit of SWP water to be provided at the Delta by Mojave. In wet years, the City would send SWP water to be "banked" or "stored" in Mojave's groundwater basin. During dry years, the City can recover one-half of its stored water through the NBA from Mojave's SWP allocation, while Mojave uses its groundwater to replace the SWP water that goes to the City. There is no physical transfer of water; the City's volume of stored water is tracked in an account and deducted when the City takes Mojave's SWP allocation through the NBA. There is no monetary cost for the Mojave Exchange water.

The agreement with Mojave was terminated in 2007. The City still has access to 2,000 AF of banked water. One thousand AF must be recovered by 2014, and the remaining 1,000 AF must be recovered by 2015 or Benicia loses the rights to the water. The Director of Public Works will ensure the water is utilized.

Transfer or Exchange Opportunities

Transmission facilities from the Delta via the NBA and Lake Berryessa via the Putah South Canal allow for a variety of short- or long-term water transfer or exchange options. Such transfers or exchanges might occur with other NBA members, other SWP entities, or Solano Project members. These shared opportunities highlight the value of statewide and regional water management planning efforts. Two specific options currently available to the City are:

- **Storage Agreement for Solano Project Water** – The City has a storage agreement with SCWA that provides an option to store up to 9,000 AF in Lake Berryessa for use as emergency supply. To exercise this agreement, Benicia must exchange a portion of its SWP water (Table A water) water for Solano Project water or purchase it from other members that have the capability to use either source. The other entity uses the NBA water and foregoes the use of the Solano Project water. The City has not exercised this agreement to date since it specifies that the first Project water spilled (released over the dam), if the lake is full, is Benicia's water whether the City needs it at the time or not. The City would only consider exercising this agreement if lake levels were low enough that it was not likely that the lake would spill.

- **Solano Project Drought Measures Agreement** - The Solano Project contracting cities (Fairfield, Vacaville, Vallejo, and Suisun City) have an agreement with the two agricultural Solano Project contracting districts (SID and Maine Prairie Water District) to share water supplies during drought periods. Benicia is not a member of the Project, since the City relinquished its contractual rights to Solano Project water when SWP water was made available. However, Project members may transfer water from the Solano Project to the City. The region has historically cooperated in this regard to collectively maintain the interdependent urban and agricultural economies of the region.

The general types of transfers or exchanges that the City can continue to use, if needed, are summarized below:

- **Core Transfers** make water available through multi-year contracts that convey a specific amount of water to the purchaser each year. The specific conditions depend on the agencies involved and contract terms. Examples include the City's 2009 agreement with SID and its 1962 agreement with the City of Vallejo.

- **Spot Transfers** make water available for a limited duration (typically one-year or less) through a contract executed during the year of delivery. Some examples of spot transfers are the State Drought Water Bank in the critically dry year of 1991, the State's voluntary water purchase program in 2001, and Benicia's previous short-term agreements with SID.

- **Option Transfers** are multi-year contracts that allow the purchaser to obtain a specified quantity of water at some future date. They usually require a minimum payment for water even if the water is not needed in a given year. An option or "take" price is established in years water is drawn.

- **Storage Agreements** allow one entity to lease or purchase storage in another entity's surface or groundwater storage facility. An example is Benicia's storage agreement for Solano Project water.

- **Water Exchanges** are agreements that allow two agencies to exchange water from one source for water from another source, typically during the same year. Exchanges can also occur with the same source where one agency exchanges its right to take water at a given

time from the source with another agency, and then can take the water from the source at another time. Exchanges can also involve storage agreements. An example is Benicia's participation in the Mojave Banking and Water Exchange.

Groundwater

Groundwater supplies are used by several municipalities in Solano County to supplement the surface water supplies. The addition of groundwater is particularly useful when the surface water is experiencing high turbidity due to storm water runoff or seasonal canal cleanings, or when the NBA diversions are restricted to protect Delta smelt or during droughts. Unfortunately, groundwater supplies are not readily available in the Benicia area.

Recycled Water

The City provides wastewater collection, treatment, and disposal services to customers within its service area. The City's wastewater collection system consists of approximately 150 miles of pipelines and 24 lift stations. The majority of the collection system relies on gravity flow through the pipelines. Due to terrain restrictions, it also relies on 24 pump stations to transport the collected wastewater from low points to suitable locations for continued transmission by gravity.

The City operates and maintains a 4.5-mgd wastewater treatment plant (WWTP) facility located on seven acres of land at the south end of East 5th Street. The WWTP provides secondary treatment to domestic, commercial, and industrial wastewater. The facility receives flows from two main service areas: the predominantly residential area located west of the plant and the predominantly industrial area located east of the plant. Average dry weather effluent flow from the WWTP in 2010 was 2.1 mgd and is projected to increase to 2.7 mgd at buildout. Treated wastewater or effluent is discharged into the Carquinez Strait of the San Francisco Bay via a deep water outfall.

The City and Valero's Benicia Refinery completed a preliminary design report to upgrade the WWTP to tertiary treatment allowing for non-restricted recycled water reuse of effluent. The refinery has consumed an average of 4.2 mgd of raw water over the past 10 years; therefore any use of recycled water by the refinery would free-up raw water for use by the City.

The initial concept for upgrading to tertiary treatment was to provide up to 2 mgd of recycled water for use by the refinery as cooling tower make-up water. The tertiary project would require granular media filtration and chlorine disinfection of secondary effluent to meet Title 22 regulations. For use as cooling tower makeup water use at the refinery, additional treatment is required to prevent scaling, control corrosion, and provide comparable water quality for use within six cycles of concentration. Ammonia and Phosphorus removal were also considered necessary to prohibit corrosion and scaling within the refinery facilities. All of these treatment considerations added up to a tertiary plant of prohibitive costs. While the Benicia Refinery may be willing to pay a premium for a firm, uninterrupted, drought-proof supply of cooling tower water, the estimated recycled water costs far outweighed the current raw water unit prices. At the direction of the City Council, this project has been put on hold.

Water Shortage and Drought Contingency Plans

Water Shortage and Drought Contingency Plans have been developed by Benicia and other water supply agencies. The plans identify water conservation measures which have already been implemented, as well as emergency water conservation plans to be implemented if necessary. The plans also identify "trigger" mechanisms to implement emergency actions. The plans developed by Benicia and SCWA include water conservation ordinances, development of public awareness programs, and evaluations of future water conservation programs including a detailed analysis of reclaimed water opportunities with Valero, the City's largest raw water user.

SCWA also established a Solano Drought Pool in 1991, in addition to implementing the water conservation programs. The Pool provided a mechanism for willing agricultural water users to reduce surface water diversions and sell water to municipalities served by SCWA. The purchased water can be used immediately or stored as carryover storage in Lake Berryessa. The SCWA also provided the mechanism for member agencies to participate in the State Drought Water Bank or to enter into temporary water transfers.

Other alternatives for conserving water are addressed in Section 7 – Sustainability.

POTENTIAL FUTURE WATER SUPPLY AND STORAGE OPPORTUNITIES

The following projects are being developed through the Solano Water Authority (SWA). The SWA is a joint powers authority made up of eleven Solano County agencies, including the seven cities, three agricultural districts, and the County. The SWA, through the Joint Exercise of Powers Agreement, provides a mechanism whereby the agencies may participate in jointly funded water projects for their mutual benefit.

- **Noonan Reservoir** - This proposed project would construct a joint use water storage reservoir benefitting municipal interests in Solano County and SID. The reservoir would be located on the southerly side of the Putah South Canal between Fairfield and Vacaville. The reservoir would provide the capability of commingling and storing both NBA and Solano Project water supplies. The project would also provide the flexibility for public agencies within Solano County (Benicia is a participant) to enter into water transfer agreements that could exchange NBA water for Solano Project water.

- **Highline Canal** - Considered an initial stage of the Noonan Reservoir project, although also a standalone project, the Highline Canal project would allow project participants to exchange NBA water for Solano Project (Lake Berryessa) water, presently used in SID's Dally service area (east of Peabody Road). The proposed project includes a pump station on the NBA and a pipeline from the pump station to the head of SID's Dally Highline Canal. The benefits of the project for the City are related to both water quality improvement and water supply. With the project, the City will be able to deliver NBA water to SID at times during SID's irrigation season. In exchange, SID would provide the City with Solano Project water that would be used at other times of the year when either the NBA is shut down due to maintenance or because of environmental constraints. SCWA's Integrated Regional Water Management Plan (IRWMP), with the City as a

participant, includes a high priority action to work with DWR and other agencies to explore water supply and storage opportunities that could increase the reliability of Solano County's water supplies. Storing water in wet years for later use in drier years would help Solano water agencies maintain reliable water supplies. Storage could be in the form of groundwater banking (groundwater storage) or surface water storage. The City participates in these regional planning efforts through the SCWA.

The SCWA IRWMP includes a high priority item to identify opportunities for conjunctive groundwater use as a means of increasing water supply and reliability. Conjunctive use projects integrate the use of groundwater and surface water. The surface water provides supplies to local users and recharges the groundwater basin in normal or wet years. Groundwater in storage then provides supply during drier years when surface supplies are reduced. Agencies within the County with good groundwater resources would use groundwater during dry years, which would free up more surface water for those agencies that have poor quality groundwater, such as the City of Benicia.

SCWA's IRWMP also identifies new surface water storage within Solano County as a potential long-term option to help meet future demands by storing water during normal-to-wet years when water is available so that the stored water would be available during drier years when other supplies, such as the SWP, are reduced. Additional evaluations are needed to determine whether such facilities are feasible. For example, the idea of using Delta Islands as surface storage sites has been discussed; however, there are major issues with respect to levee stability/vulnerability and seepage. This potential supply option would be investigated as part of the regional water management planning efforts that include the City as an active participant.

City of Vallejo Inter-tie

The City has an agreement in place to receive water from the City of Vallejo. According to Amendment 2 of the Agreement, Vallejo's obligation to provide water extends through February 2025 (See Appendix A-4). The Agreement includes up to 3 mgd of treated water in lieu of raw water. Currently, Vallejo has more than adequate capacity in the Fleming Hill Water Treatment Plant because capacity requirements have been reduced due to closing of the Mare Island Ship Yard.

Although an agreement to deliver treated water is in place, there is no connecting pipeline to deliver the treated water to Benicia. Because there currently are adequate treatment facilities and raw water supplies, the City of Benicia has not pursued discussions with Vallejo to plan for the inter-tie connection. No feasibility studies have been prepared for this project and any plans for the treated water inter-tie are at least ten years in the future.

In very preliminary discussions among City of Benicia staff, a possible alignment for the future inter-tie would be from Benicia Road at Columbus Parkway, crossing at some point under I-780, running parallel to I-780 along the frontage road, and tying into the loop at West K Street and Military West.

Jameson Canyon

Benicia considered pursuing planning studies with Vallejo to construct a reservoir in Jameson Canyon. This potential reservoir could provide off-stream storage. Conveyance facilities that could be used to transport water in both directions could be considered as part of the project. However, due to the high cost of the facility, this effort was abandoned. In the spring of 2012, the City of American Canyon solicited proposals to prepare a feasibility study for the construction of the Jameson Reservoir.

Alternative Intake Project

Although not an additional source of water, DWR proposes to construct and operate an alternative intake on the Sacramento River, upstream of the Sacramento Regional Wastewater Treatment Plant. The intent of this project is to improve water quality and to provide more reliable deliveries of the State Water Project supplies to SCWA and the Napa County Flood Control and Water Conservation District.

The new intake will connect to the existing NBA system by a new transmission main. The proposed alternative intake would be operated in conjunction with the existing NBA intake at Barker Slough. This change will affect treatment operations at the WTP, hopefully making treatment less of a challenge, specifically with regard to total organic carbon (TOC).

SUMMARY

Based on this review of Benicia's contracted water supplies, supply reliabilities, and water demands, the City has confirmed water supplies to meet its demands. However, Benicia is at the end of long conveyance facilities subject to negative impacts caused by regulatory, judicial, and equipment disruptions. For instance, in order to protect the Longfin Smelt, flow in the NBA is reduced from 130 cubic feet per second (cfs) to 50 cfs. Therefore, Benicia is aggressively pursuing methods to ensure reliable long and short-term water supplies. Past efforts include a Settlement Water Agreement with DWR for "Area of Origin" water, extension of water supply agreement with Vallejo and a new water agreement with SID. Future efforts will consider methods to maximize the use of Settlement Water to provide increased reliability.

REFERENCES

1. State Water Project Contract with SCWA, October 1985 (Appendix A-1)

2. Settlement Water Agreement with DWR, May 2003 (Appendix A-2)

3. Vallejo Agreement, February 1962; Amendment 1, April 1962; Amendment 2, April 1987 (Appendix A-3)

4. SID Agreement, March 2009 (Appendix A-4)

5. State Water Project Reliability – SCWA, Data from 1922-2003 (Appendix A-5)

6. Solano Project Reliability – SCWA, Data from 1906-2006 (Appendix A-6)

7. Settlement Water Availability (Appendix A-7)
    a. Chart – DWR, Term 91 Curtailment
    b. Table – NV5, Data prepared from DWR Chart

8. NBA Maximum Flow Allocation – SCWA (Appendix A-8)

SECTION 4 – EXISTING WATER SYSTEM FACILITIES

The City's existing water system consists of raw water supply and transmission, treatment, storage and distribution facilities. Each of the existing system components is described in this section. The water treatment facilities are discussed in greater detail in Section 6.

WATER DISTRIBUTION SYSTEM

The water distribution system delivers potable water to the residential, business, and industrial land uses within the existing City limits. The distribution system facilities consist of pipelines, pump stations, pressure reducing valves, and storage reservoirs. Figure 4-1 is a schematic of the existing water distribution system facilities.

Pressure Zones

The existing distribution system is separated into three main pressure (or service) zones: Zone I, Zone II, and Zone III. Figure 4-2 is a schematic representation of the approximate boundary for each individual pressure zone. Zone I includes primarily commercial and industrial land uses along the eastern sector of the City, as well as the Arsenal area, and residential land uses south of Military Avenue. Zone II is primarily the western residential area located between Interstate 780 (I-780) and Military Avenue including the residential area between the Valero Refinery property and I-780. Zone III includes primarily residential development north of I-780 and west of 2nd Avenue. There are seven intermediate pressure zones served by Zone III, which rely on pressure reducing valve stations for pressure and flow requirements. Table 4-1 is a summary of the corresponding service elevations for each pressure zone. Figure 4-2 is a schematic representation of the pressure zone boundaries.

TABLE 4-1
EXISTING WATER DISTRIBUTION SYSTEM PRESSURE ZONES

Pressure Zone	Maximum Water Surface Elevation (ft)	Minimum Service Elevation (ft)	Maximum Service Elevation (ft)	Minimum Static Pressure (psi)	Maximum Static Pressure (psi)
I	234	14	110	54	95
II	314	110	215	43	88
III[a]	580	215	475	45	158

[a] Seven isolated pressure zones are served from Zone III through pressure reducing valve stations.

In Zone I, ground elevations vary from 14 to approximately 110 feet, which result in a wide range of pressures (between 54 and 95 psi) within Zone I. Water is provided to Zone I from the Zone I water storage reservoir (also referred to as the clearwell), the chlorine contact tank (CCT), and the R-1 Reservoir. The clearwell and the CCT are both located at the water treatment plant (WTP).

Zone II includes the area north of I-780 between Drolette Way and Casa Grande Street and portions of the old downtown area. Zone II is supplied by water from the P-1 Pump Station. The R-2 Reservoir water levels are maintained by the WTP operator via SCADA through the

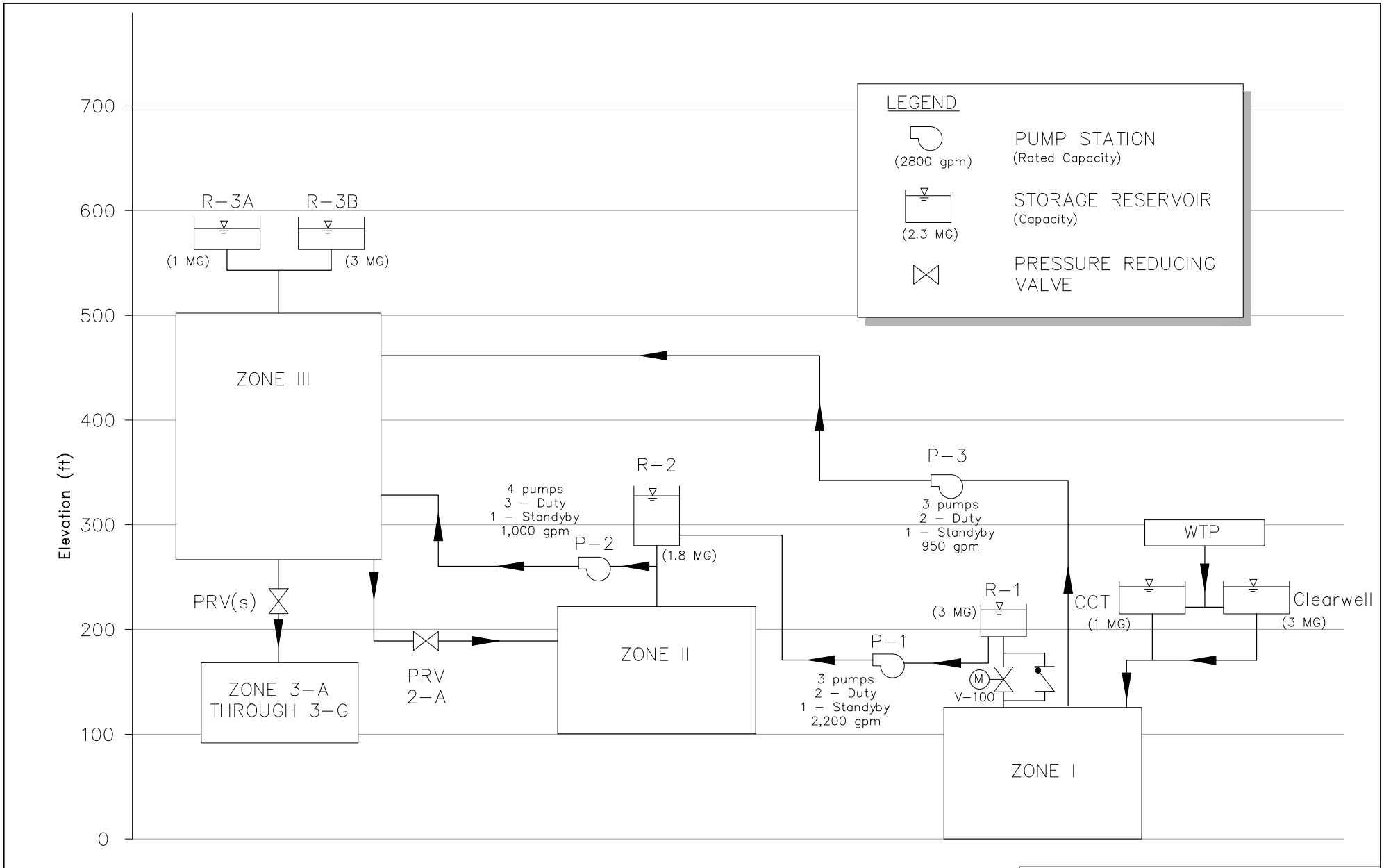
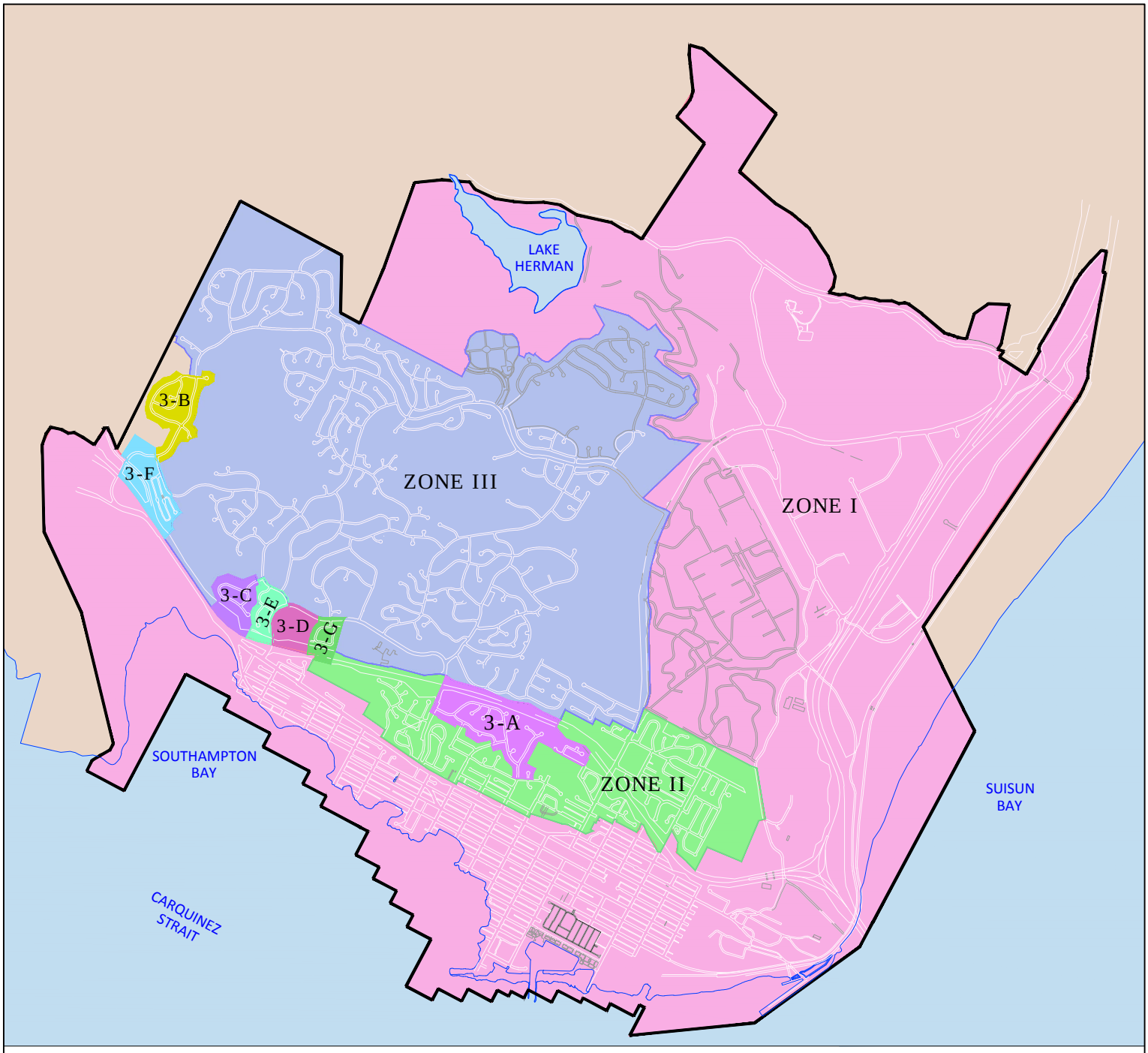


FIGURE 4-1

CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

TREATED WATER SYSTEM SCHEMATIC

NV5
BEYOND ENGINEERING



LEGEND

BENICIA CITY LIMITS BOUNDARY

SHORE LINE/EDGE OF WATER BODY

N

0 3700 7400

1" = 3700'

FIGURE 4-2

CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

EXISTING PRESSURE ZONE BOUNDARIES

NV5 BEYOND ENGINEERING

manual operation of the P-1 Pump Station. The predominant land uses in Zone II are residential and parks, with some light commercial.

Zone III primarily includes the Southampton development and areas to the north of I-780. Water is delivered to Zone III from either the P-2 Pump Station (Zone II) or the P-3 Pump Station (Zone I). These pump stations fill the R-3A and R-3B Reservoirs. The R-3A and R-3B Reservoirs operate in parallel and the water levels are maintained by the WTP operator via SCADA, through the manual operation of the P-2 Pump Station or the P-3 Pump Station. The land uses in Zone III are primarily residential.

Storage Reservoirs

Storage reservoirs are located in each of the main pressure zones to provide water during peak demand periods and to provide fire and emergency storage capacity. There are currently six water storage reservoirs in the distribution system, with a total capacity of 12.8 million gallons. The reservoirs range in size from 1.0 to 3.0 million gallons. Three of the reservoirs are pre-stressed concrete tanks and the other three reservoirs are welded steel tanks. Table 4-2 is a summary of the pertinent data for the existing reservoirs.

TABLE 4-2
EXISTING WATER DISTRIBUTION SYSTEM STORAGE FACILITIES

Pressure Zone	Name	Storage Capacity (MG)	Base Elevation (ft)	Overflow Elevation (ft)	Tank Height (psi)	Tank Diameter (ft)	Tank Construction
I	Chlorine Contact Tank	1.0	215	233	20	103	Steel
I	Clearwell	3.0	215	232	20	163	Pre-stressed Concrete
I	R-1 Reservoir	3.0	193	214	25.5	160	Steel
II	R-2 Reservoir	1.8	280	315	42	95	Steel
III	R-3A Reservoir	1.0	563	583	20	92	Pre-stressed Concrete
III	R-3B Reservoir	3.0	563	583	20	160	Pre-stressed Concrete
	Total Capacity	12.8					

The R-1 Reservoir, located in Zone I, was constructed with a maximum water surface elevation approximately 14 feet lower than the primary Zone I tanks (clearwell and chlorine contact tank). The R-1 Reservoir is filled with water from the primary Zone I tanks. A motorized valve (V-100) on the inlet pipeline of the R-1 Reservoir controls when the tank is filled. The motorized valve was designed to automatically operate on the R-1 Reservoir levels; however that control strategy does not align well with the operation of the clearwell. Currently, the motorized valve (V-100) is opened when the operator needs to lower levels in the clearwell or when the P-1 Pump Station is on-line pumping water from the R-1 Reservoir to Zone II and the operator needs to fill the R-1 Reservoir. This motorized valve (V-100) is operated between 3-4 times a day and has become a strategic tool in minimizing water age within the R-1 Reservoir.

During normal operation and typical Zone I demands, the R-1 Reservoir is not a factor operationally for Zone I as it rarely draws down through its check valve. The check valve will

only open on extreme conditions (i.e. main breaks) that cause pressure differential in the system. During normal operating conditions, the R-1 Reservoir is essentially a wetwell for the P-1 Pump Station to serve demands in Zone II and fill the R-2 Reservoir.

The R-2 Reservoir for Zone II is filled with water from the P-1 Pump Station (located north of the Corporation Yard) which gets its water from the R-1 Reservoir. The R-2 Reservoir water levels are maintained by pump controllers set at "start-stop" designated levels using SCADA. When the R-2 Reservoir is out of service or cannot provide adequate level of service to Zone II, a pressure reducing valve station connecting Zone II to Zone III can be activated manually to serve the water needs of Zone II.

The R-3A and R3B Reservoirs for Zone III typically receive water from the P-2 Pump Station (located across from the Corporation Yard) conveyed from the Zone II R-2 Reservoir. For redundancy and in emergency conditions when the P-2 Pump Station cannot keep the R-3A and R-3B Reservoirs filled, the P-3 Pump Station (located at the intersection of Rose Drive and East 2nd Street) is energized to lift water from Zone I directly into Zone III.

Pump Stations

Water is delivered to Pressure Zones II and III by three pump stations. The P-1 Pump Station located north of the City's Corporation Yard, delivers water to Zone II from Zone I. The P-2 Pump Station located across from the Corporation Yard approximately 1,200 feet west of East 2nd Street and north of Tenny's Drive conveys water from Zone II to Zone III. Similarly, the P-3 Pump Station located at the corner of Rose Drive and East 2nd Street delivers water directly from Zone I to Zone III.

The P-1 Pump Station has a stationary emergency generator, manual transfer switch, and load bank. A stationary emergency generator and manual transfer switch is being considered for the P-3 Pump Station as part of the Renewal Energy Project 2012.

Table 4-3 is a summary of the existing pump station pertinent data.

Pressure Reducing Valve Stations

Because of the variance in ground elevation within Zone III, several pressure reducing valve stations are located to provide an adequate level of service. In addition, in 1996 the City installed an additional pressure reducing valve station to supply all of Zone II from Zone III when the Zone II R-2 Reservoir is out of service. All pressure reducing valve stations are equipped with ClaVal control valves. Each valve station reduces pressure from the Zone III pressure zone to serve intermediate pressures in isolated water main systems at lower elevations. All connections in Zone III are required to have individual pressure regulators at their shut-off valve in the event that high system pressures are observed or existing valve stations fail creating dangerous pressure conditions in the system.

TABLE 4-3
EXISTING WATER DISTRIBUTION SYSTEM PUMP STATION FACILITIES

Pump Station	Zone Lift	No. of Pumps	Pump No.	Year Installed	Pump Type	Motor Horsepower (HP)	Rated Capacity (gpm)	Discharge Head (ft)	Pump Manufacturer
P-1	Zone I to Zone II	3	101	2007	Horizontal Centrifugal	100	2,200	127.5	Floway
			102	2007	Horizontal Centrifugal	100	2,200	127.5	Floway
			103	2007	Horizontal Centrifugal	100	2,200	127.5	Floway
P-2	Zone II to Zone III	4	201	2004	Horizontal Centrifugal	125	1,000	350	PACO
			202	2004	Horizontal Centrifugal	125	1,000	350	PACO
			203	2002	Horizontal Centrifugal	125	1,000	350	PACO
			204	2002	Horizontal Centrifugal	125	1,000	350	PACO
P-3	Zone I to Zone III	3	301	2007	Vertical Turbine	125	950	403	Floway
			302	2007	Vertical Turbine	125	950	403	Floway
			303	2007	Vertical Turbine	125	950	403	Floway

At each valve station, daily normal demand is provided through a 2-inch or 3-inch valve. When system pressures drop whether caused by high consumption (use) from irrigation demand or fire flow, the 6-inch or 8-inch valve will open to allow full flows into the sub-zone. When pressures return to normal within the sub-zone, the 6-inch or 8-inch valve will automatically close and the 2-inch or 3-inch normal daily demand valve will open fully to allow daily demand.

Table 4-4 is a summary of the existing pressure reducing valve station pertinent data.

TABLE 4-4
EXISTING WATER DISTRIBUTION SYSTEM PRESSURE REDUCING VALVE STATIONS

Valve State Location	Zone Served	Approximate Elevation (ft)	Valve Station Configuration	Approximate Outlet Pressure (psi)
West 7th Street and Lori Drive	3-A	125	8-inch x 3-inch	95
Blake Court and Rose Drive	3-B	220	6-inch x 2-inch	100
London Circle	3-C	100	6-inch x 2-inch	75
Club Pacifica	3-D	150	6-inch x 2-inch	75
Devonshire Drive	3-E	135	6-inch x 2-inch	75
Cambridge Drive at Rose Drive	3-F	80	6-inch x 2-inch	170
Grove Circle	3-G	160	6-inch x 2-inch	75
Tennys Drive at East 2nd Street	2-A	200	8-inch x 4-inch	75

Distribution System Pipelines

The water distribution system pipelines range in diameter from 4-inch to 30-inch. Most of the larger pipelines are steel; the majority of the pipelines 12-inch in diameter or less are constructed of ductile iron pipe.

The current City Design Standards require a minimum pipe size of 8-inch for all water mains with the installation of 6-inch water mains permitted only beyond the last fire hydrant. Similarly, the current standards specify a pipe material of ductile iron class 50 with corrosion protection in areas designated by the City Engineer.

RAW WATER TRANSMISSION SYSTEM

Raw water is delivered to the City via the raw water transmission system, which is comprised of two pump stations and approximately 75,000 feet of 24-, 30-, and 36-inch diameter pipelines. Figure 4-3 is a schematic representation of the raw water transmission system for the City of Benicia.

The primary raw water source for the City is surface water from the State Water Project (SWP). The Barker Slough Pumping Plant diverts water from Barker Slough, on the Sacramento-San Joaquin River Delta, to the North Bay Aqueduct (NBA). The NBA then transfers this raw water to the Cordelia Forebay. From the Cordelia Forebay, the NBA Pump Station transmits raw water through a 30-inch transmission line to the 36” Raw Water Transmission Line (RWTL). The NBA Cordelia Pumping Plant consists of three pumps, two rated at 13.0 cfs (8.4 mgd) and one rated at 6.0 cfs (3.9 mgd). The total pumping capacity at the pump station is 32.0 cfs (20.7 mgd). The Barker Sough Pumping Plant and the NBA Cordelia Pumping Plant are operated by the Department of Water Resources.

The City owns and operates an emergency/supplemental supply pump station, referred to as the Cordelia Pump Station, to convey raw water from the Putah South Canal Terminal Reservoir. The Cordelia Pump Station consists of four pumps, each rated at 7.1 cfs (4.6 mgd). The total capacity at this station is 28.5 cfs (18.4 mgd). The station is operated manually by City staff when necessary. The Cordelia Pump Station is generally operated if NBA water is unavailable or the water quality is poor, usually between January and May.

Water conveyed from either source (NBA Cordelia Pumping Plant or Cordelia Pump Station) is delivered to a diversion structure located at the water treatment plant. Flows in excess of the daily demand at the plant are diverted by gravity to Lake Herman through a 24-inch/30-inch pipeline. Raw water is also provided to the Valero Refinery through a 20-inch pipeline. The City has the ability to convey raw water from Lake Herman to the water treatment plant for treatment through the City owned and operated Lake Herman Pump Station. This pump station consists of three pumps rated at 8.0 cfs (5.2 mgd). The total pumping capacity at the Lake Herman Pump Station is approximately 24.0 cfs (15.6 mgd).

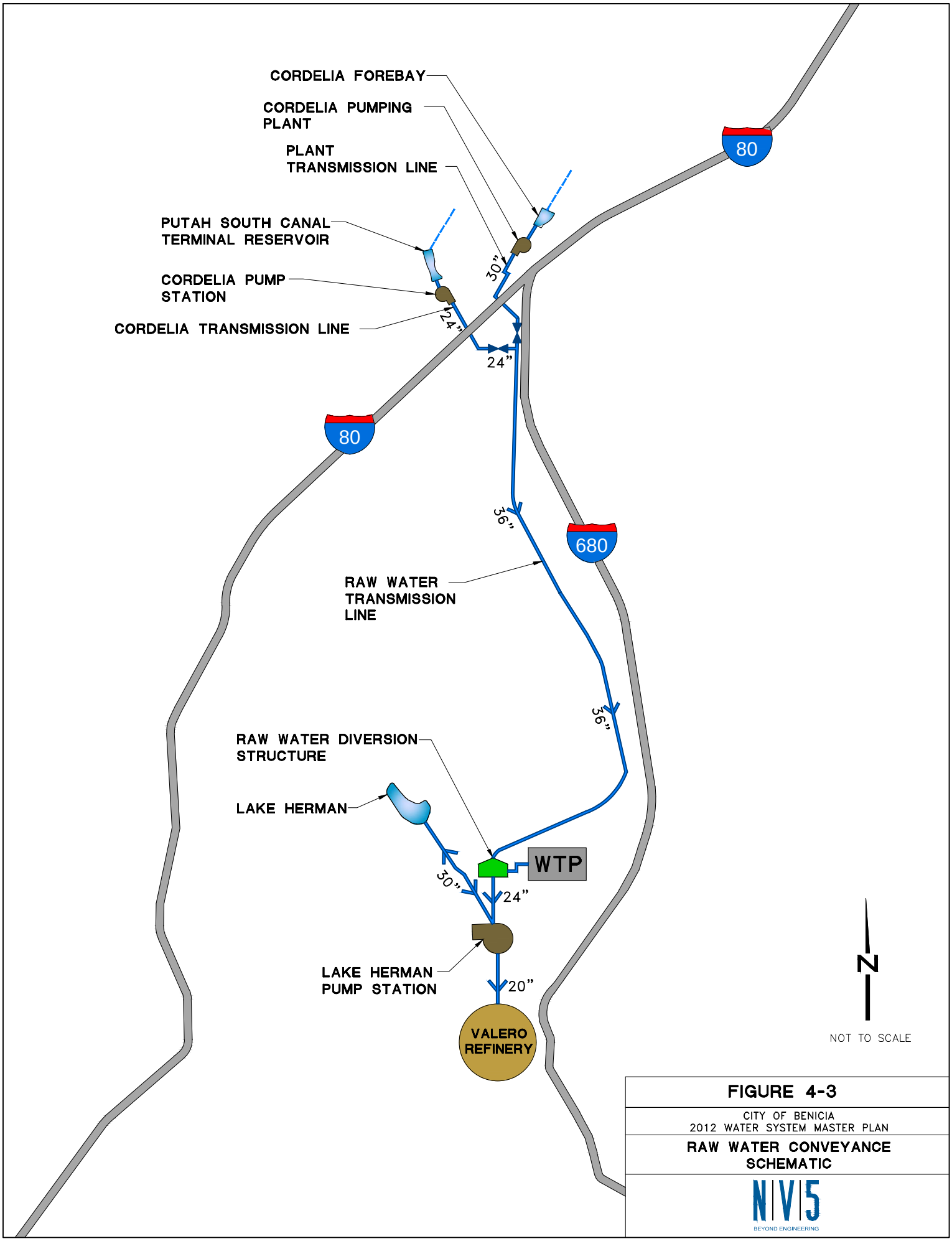


FIGURE 4-3

CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

RAW WATER CONVEYANCE SCHEMATIC

NV5
BEYOND ENGINEERING

WATER TREATMENT PLANT

The existing City water treatment plant was constructed in 1971. The plant was originally designed for a capacity of 6 mgd. In 1989, the plant was expanded to 12 mgd. At that time, the plant was designed to accommodate two additional expansions of 6 mgd for a total plant capacity of 24 mgd. Treatment process units were added in 2006 to improve performance and reliability, but the rated capacity of the plant was unchanged. The major plant facilities include:

- Inlet diversion structure
- Flash mix structure
- Two upflow clarifiers
- Two flocculation/sedimentation basins (4 mgd and 8 mgd)
- Six dual-media filters
- Chemical handling building with laboratory facilities
- Filter control center with complete instrumentation and automatic filter control systems
- Chemical storage facility
- A 250 kW standby generator with 1500-gal diesel tank
- Chlorine gas disinfection system
- Clearwell
- Chlorine contact tank (CCT)
- Backwash tank and backwash pumps
- Washwater holding basin
- Washwater recovery pump station
- PLC-based Supervisory Control and Data Acquisition (SCADA) system
- Six sludge drying lagoons

Improvement projects at the water treatment plant were completed in 2006 and 2009. They were implemented to satisfy new and anticipated drinking water regulations; upgrade or replace equipment or facilities that have reached their useful life; and /or to provide redundancy and reliability in the water system.

OPERATIONS

The City operates a conventional surface WTP to meet system demand.

The water distribution system is primarily a gravity operation. Water flows by gravity from the clearwell at the water treatment plant to the Zone I and the R-1 Reservoir. Water is pumped from Zone I to Zone II to Zone III**.** The pump stations are operated based on the water level in each zone reservoir, system demand, and the pump stations are manually operated by the operators to reduce water age in each reservoir.

SECTION 5 – DISTRIBUTION SYSTEM EVALUATION

Section 5 includes the results of the evaluation and analysis of the water distribution system. Included is a summary of the treated water storage and pumping capacity evaluation, a description of development and calibration of the hydraulic model, a summary of the results from the hydraulic evaluation, and a discussion of the recommended projects to mitigate existing and future deficiencies in the distribution system. This section also includes a summary of the raw water transmission system and a discussion of Firm Capacity.

EXISTING AND PROJECTED MAXIMUM DAY DEMANDS

The storage and pumping analysis and the hydraulic evaluation utilizing the hydraulic model are based, in part, on existing and projected maximum day demands from each pressure zone. The total existing average day demands and projected water demands for the City, as presented in Section 2, are as follows:

- Existing Average Day Demand – 3.73 mgd
- Projected Average Day Demand – 4.02 mgd

The maximum day demand is estimated using a peaking factor of 1.5 applied to the average day demand. Therefore, the existing and projected maximum day demands are as follows:

- Existing Maximum Day Demand – 5.60 mgd
- Projected Maximum Day Demand – 6.03 mgd

Table 5-1 is a summary of the existing and projected buildout average day and maximum day demands separated by pressure zones.

TABLE 5-1
EXISTING AND BUILDOUT WATER DEMANDS BY PRESSURE ZONE

	Existing Conditions		Buildout Conditions	
Pressure Zone	**Average Day Water Demand (mgd)**	**Maximum Day Water Demand (mgd)**	**Average Day Water Demand (mgd)**	**Maximum Day Water Demand (mgd)**
Zone I	1.45	2.18	1.56	2.34
Zone II	0.48	0.72	0.52	0.78
Zone III	1.80	2.70	1.94	2.91
Totals	**3.73**	**5.60**	**4.02**	**6.03**

Table 5-1 includes projected average day and maximum day demands for one new development slated to occur at buildout (Seeno Property). The Seeno Property, located south and east of the water treatment plant north of East 2nd Street, will include approximately 535 acres of general commercial and limited industrial land uses. This future development is located at elevations that require separate pumping, piping, and storage facilities. For planning purposes, this master plan update assumes that the Seeno Property development will be served from Zone I, since this appears to be the most efficient and cost-effective alternative.

STORAGE CAPACITY ANALYSIS

Water storage capacity requirements were developed and evaluated for each existing and future pressure zone. Storage capacity requirements include:

- Operational storage
- Fire flow storage
- Emergency storage

Operational Storage

Operational storage volume is the amount of storage capacity in a system to absorb fluctuations in demand compared to supply. With operational storage, system pressures are improved and stabilized to better serve customers throughout the service area. In the absence of appropriate above-ground storage, the source of supply provides peak hour demands.

Operational storage capacity is assumed to be 25 percent of the maximum day demand in accordance with AWWA guidelines.

Fire Flow Storage

Fire flow storage volume is provided for firefighting purposes to allow gravity flow in the event the source flow is interrupted. Fire flow storage volumes vary and are normally based on the requirements of the local Fire Marshall and the Insurance Services Office (ISO) requirements. The Benicia Fire Department uses the Uniform Fire Code Appendix III (Table III-A) and NPFA Handbook, 19th Edition, Section 5, Table 5-2 to assess individual building fire flow requirements in conjunction with accepted industry practices. Table 5-2 is a summary of the minimum fire flow requirements confirmed by the Benicia Fire Department for the selected land use categories.

TABLE 5-2
FIRE FLOW REQUIREMENTS

Land Use Category	Fire Flow (gpm)	Duration (hrs)
Single Family Residential	1,500	2
Multiple Family Residential	2,500	2
Schools	2,500	2
Business and Small Commercial	3,500	3
Industrial and Large Commercial	3,500 – 5,000	4

Application of these fire flow criteria varies within each pressure zone. As indicated in Table 5-2, fire flows range from 3,500 to 5,000 gpm for the industrial and large commercial land use classifications. A 5,000 gpm fire flow is required in the commercial/industrial area on the northeast side of Zone I and the area east of East 7th Street. All other commercial/industrial areas of Zone I are evaluated at a fire flow of 3,500 gpm. Zone II and Zone III have a maximum fire flow requirement of 2,500 gpm due to the schools and multi-family land uses within these pressure zones. Fire flow requirement within the residential areas of all zones is approximately 1,500 gpm.

Based on the discussion above and Table 5-2, the maximum fire flow requirements are:

- In Zone I: 5,000 gpm for 4 hours (1.3 million gallons)
- In Zone II: 2,500 gpm for 2 hours (0.3 million gallons)
- In Zone III: 2,500 gpm for 2 hours (0.3 million gallons)

Emergency Storage

Emergency storage is the storage volume available to meet demands during emergency situations such as pipeline failures, major trunk main failures, pump failures, electrical power outages, or natural disasters. The volume of water allocated for emergency uses is determined by the historical record of emergencies experienced and the amount of time which is expected to lapse before the emergency can be corrected. The amount of emergency storage included within a particular water distribution system is an owner option, based on an assessment of risk and the desired degree of system dependability. In California, emergency storage volumes vary by agency. It is not uncommon for emergency storage volumes to range from 25 percent of the average day demand to over 100 percent of maximum day demand. The lower emergency storage volume range is typical in systems with:

- Single pressure zones
- Adequate and reliable (including emergency power) water supply sources that could be utilized in an emergency
- Redundant pumping facilities when several pressure zones exist
- More than one transmission system source

If some, or all, of the criteria listed above do not apply, then it is appropriate to use the higher emergency storage volume range.

The City has storage capacity in each pressure zone. In addition, there is gravity flow into Zone I, one pump station (P-1 Pump Station) that can deliver water to Zone II, and two pump stations (P-2 Pump Station and P-3 Pump Station) that can deliver water to Zone III. Due to this pumping arrangement and storage capacity, it is recommended that emergency storage criteria be established at 50 percent of maximum day demand for each pressure zone.

Storage Requirements

Table 5-3 is a summary of the total storage requirements based on the existing demand by pressure zone. Table 5-4 is a summary of the total storage requirements based on the projected demand at buildout by pressure zone.

TABLE 5-3
EXISTING STORAGE REQUIREMENTS BY PRESSURE ZONE

Pressure Zone	Existing Max Day Demand (mgd)	Available Storage (MG)	Storage Requirements				Additional Storage (MG)
			Operational (MG)	Fire Flow (MG)	Emergency (MG)	Total (MG)	
Zone I	2.18	7.00	0.55	1.30	1.09	2.94	-4.07
Zone II	0.72	1.80	0.18	0.30	0.36	0.84	-0.96
Zone III	2.70	4.00	0.68	0.30	1.35	2.33	-1.68
Totals	5.60	12.80	1.40	1.90	2.80	6.10	-6.70

TABLE 5-4
BUILDOUT STORAGE REQUIREMENTS BY PRESSURE ZONE

Pressure Zone	Existing Max Day Demand (mgd)	Available Storage (MG)	Storage Requirements				Additional Storage (MG)
			Operational (MG)	Fire Flow (MG)	Emergency (MG)	Total (MG)	
Zone I	2.34	7.00	0.59	1.30	1.17	3.06	-3.95
Zone II	0.78	1.80	0.20	0.30	0.39	0.89	-0.92
Zone III	2.91	4.00	0.73	0.30	1.46	2.48	-1.52
Totals	6.03	12.80	1.51	1.90	3.02	6.42	-6.38

The storage requirements are compared to existing storage capacity in each pressure zone to determine deficiencies.

Each of the existing pressure zones has a surplus of storage capacity under existing demand conditions, and no additional storage capacity is necessary. However, this analysis is based on assuming the storage capacity of the R-1 Reservoir is used for operational, emergency, and fire flow conditions in Zone I. Due to the lower base elevation of this tank much of this storage capacity is more serviceable for Zone II than for Zone I. The R-1 Reservoir is located at a hydraulic grade line much lower than the Zone I reservoirs (clearwell and chlorine contact tank), and thus, it is not a necessary component in the operation of Zone I. However, the R-1 Reservoir does provide a fairly large amount of fire and emergency storage to Zone II and partially to Zone I.

If the R-1 Reservoir capacity (3.0 MG) is taken out of service, the analysis concludes that the existing storage is adequate. This conclusion is still valid at buildout conditions where the additional storage required remains negative. In other words, there is a surplus of storage.

At existing demands, Zone II has surplus storage of approximately 1.0 million gallons. Zone II is the smallest of the pressure zones and will not require the total storage volume allocated in the R-2 Reservoir. This additional capacity can be utilized for Zone I in an emergency; it also provides increased reliability and flexibility for pumping from Zone II to Zone III at the P-2 Pump Station.

Zones I, II, and III have a surplus of storage capacity even at buildout.

The future proposed development (Seeno Property) will require a separate pressure zone with specific pumping, piping, and storage facilities. The storage capacity for new developments should be reviewed and approved by the City at the time of development.

PUMPING CAPACITY ANALYSIS

Three pump stations deliver water to Zones II and III from Zone I. Each of the pumping stations was evaluated to determine if the existing capacity is sufficient to deliver maximum day demands to the upper pressure zones under existing and buildout demands.

Evaluation Criteria

Pump stations are normally sized to deliver maximum day demands to the pressure zone they serve. Peak hour demands are met by storage capacity in the pressure zone. Since all pressure zones in the City's water distribution system have adequate storage capacity, the pump stations should be sized to deliver maximum day demand. In the case of P-1 Pump Station, it must be sized to pump maximum day demand for Zone II as well as transfer a portion of the Zone III maximum day demand. Zone III maximum day demand must be delivered by a combination of the P-2 Pump Station (from Zone II) and the P-3 Pump Station P-3 (from Zone I).

Each pump station should consist of at least two duty pumps and one standby pump with the same capacity as the largest pump. The total capacity of the duty pumps is referred to as the firm capacity. Firm capacity should at least equal the maximum day demand.

Pumping Requirements

In order to evaluate the adequacy of pumping capacity, it is necessary to determine an operating scenario and perform the analysis, assuming a level of capacity provided by one pump station with the remainder provided by the other station. Two separate pumping scenarios were investigated: (1) Utilizing firm pumping capacity at the P-3 Pump Station (1,900 gpm); and (2) pumping to Zone III with P-3 Pump Station out of service. Analysis of these two scenarios should indicate if existing pumping capacity is sufficient for existing and buildout demands.

Pumping Scenario 1: P-3 Pump Station at Firm Capacity. Table 5-5 summarizes the pumping requirements by pressure zone for existing demands, utilizing the criteria presented above and with the P-3 Pump Station at firm capacity (1,900 gpm). Table 5-6 is a summary of the pumping requirements by pressure zone for buildout demands. Pumping requirements are compared to existing pumping capacity in each pressure zone to determine deficiencies.

TABLE 5-5
EXISTING CONDITIONS PUMP STATION FLOW REQUIREMENTS – PUMPING SCENARIO 1

Pump Station	Zone Lift	Total Pumps Duty	Total Pumps Standby	Pump Capacity (gpm)	Total Firm Capacity (gpm)	Maximum Day Demand (gpm)	Transfer To Upper Zones (gpm)	Total Capacity Required (gpm)	Additional Capacity Required (gpm)
P-1	Zone I to Zone II	2	1	2,200	4,400	500	0	500	-3,900
P-2	Zone II to Zone III	3	1	1,000	3,000	0	0	0	-3,000
P-3	Zone I to Zone III	2	1	950	1,900	1,900	0	1,900	0
Totals					9,300	2,400	0	2,400	-6,900

TABLE 5-6
BUILDOUT CONDITIONS PUMP STATION FLOW REQUIREMENTS – PUMPING SCENARIO 1

Pump Station	Zone Lift	Total Pumps Duty	Total Pumps Standby	Pump Capacity (gpm)	Total Firm Capacity (gpm)	Maximum Day Demand (gpm)	Transfer To Upper Zones (gpm)	Total Capacity Required (gpm)	Additional Capacity Required (gpm)
P-1	Zone I to Zone II	2	1	2,200	4,400	542	120	662	-3,738
P-2	Zone II to Zone III	3	1	1,000	3,000	120	0	120	-2,880
P-3	Zone I to Zone III	2	1	950	1,900	1,900	0	1,900	0
Totals					9,300	2,562	120	2,682	-6,618

Pumping Scenario 2: P-3 Pump Station Out of Service. In this scenario, the P-3 Pump Station is assumed to be out of service, and all pumping to Zones II and III must be handled by the P-1 Pump Station and P-2 Pump Station. Although not a normally expected operating scenario, this analysis will indicate the ability of the system to respond to an emergency situation. Table 5-7 is a summary of the pumping requirement by pressure zone for existing demands under this pumping scenario. Table 5-8 is a summary of the pumping requirements by pressure zone for buildout demand with the P-3 Pump Station out of service.

TABLE 5-7
EXISTING CONDITIONS PUMP STATION FLOW REQUIREMENTS – PUMP SCENARIO 2

Pump Station	Zone Lift	Total Pumps Duty	Total Pumps Standby	Pump Capacity (gpm)	Total Firm Capacity (gpm)	Maximum Day Demand (gpm)	Transfer To Upper Zones (gpm)	Total Capacity Required (gpm)	Additional Capacity Required (gpm)
P-1	Zone I to Zone II	2	1	2,200	4,400	500	1,875	2,375	-2,025
P-2	Zone II to Zone III	3	1	1,000	3,000	1,875	0	1,875	-1,125
P-3	Zone I to Zone III	0	1	950	0	0	0	0	0
Totals					7,400	2,375	1,875	4,250	-3,150

TABLE 5-8
BUILDOUT CONDITIONS PUMP STATION FLOW REQUIREMENTS – PUMP SCENARIO 2

Pump Station	Zone Lift	Total Pumps Duty	Total Pumps Standby	Pump Capacity (gpm)	Total Firm Capacity (gpm)	Maximum Day Demand (gpm)	Transfer To Upper Zones (gpm)	Total Capacity Required (gpm)	Additional Capacity Required (gpm)
P-1	Zone I to Zone II	2	1	2,200	4,400	542	2,021	2,563	-1,837
P-2	Zone II to Zone III	3	1	1,000	3,000	2,021	0	2,021	-979
P-3	Zone I to Zone III	0	1	950	0	0	0	0	0
Totals					7,400	2,563	2,021	4,584	-2,816

Evaluation Results

The results of the pumping capacity evaluation indicate that the existing pump stations have adequate firm capacity to provide maximum day demand conditions to each pressure zone, even under circumstances when the P-3 Pump Station is out of service.

A new pump station will most likely be required to convey water from Zone I to the future Seeno Property development. This new development will require separate pumping, storage, and piping facilities.

DEVELOPMENT OF HYDRAULIC NETWORK MODEL

The water distribution system hydraulic model was developed using WaterCAD, V8i, software prepared and distributed by Bentley. WaterCAD can perform steady-state and extended period simulations of hydraulic and water quality behavior in water distribution system networks.

The hydraulic network model of the existing water supply and distribution system was developed based on the City's water system base maps. Model input data that describe the physical characteristics of pipelines (length, diameter, and roughness) and junction nodes (elevations and nodal demand) were extracted from the base map or estimated from data provided by City staff.

Junction nodes define the end points of pipes and pipe segments and represent points of entry of water supply or discharges to meet water demands for a specific localized area. Analysis of the water system is accomplished by the model solving a series of hydraulic equations for pressure and flow. The result of modeling simulations is a numerical set of pressures and flows that simultaneously satisfy the equations for every pipeline and junction node in the network.

Modeling Criteria

Establishing computer modeling criteria is a key factor in model development, calibration and use of the hydraulic network model, as well as interpretation of the modeling results. Criteria used in developing the City's hydraulic model and the input data are described below:

- All pipes 8 inches in diameter and larger were included in the model, except in critical areas of the system where modeling 6-inch and 4-inch diameter pipes was necessary to complete a loop to provide accurate flow distribution.

- Pipe lengths and nominal diameters were obtained from the existing water system base maps developed and maintained by the City.

- Pipe roughness coefficient, Hazen-Williams "C" factor, was assigned based on pipe material and age.

- Pump station pipe configurations, pump performance curves, and motor nameplate information were acquired from "as-built" plans and documentation provided by City staff.

- Ground surface elevations were obtained from LIDAR data obtained from Solano County.

- Water demands are expressed in gallons per minute (gpm).

Skeletonization

The purpose of skeletonizing a water distribution system is to develop a model that accurately simulates the hydraulics of the pertinent pipelines delivering water throughout the system. Skeletonizing tends to reduce the complexity of the model which yields faster analyses, without compromising the water distribution system. The City’s water distribution system model was skeletonized to a certain extent and if necessary can be expanded to meet the needs of the City in the future.

Roughness Coefficient

Pipe material and age were the criteria used to establish a roughness, "C" factor. In general, "C" factors ranged from 100 to 115 in older portions of the City. For the City's new developing area

in the northwest, "C" factors were assumed between 120 and 130. All new pipes, regardless of material, assumed a "C" factor of 130.

Assignment of Water Demands

Water demands were distributed throughout the network model using land use data provided by the City. The land use (unit) water demand factors are defined in Section 2 and correspond to each of the City's major land use designations. These land use designations include: single family, multi-family, commercial, industrial, parks, and open space.

Water demand worksheets were developed from the City's Land Use Zone Map and used to calculate the estimated existing and buildout water demands by land use designation. Water demands were then distributed throughout the system by assigning the calculated demands to junction nodes in the network model. As a general rule, assignments were made to as many nodes as possible. It was possible for a junction node to be assigned demand from one or more adjacent land use areas. There is no direct computer link between the water demand worksheets and the WaterCAD software at this moment. The software does have the capability to assign demand according to the land use designations (land use zone map) and the model can be updated to this method in the future. For purposes of this master plan update, the water demands were assigned to junction nodes manually.

Model Calibration

A model is considered calibrated for a set of operating conditions and water uses if it can predict flows and pressures with reasonable agreement. Calibration can be defined as a two-step procedure: (1) comparison of demand and pressures predicted by the model with observed demand and pressures for the known operating conditions, and (2) adjustment of the model input data to improve agreement between observed and model predicted values. Water demands, reservoir levels, and pump operating conditions are continually changing in the City's water system. Thus, to calibrate the model, it was necessary to obtain a "snapshot" of system demand and pressures at a single point in time along with specific operating conditions (i.e. reservoir levels and pump operation). The key to creating an accurate computer model lies within the data collection and observation periods.

The City's staff conducted a series of fire flow tests at the following locations within the City on February 27, 2012 between 11AM and 2PM.

- Location 1: Stone Road at Getty Court (industrial location, in Zone I)
- Location 2: Solano Drive at Willow Court (residential location, in Zone III)
- Location 3: 1300 Drolette Way (institutional location, in Zone II)
- Location 4: West K Street at Military West (downtown location, in Zone I)

At each of these locations, the hydrant was flushed via the 2-½ inch port and a 15 ft fire hose, through a HydroBlaster diffuser.

The field results obtained for each location included:

- Fire hydrant elevation, ft
- Static pressure, psi
- Residual pressure, psi
- Pitot read, pressure in psi at flow in gpm

In addition to the individual field test results, the City provided system operational data at the time of the field tests:

- Reservoir elevations
- Pump station operation
- Total demand per Zone

To assess the model's ability to accurately represent the behavior of the existing system, pressures and flows predicted by the model were compared with the data collected in the field. Given the uncertainties involved in monitoring and duplicating conditions in the water system (including such things as actual demands, pipeline conditions, valve positions, and pump efficiency), it is assumed that the model predicted results (demand and pressure) should be within 10 percent of the field results. This 10 percent accuracy is an industry standard typically accepted for models used in master planning efforts. If the model is used for operational optimization, the modeling results should be within 5 percent of the field results.

Calibration Results

Table 5-9 is a comparison of the model results comparison with the field results. Although the accuracy at some locations approaches 10 percent, the overall results of the calibration runs indicate that the model simulates the City's water system with a high level of accuracy and correlates well with observed conditions.

TABLE 5-9
MODEL CALIBRATION RESULTS – FEBRUARY 27, 2012[a]

				Field Data			Model Data			% Difference	
Fire Flow Location	Zone	Land Use	Model Junction Node	Static Pressure (psi)	Residual Pressure (psi)	Flow (gpm)	Static Pressure (psi)	Residual Pressure (psi)	Flow (gpm)	Static Pressure	Residual Pressure
Stone Rd at Getty Ct	I	Industrial	J17-03	73	70	863	69	68	863	5.48	2.86
Solano Dr at Willow Ct	III	Residential	JF3-06	115	105	1,119	106	102	1,119	7.83	2.86
1300 Drolette Way	II	Institutional	JC5-31	105	90	957	103	87	957	1.9	3.33
West K St at Military West	I	Downtown	JC3-04	90	70	957	82	65	957	8.89	7.14

[a] Fire flow tests conducted February 27, 2012 between 11AM and 2 PM

The results of the calibration effort for February 27, 2012 indicate that the model accurately represents system performance at that time. Most of the model runs to analyze the system will be conducted under maximum day or peak hour demand conditions. The calibrated model was run under existing average day demand conditions which is typical of the time the calibration results were observed. It is recommended that hydraulic models be calibrated using maximum day demand or peak hour conditions, when the system is under the most stress. With the availability of SCADA information, it is recommended that the model be calibrated in the future using fire flow tests conducted in the summer months.

For purposes of this master plan update, the calibrated model is acceptable and may be used in all subsequent evaluations of existing and buildout system operations.

DISTRIBUTION SYSTEM ANALYSIS

The calibrated hydraulic model was utilized to evaluate the performance of the water distribution system under existing demand conditions and buildout demand conditions. The model provides information on pressure, flow, head loss, velocity, and other hydraulic information. This information is then compared to evaluation criteria that represent the level of service for the City. System deficiencies are typically observed when the evaluation criterion is not met.

Evaluation Criteria

Table 5-10 is a summary of the evaluation criteria used for the analysis of the City's distribution system hydraulic model.

TABLE 5-10
DISTRIBUTION SYSTEM EVALUATION CRITERIA

Criteria	Value
Minimum pressure – average day demand	40 psi
Minimum pressure – maximum day demand	35 psi
Minimum pressure – peak hour demand	30 psi
Minimum residual pressure – fire flow	20 psi
Maximum pressure at service connection	125 psi (PRV required at 80 psi per UFC)
Maximum velocity	8 ft/sec (typical) 12 ft/sec (short durations)
Maximum head loss	10 ft per 1000 ft
Main sizing	Greater of maximum day plus fire flow or peak hour demand

Model Simulations - Existing Demand Conditions

The most common hydraulic modeling simulations that stress the system capacity are: maximum day demand, maximum day demand plus fire flow, and peak hour. The modeling results for these simulations are compared with the evaluation criteria presented in Table 5-10 to identify any potential system deficiencies. The evaluation does not address the adequacy of the minor distribution piping between the modeled network and the point of use.

For each of the simulations for existing conditions, it is assumed that the levels in the reservoirs are at the point just before the pump stations are ON. This condition represents the worst case scenario, when the reservoir is at the lowest level in the normal operation. In other words, the system is primarily fed via gravity with flow from the reservoirs.

To ensure all the pressure zones are evaluated properly, maximum day demand and fire flow simulations are carried out within each pressure zone. Below is a list of all the modeling simulations to evaluate the existing conditions:

- Simulation 1: Max Day Demand
- Simulation 2: Peak Hour Demand
- Simulation 3: Max Day Demand + Fire Flow at Arsenal Area (5,000 gpm) Zone I
- Simulation 4: Max Day Demand + Fire Flow at Benicia High School (2,500 gpm) Zone I
- Simulation 5: Max Day Demand + Fire Flow at City Hall (3,500 gpm) Zone I
- Simulation 6: Max Day Demand + Fire Flow at Industrial Way (5,000 gpm) Zone I
- Simulation 7: Max Day Demand + Fire Flow at Robert Semple Elementary School (2,500 gpm) Zone II
- Simulation 8: Max Day Demand + Fire Flow at 1459 Drolette Way (1,500 gpm) Zone II
- Simulation 9: Max Day Demand + Fire Flow at 822 Bantry Way (1,500 gpm) Zone III
- Simulation 10: Max Day Demand + Fire Flow at Henderson Elementary School (2,500 gpm) Zone III
- Simulation 11: Max Day Demand + Fire Flow at 570 Lori Dr. (2,500 gpm) Zone 3-A
- Simulation 12: Max Day Demand + Fire Flow at 949 Rose Dr. (1,500 gpm) Zone 3-B

Each of the model runs is described below. Deficiencies resulting from the model runs were corrected by recommending projects summarized later in this section. In some instances, corrections were made through an iterative process to produce a cost-effective solution to the deficiency.

Simulation 1 – Max Day Demand. This modeling simulation assesses the capabilities of the existing water distribution system during a hot summer day.

The model run predicts that residual pressures throughout the system are at or above 35 psi, with the exception of the following areas:

- The 12-inch Zone I water main on Park Road south of Camel Road
- The 12-inch Zone III water main on Belvedere Drive west of Rose Drive

The low residual pressures (less than 35 psi) in the Park Road area may be erroneous model results due to the uncertain connectivity between the existing 12-inch water main and the water mains south of I-780.

Recommendation: Confirm the connectivity of the water mains.

Another reason for the low residual pressures in this area is the high ground elevation at certain locations. The City should consider valving off the area north ofI-780 and making it permanently part of Zone II.

The low residual pressures (less than 35 psi) in the Belvedere Drive area are due to the high ground elevations. There is a ground elevation change of approximately 40 to 50 feet from Rose Drive and Belvedere Drive to the intersection of Belvedere Drive and Regis Court. Upsizing the water mains will not have a beneficial impact.

Recommendation: Maintain the reservoir levels at or near the overflow elevation. Also, confirm the ground elevations using a GPS unit to ensure the model has correct input data.

Portions of the Zone III, particularly north of Rose Drive and along Southampton Road exhibit residual pressures during maximum day demand above 125 psi. These high residual pressures are a result of the reservoir elevation in comparison to the low ground elevations. Again, these high residual pressures are in the northeast area of Zone III and the south boundaries of Zone III. The City requirement to have all Zone III customers install individual pressure regulators at their shut-off valve ensures that users will experience system pressures within the acceptable range.

Simulation 2 – Peak Hour Demand. This modeling simulation assesses the ability of the existing water distribution system to deliver high water demands during a hot summer day in the afternoon or early evening. The simulation identifies pipelines with high velocities or head losses and areas of low pressure resulting from the increased head losses.

The modeling results indicate that on the whole, the distribution system will experience residual pressures, velocities, and head losses that are acceptable per the evaluation criteria noted in Table 5-10. The only exceptions for not meeting the minimum residual pressure are the same areas identified under Simulation 1.

Simulation 3 – Max Day + Fire Flow at Arsenal Area (5,000 gpm) Zone I. This simulation was selected to model the water system response in a critical emergency condition represented by a 5,000 gpm fire flow occurring in the arsenal area (end of Tyler Street) during a maximum day demand condition.

The modeling simulation confirms that the existing 12-inch water main on Park Road south of Camel Road will experience high head losses and residual pressures less than 20 psi under this condition. These results are not acceptable when compared to the evaluation criteria of Table 5-10. A new 18-inch pipeline is recommended on Park Road from the termination of the existing 24-inch transmission main extending south on Park Road, past Camel Road, across I-780, and connecting to the existing 14-inch in the Arsenal Area. By adding this recommended 18-inch

pipeline, the residual pressures, velocities, and head losses in the area meet the recommended criteria.

Furthermore, the existing 14-inch pipeline on Park Road west of Industrial Way to Bayshore Road is the only conduit for delivering water to the southern portion of Zone I. If this pipeline is out of service, the entire southern portion of Zone I will have to be supplied with water from the R-1 Reservoir which is not normally used to supply water to the Zone I. This deficiency can be mitigated by including a new 24-inch pipeline in Park Road from Industrial Way to Bayshore Road. This pipeline parallels the single pipeline in Park Road that connects the two portions of Zone I. This new pipeline is an extremely important project to increase the reliability of the distribution system and enhance its performance should the Park Road pipeline be damaged at any time.

In this area, it is evident that the existing 6-inch water main on Jefferson Street from Grant Street to Park Road is undersized. Model results illustrate that this section of existing 6-inch cast iron pipe on Jefferson Street should be replaced with 8-inch ductile iron pipe. In addition, the 6-inch pipeline is located inside the curb and not in the street as currently shown on the utility maps.

Finally, the existing water distribution system on Grant Street includes a dead-end 12-inch water main near Bayshore Road. The recommendation is to extend this existing water main and connect it to the existing water 8-inch water main on Bayshore Road to completely loop the distribution system in this area.

- **Recommendation 1**: Install a new 18-inch water main along Park Road from the northeast comer of the National Guard Armory to Oak Road and connect to the existing 14-inch water main in the Arsenal Area. This pipeline, a length of approximately 3,000 feet, will deliver water to the southern portion of Zone I.

- **Recommendation 2**: Install a new 24-inch transmission water main on Park Road from Industrial Way to Bayshore Road parallel to the existing 14-inch transmission main. This would be a reliability transmission main to ensure water can be delivered to the southern end of Zone I in case there is a break in the existing transmission main on Park Road.

- **Recommendation 3**: Replace approximately 950 feet of existing 6-inch cast iron pipe with 8-inch ductile iron pipe from Grant Street to Park Road on Jefferson Street. The existing pipe is in poor condition. New pipe will reduce maintenance costs.

- **Recommendation 4**: Construct approximately 500 feet of 12-inch ductile iron pipe on Grant Street from the terminus of the existing 12-inch pipeline to Bayshore Road, thus completing a loop in the area. This will provide better flow distribution and increase fire protection.

Simulation 4 - Max Day Demand+ Fire Flow at Benicia High School (2,500 gpm) Zone I. This simulation was selected to model the water system response in a critical emergency condition represented by a 2,500 gpm fire flow occurring at the Benicia High School (existing 8-inch water main on Military West) during a maximum day demand condition.

The results of this modeling simulation indicate residual pressures less than 20 psi at the fire node with a fire demand of 2,500 gpm. To mitigate this residual pressure deficiency, it is recommended to install a 12-inch pipeline in Military West between West 6th Street and Plaza de Oro. This new pipeline will ensure the residual pressures of 20 psi or greater and reduce head losses on the existing water mains on the west side of Zone I. This pipeline would extend a 12-inch pipeline that currently reduced to 8 inches at West 6th Street.

- **Recommendation 5**: Install a new 12-inch water main along Military West from West 6th Street to Plaza de Oro to extend an existing 12-inch that reduces to 8-inch at West 6th Street.

Simulation 5 - Max Day Demand + Fire Flow at City Hall (3,500 gpm) Zone I. This simulation was selected to model the water system response in a critical emergency condition represented by a 3,500 gpm fire occurring at City Hall during a maximum day demand condition.

This run indicates that residual pressures predicted at the fire node are acceptable. The model also concludes that the existing 10-inch water main on East 2nd Street south of Military East to L Street will exhibit velocities just above 8 ft/sec and head losses above 10 ft/1000 ft of pipeline. These results have a minor impact to the system and no recommendations for improvements are necessary at this time.

Simulation 6 - Max Day Demand + Fire Flow at Industrial Way (5,000 gpm) Zone I. This simulation was selected to model the water system response in a critical emergency condition represented by a 5,000 gpm fire occurring in the vicinity of Industrial Way and Lake Herman Road during a maximum day demand condition.

The results of this modeling simulation indicate that all hydraulic evaluation criteria were met.

Simulation 7 - Max Day Demand + Fire Flow at Robert Semple Elementary School (2,500 gpm) Zone II. This simulation was selected to model the water system response to a fire flow condition at the Semple Elementary School served by Zone II represented by a flow of 2,500 gpm at the intersection of East 3rd Street and S Street.

The modeling results for this simulation indicate residual pressures meeting the evaluation criteria. However, the existing 8-inch water mains on S Street and East 3rd Street may experience velocities above 8 ft/sec and high head losses above 10 ft/1000 ft of pipeline. These results are minor, of short duration, and have no impact on the system, thus no recommendations for improvements are necessary.

Simulation 8 - Max Day Demand + Fire Flow at 1459 Drolette Way (1,500 gpm) Zone II. This simulation was selected to model the water system response to a residential fire flow condition at 1459 Drolette Way in the most western end of the pressure Zone II.

The results of this modeling simulation indicate that the residual pressure at the fire node is approximately 18 to 19 psi. These low pressures are primarily due to the long dead-end condition of the existing 8-inch water main which extends approximately 1,100 ft from Cheryl Drive. A

simple solution that would mitigate the residual pressure deficiency in this area is to construct a new 8-inch water main connecting the existing dead-end water main on Drolette Way with the existing 8-inch water main on Corrigan Court. A preliminary analysis concludes that there may be an existing utility easement between 1457 Drolette Way and 1455 Drolette Way. It is assumed that this easement can be used to install a new 8-inch water main. This looping would ensure adequate residual pressures and lower velocities as well as minimizing head losses.

- **Recommendation 6**: Install a new 8-inch water main loop between the existing 8-inch water mains on Drolette Way and on Corrigan Court using the existing utility easement between 1457 and 1455 Drolette Way.

Simulation 9 - Max Day Demand + Fire Flow at 822 Bantry Way (1,500 gpm) Zone III. This simulation was selected to model the water system response in a critical emergency condition represented by a 1,500 gpm fire occurring in Zone III at the dead end of the existing 8-inch water main on Bantry Way during a maximum day demand condition.

The results of this run indicate that while the residual pressures are within the limits of the evaluation criteria, this existing 8-inch water main will experience high velocities (less than 10 ft/sec) and high head loss (greater than 10 ft/1000 ft) due to the long dead-end condition. These results are minor and have no impact on the system, thus no recommendations for improvements are necessary.

Simulation 10 - Max Day Demand + Fire Flow at Henderson Elementary School (2,500 gpm) Zone III. This simulation was selected to model the water system response to a critical fire flow of 2,500 gpm at the existing Henderson Elementary School on Hastings Drive as part of the service from Zone III.

The results of this modeling simulation indicate that all hydraulic evaluation criteria were met.

Simulation 11 - Max Day Demand + Fire Flow at 570 Lori Dr. (2,500 gpm) Zone 3-A. This simulation was selected to model the water system response in a critical emergency condition represented by a 2,500 gpm fire occurring in Zone 3-A near the Bridgeview Apartments at the intersection of Lori Drive and Sandy Way during a maximum day demand condition.

The results of this modeling simulation conclude that while adequate residual pressures are achievable at the fire junction node, the nodes further into the pressure zone (north end of Shirley Drive) will experience residual pressures less than 20 psi during this critical condition. It appears that this specific area has ground elevations that are at least 65 ft higher than the overall Zone 3-A area. This dramatic change in elevation can reduce the residual pressure as much as 30 psi.

Recommendation: Confirm the ground elevations in this area prior to defining improvements to mitigate the deficiency noted by the modeling results.

Furthermore, analysis of the existing distribution system in this area concludes that Zone 3-A has a single source of supply, the existing 8-inch water main crossing I-780 from Southampton Road to the intersection of West 7th Street and Lori Drive. This single source water main for Zone 3-A

will exhibit high head losses (as high as 120 ft/1000 ft) and high velocities (as high as 16 ft/sec) during this type of critical conditions (maximum day plus fire flow). In addition, a potential out-of-service condition on this existing 8-inch would require the City to service Zone 3-A manually by opening zone valves. For redundancy and operational continuity, it is recommended to install a new 12-inch water main on West 7th Street from Southampton Road to Lori Drive across I-780. This will improve the residual pressures in this system and reduce head losses.

- **Recommendation 7**: Install a new 12-inch water main on West 7th Street extending from Southampton Road to Lori Drive across I-780.

In this same general area, there is a deficiency in the ability to feed water to the western end of Zone II. In June 2010, a pipe break in Military West left over 300 homes and an elementary school completely out of water. For emergency purposes, installing a new pressure reducing valve (PRV) station on West 7th Street will allow the City to feed the western end of Zone II. This recommended PRV station will only be activated if there is a major break on the 12-inch water main between West 5th Street and West 7th Street along Military West. The PRV station would be located directly across the street from the existing Zone 3-A station and provide water through Carolina Drive, Anita Circle, and Cheryl Drive.

This PRV station is an emergency back-up recommendation, and will be slated for inclusion in a future CIP, tentatively scheduled for FY 2021-32 planning period.

- **Recommendation 7A**: Install a new PRV station to serve as emergency back-up for feeding water to the western end of Zone II.

An additional alternative to mitigating flow restrictions in western Zone II would be installation of a pipeline through the easement between Alto Loma and Raymond Drive. The City's utility maps show that the pipelines have blind flanges set for a future connection.

Simulation 12 - Max Day Demand + Fire Flow at 949 Rose Dr. (1,500 gpm) Zone 3-B. This simulation was selected to model the water system response during a fire flow condition of 1,500 gpm occurring in Zone 3-B near 949 Rose Drive.

The results of this modeling simulation indicate that all hydraulic evaluation criteria were met.

Buildout Hydraulic Model

The buildout conditions hydraulic model was developed by increasing demands in certain areas to account for development of existing undeveloped land and areas planned for future development. The majority of the future demand will come from infill projects within Zone I. Other major development, like the Seeno Property is assumed to include a new booster pump station, storage facilities, and pipelines from Zone I to provide adequate water service to the area. It is assumed that the new booster pump station for this new development will be sized to provide the necessary flow to meet all future demand conditions of this development. Therefore, for purposes of modeling the buildout system, demands of peak hour and maximum day plus fire flow were evaluated at the point where the booster pump station may be located.

The simulations identified for the existing conditions were again executed for the future buildout demand condition. The future buildout demand model simulations conclude that the proposed improvements (recommendations) were still valid. No additional system improvements are necessary to meet the future buildout demands with the exception of separate pumping, piping, and storage facilities for the future Seeno Property development.

A final analysis of the buildout distribution system concludes that delivery of potable water to the distribution system relies on a key 30-inch water transmission main from the existing water treatment plant. This 30-inch water transmission main has been recently confirmed to be of asbestos cement pipe (ACP) material. A potential break in this existing 30-inch ACP transmission main would severely impact water service to the City's service area. A recommendation is to install a new 36-inch ductile iron pipe transmission main parallel to the existing transmission main to serve as a redundancy main. This new parallel 36-inch transmission main would extend from the water treatment plant to West Industrial Way (approximately 2,700 feet) and to serve Seeno's Business Park.

- **Recommendation 8**: New 36-inch redundant transmission water main (approximately 2,700 feet) from water treatment plant to West Industrial Way.

In addition, the City has considered entering into an agreement with the City of Vallejo to construct an emergency inter-tie connection between the City of Vallejo and the City of Benicia. The City of Vallejo has an existing 12-inch water main on Benicia Road just west of the City near Columbus Parkway. It has been conjectured that an inter-tie connection would extend from this 12-inch water main, along Columbus Parkway, across I-780 near Rose Drive, follow the service road and connect to the City of Benicia Zone I water distribution system near Military West and K Street. This emergency inter-tie connection would provide the City with a means to serve Zone I during a catastrophic emergency that may put the existing water treatment plant out of service for a substantial period.

- **Recommendation 9**: New 12-inch inter-tie connection from the City of Vallejo to the City of Benicia (approximately 8,200 feet) along Columbus Parkway and service road to Military West and K Street.

The City should further investigate the recommendation (see Buildout Hydraulic Model) for the construction of an emergency interconnection (inter-tie) with the City of Vallejo to receive treated water in an emergency. The two systems are located very close to each other on the west side of the Benicia. This inter-tie could consist of a pipeline connected to the existing water main on Benicia Road in the City of Vallejo near Columbus Parkway. A feasibility study should be completed first to confirm that the pressures at the proposed connection would match with the existing pressures in the City of Benicia's system. The study would consist of modeling analyses for the various pipeline alignments and potential conditions.

RAW WATER SUPPLY SYSTEM EVALUATION

The City has two sources of raw water that can be delivered to the water treatment plant through the raw water transmission system; see also Sections 3 & 4. Both the Cordelia Pump Station and

the North Bay Aqueduct (NBA) Pump Station can pump different sources of water to the raw water diversion structure at the Benicia Water Treatment Plant (WTP).

The NBA Pump Station conveys surface water from the Cordelia Forebay using three pumps with a total pumping capacity of 32.0 cfs (20.7 mgd). This pump station is owned and operated by the Department of Water Resources (DWR).

The Cordelia Pump Station conveys surface water from the Putah South Canal Terminal Reservoir using four pumps with a total pumping capacity of 28.5 cfs (18.4 mgd). The Cordelia Pump Station is owned and operated by the City.

The NBA receives Delta source water from Barker Slough Pumping Plant (BSPP) on Barker Slough. The Delta source water pumped by the BSPP flows into the Cordelia Forebay through the North Bay Aqueduct. This pump station (BSPP) has a rated design capacity of 162 cfs. The BSPP has nine pumps installed: two pumps are rated at 14 cfs and seven are rated at 28 cfs. A tenth pump rated at 28 cfs for Fairfield and Vacaville's 20 cfs peaking capacity has not been installed. Due to pumping discrepancies, the Solano County Water Agency (SCWA) and DWR have performed flow testing and hydraulic modeling to determine the actual pumping capacity. Based on their analyses, it was determined that the pipe pressures needed to be restricted by limiting pumping to six large and two small pumps. This results in a BSPP operational capacity of 130 cfs and provides Benicia 26.6 cfs of NBA capacity.

To provide for redundancy and account for electrical and mechanical breakdowns, it is recommended that "Firm Capacity" be utilized in raw water system master planning. Firm capacity is defined as the capacity available with the largest pump out of service. Because the operational capacity requires a large pump to be out of service to limit pipe pressures, the 26.6 cfs would be Benicia's Firm Capacity.

In addition to Firm Capacity impacts, the California Department of Fish and Game issued an incidental take permit in 2009 for Longfin Smelt for the NBA. The permit can restrict diversions in the NBA to 50 cfs from January 15 to March 30 in dry and critically dry years. If the limit is applied, Benicia's NBA flow allocation would be:

$$50 \text{ cfs} \times 20.4\% = 10.2 \text{ cfs}$$

These adjusted flow capacities are integral to ensuring reliable and optimal raw water deliveries in the future.

RAW WATER DELIVERY OPTIMIZATION

Delivery optimization is analyzed using two separate water supply conditions:

1. Normal Year Demand (2035) – Firm Capacity
2. Dry Year Demand (2035) – Longfin Smelt Pumping Restriction

In the following tables, the buildout demand is compared with both the Firm Capacity supply and a dry year supply with the Longfin Smelt Pumping Restriction. The purpose of the tables is to

display how the future demands compare to the restricted delivery of supply water, thus determining if there is adequate supply.

Firm Capacity Delivery with Normal Year Demand (2035)

Table 5-11 is a summary of the buildout monthly demand compared to the City's surface water flow allocation during a normal year. The water supply to the City of Benicia consists of raw water from the NBA and Solano Irrigation District (SID). These supplies are balanced to compensate for the total buildout demand in a Normal Year.

TABLE 5-11
NORMAL YEAR RAW WATER OPTIMIZATION (2035) – FIRM CAPACITY

	Demand[a]	Supply, AF/month		
Month	**AF/month**	**NBA**	**SID[b]**	**Total**
January	597	497	100	597
February	597	497	100	597
March	716	566	150	716
April	955	805	150	955
May	1,195	1,095	100	1,195
June	1,313	1,213	100	1,313
July	1,433	1,333	100	1,433
August	1,433	1,333	100	1,433
September	1,313	1,213	100	1,313
October	1,075	775	300	1,075
November	716	416	300	716
December	597	497	100	597
Total	11,940	10,240	1,700	11,940

[a] Normal year water demand (2035) as presented in the City of Benicia's 2010 UWMP.
[b] SID supply is not limited on a monthly basis, but it is restricted to an annual maximum of 2,000 AF

The Firm NBA Capacity for Benicia is 26.6 cfs or (1,580 AF/month). Based on the firm capacity and the analysis presented in Table 5-11, the City has adequate firm capacity in the NBA to meet its Normal Year water demand at the predicted 2035 buildout demand. The SID supply is utilized throughout the year to balance and meet the total demand.

Pumping Restricted Delivery with Dry Year Demand (2035)

Table 5-12 is a summary of the monthly demand compared to the City's surface water flow allocation during a dry year and Longfin Smelt Pumping Restriction. The water supply to the City consists of raw water from both the NBA and SID.

TABLE 5-12
DRY YEAR RAW WATER OPTIMIZATION (2035) – LONGFIN SMELT PUMPING RESTRICTION

	Demand[a]	Supply, AF/month		
Month	**AF/month**	**NBA**	**SID[b]**	**Total**
January	597	397	200	597
February	597	397	200	597
March	716	516	200	716
April	955	755	200	955
May	1,195	1,095	100	1,195
June	1,313	1,213	100	1,313
July	1,433	1,333	100	1,433
August	1,433	1,333	100	1,433
September	1,313	1,213	100	1,313
October	1,075	775	300	1,075
November	716	416	300	716
December	597	497	100	597
Total	11,940	10,240	2,000	11,940

[a] Dry year water demand (2035) as presented in the City of Benicia 2010 UWMP.
[b] SID supply is not limited on a monthly basis, but it is restricted to an annual maximum of 2,000 AF

The NBA Capacity for Benicia during January 15 to March 30 is 10.2 cfs or (606 AF/month). Based on the capacity restriction and the analysis presented in Table 5-12, the City of Benicia has adequate capacity in the NBA to meet its Dry Year water demand during Longfin Smelt Restrictions.

RAW WATER SUPPLY TRANSMISSION SYSTEM

The raw water supply transmission system from the Cordelia Forebay and/or the Terminal Reservoir is currently in good shape and is not in need of major improvements. The primary concerns are with the corrosion protection of the transmission pipeline and the reliance on a single 36-inch raw water transmission pipeline to supply raw water to the water treatment plant.

Limited corrosion investigations have been conducted by the City on the transmission pipeline, primarily the 30-inch pipeline, from the NBA Pump Station. The results of the investigations are contained in a report by J.H. Nolt Associates dated January 1996. Facilities include replacement of the rectifiers, anode beds, test stations, and the addition of several more test stations. The improvements will mitigate corrosion and increase the life of the pipeline. The recommendations contained in this study have, for the most part, been implemented.

Subsequent to the 1996 corrosion study, the City completed a similar investigation to provide cathodic protection facilities for the 10,000 foot long, 24-inch diameter Lake Herman Transmission Pipeline (30-inch, 24-inch, and 20-inch). The recommendation to install a cathodic protection system for this pipeline was completed in 2011 as part of the Lake Herman Transmission Pipeline Cathodic Protection Rehabilitation Project.

The City is currently embarking on additional rehabilitation for the single 36-inch Raw Water Transmission Line (RWTL). The project will consist of the following elements:

1. Replace three 16-inch ball valves on the existing 36-inch RWTL with 36-inch butterfly valves.
2. Replace all 6-inch plug valves from Line Valve #2 to Line Valve #4.
3. Replace the impressed current rectifiers and anode beds at CR-5, CR-6, CR-9, CR-10, and CR-11.
4. Replace the cathodic protection test stations on the existing 30-inch NBA Transmission Line.
5. Install a line valve on the existing 24-inch Cordelia Pump Station discharge pipeline.

These improvements are summarized as follows:

- 36-inch RWTL Cathodic Protection Improvements: Replace current rectifiers and anode beds as well as cathodic protection test stations.
- 36-inch RWTL Improvements: Replace ball valves and plug valves.
- Cordelia Pump Station: Install line valve on discharge pipeline.

The City does rely, however, on only one long transmission pipeline to deliver water from either source (pump station) to the existing water treatment plant on Lake Herman Road. This puts the raw water supply in a vulnerable position as a shutdown of this pipeline would restrict raw water delivery to the plant and ultimately potable water to the City. The City is fortunate to have adequate storage capacity in each of the pressure zones which would provide a measure of relief if raw water deliveries were interrupted for short periods of time. The City could also deliver raw water from Lake Herman to the WTP and to the Valero Refinery; however, this supply volume is limited to only 30 days at maximum withdrawal.

Construction of an additional transmission pipeline to provide reliability would be cost-prohibitive. The City's current action plan to handle loss of the RWTL includes the use of water stored in Lake Herman. This involves pumping raw water from the lake (manually) using the Lake Herman Pump Station to convey the raw water to the water treatment plant. Valero Refinery would receive Lake Herman water by gravity.

RECOMMENDED IMPROVEMENT PROJECTS

The City has identified some projects which are currently either in planning, design, under construction, or part of the City's water main rehabilitation program. Here is a summary of those projects:

A. **Grant/Adams Improvement Project:** This project consists of a new Zone I 12-inch water main on Grant Street just west of Polk Street to Adams Street.
B. **K Street/Military West Connection Project:** This project consists of a new 8-inch water main along Military West from West K Street to West 14th Street to complete a loop of the system.
C. **Replace 4-inch CIP in Carolina Drive:** Replace approximately 1,680 feet of existing 4-inch cast iron pipe in Zone II with 8-inch ductile iron pipe. Existing main is undersized and in poor condition. Larger main will provide better flow distribution and increased fire protection.
D. **Replace 4-inch CIP in East 5th Street from H Street to L Street:** Replace approximately 1,100 feet of existing 4-inch cast iron pipeline and replace with 12-inch ductile iron pipe. Eliminates undersized main in poor condition located under curb. Provides better flow distribution and increases fire protection.

Figure 5-1 is a schematic representation of these projects.

The recommended improvement projects outlined based on the storage and pumping capacity analyses as well as the hydraulic evaluation presented as part of this master plan update are summarized below. The majority of these projects are immediately required to correct current deficiencies under maximum day demand plus fire flow conditions and/or peak hour demand conditions.

Other projects are immediately necessary to increase reliability of the system and enhance system performance in the event of an emergency.

LEGEND:

PROJECT IN DESIGN/PLANNING/CONSTRUCTION

(A) NEW 12" IN GRANT STREET FROM POLK STREET TO ADAMS STREET

(B) NEW 8" IN MILITARY WEST FROM WEST K STREET TO WEST 14TH STREET

(C) REPLACE 4" CIP IN CAROLINA DRIVE

(D) REPLACE 4" CIP IN EAST 5TH STREET FROM H STREET TO L STREET

RECOMMENDED PIPELINE PROJECT

(1) NEW 18" IN PARK ROAD FROM THE ARMORY TO OAK ROAD

(2) NEW 24" IN PARK ROAD FROM INDUSTRIAL WAY TO BAYSHORE ROAD

(3) REPLACE 6" IN JEFFERSON FROM GRANT STREET TO PARK ROAD

(4) NEW 12" IN ADAMS STREET FROM GRANT STREET TO BAYSHORE ROAD

(5) NEW 12" IN MILITARY WEST BETWEEN 6TH STREET TO PLAZA DE ORO

(6) NEW 8" ZONE II LOOP FROM DROLETTE WAY TO CORRIGAN COURT

(7) NEW 12" ZONE III PIPELINE FROM SOUTHAMPTON ROAD TO LORI DRIVE

(8) NEW 36" TRANSMISSION MAIN - RELIABILITY FROM WTP TO EAST 2ND STREET

(9) NEW BENICIA-VALLEJO INTER-TIE CONNECTION

(10) PUMP STATION P-2 MCC REPLACEMENT

(11) RESERVOIR R-1 RECOATING

(12) RESERVOIR R-2 RECOATING

N

0 1250 2500

1" = 1250'

FIGURE 5-1

CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

RECOMMENDED IMPROVEMENT PROJECTS

NV5 BEYOND ENGINEERING

Pipeline Projects

The pipeline projects identified by the modeling simulations include the following:

1. **New 18-inch transmission main in Park Road for Zone I.** Install a new 18-inch pipeline in Park Road from the northeast corner of the National Guard Armory to Oak Road, a length of approximately 3,000 feet, to deliver water to the southern portion of Zone I. This pipeline is required to enable extension of the Zone II boundary to the east to include the Camel Barn area, which currently exhibits low pressures. Additional minor modifications to the piping in the area will be required to extend the pressure zone and separate it from Zone I.
2. **New 24-inch transmission main in Park Road from Industrial Way to Bayshore Road:** Install a new 24-inch transmission water main on Park Road from Industrial Way to Bayshore Road parallel to the existing 14-inch transmission main. This would be a reliability transmission main to ensure water can be delivered to the southern end of Zone I in case there is a break in the existing transmission main on Park Road.
3. **Replace 6-inch CIP in Jefferson Street:** Replace approximately 950 feet of existing 6-inch cast iron pipe with 8-inch ductile iron pipe from Grant Street to Park Road. The existing pipe is in poor condition and the new pipe will reduce maintenance costs.
4. N**ew 12-inch water main in Adams Street from Grant Street to Bayshore Road:** Construct approximately 500 feet of 12-inch ductile iron to complete a loop in the area. This project will provide better flow distribution and increases fire protection.
5. **New 12-inch water main in Military West for Zone I:** Install a new 3,600 foot long, 12-inch diameter pipeline in Military West between West 6th Street and Plaza de Oro to upsize an existing 8-inch pipeline. This pipeline will correct deficiencies observed for meeting fire flows at Benicia High School. It will also bolster firefighting capabilities in the west side of Zone I.
6. **New 8-inch water main loop from Drolette Way to Corrigan Court.** Install a new 250 foot long, 8-inch diameter water main to loop the dead-end water mains on Drolette Way and Corrigan Court. This looped water main will provide additional capacity to the area and meet fire flow demands.
7. **New 12-inch water main on West 7th Street for Zone III to serve Pressure Zone 3-A:** Install a new 1,300 foot long, 12-inch diameter pipeline from Southampton Road to Lori Drive across I-780 to provide additional capacity for Zone 3-A. This pipeline will also provide redundancy in source to Zone 3-A.
8. **New 36-inch reliability transmission main from WTP:** New 36-inch redundancy transmission water main (approximately 2,700 feet) from water treatment plant to West Industrial Way.
9. **New Benicia-Vallejo Inter-Tie Connection:** New 12-inch inter-tie connection from City of Vallejo to City of Benicia along Columbus Parkway and service road to Military West.

Pump Station Projects

The pumping capacity analysis described earlier in this section identified that the existing pump stations have acceptable pumping capacity to meet both the existing conditions and buildout demands.

Although capacities of the pump stations are adequate, some upgrades are required. The Motor Control Center (MCC) at P-2 Pump Station is scheduled for replacement in the next five years. This is the oldest pump station, built in the 1960s. The MCC, associated motor starters and electromechanical controls, and switchboard have reached their service life. Also, it is very difficult to find replacement parts for failed equipment.

Pump station improvement projects include**:**

10. **P-2 Pump Station MCC Replacement:** Replace aging motor control center and associated controls.

Storage Projects

The analysis concludes that additional storage capacity is not required within the existing pressure zones during existing demands or buildout demands.

Significant costs to maintain the reservoirs are incurred when it is time to recoat the interior and exteriors of the storage tanks. Reservoirs R-1 and R-2 are scheduled to be recoated more than 10 years in the future. For budgeting purposes, the following projects are scheduled to be completed after the year 2021.

11. **Recoating of R-1 Reservoir:** Routine maintenance recoating of interior and exterior of storage tank
12. **Recoating of R-2 Reservoir:** Routine maintenance recoating of interior and exterior of storage tank

New Development Projects

The future development - Seeno property - will be served by separate facilities from Zone I. These facilities and estimated costs are unknown at this time. Pumping and storage capacities will need to be calculated once the project is defined. The development will require in-system improvements and possibly may require more than one pressure zone. Determination of these facilities and costs is dependent on the specific development plans that are prepared for the site and is beyond the scope of this master plan. Facility costs will be borne by developers.

Several pipeline projects have been identified through the hydraulic evaluation and are necessary to correct hydraulic deficiencies and/or improve operational reliability and performance. Some pipeline projects may be identified by City staff to reduce maintenance, improve water quality, or increase fire protection. Unless otherwise noted, the cost estimates are based on the following

assumptions: typical urban street construction; pavement removal and repaving; many crossing existing utilities; traffic control required; minimum cover; no cathodic protection.

Raw Water Transmission System Projects

The recommended improvements to the raw water transmission system are as follows:

- 36-inch RWTL Cathodic Protection Improvements: Replace selected rectifiers and anode beds as well as cathodic protection test stations.
- 36-inch RWTL Improvements: Replace ball valves, and plug valves.

The improvements to the Cordelia Pump Station have been initiated at the time of this master plan study, therefore they will not be included as part of the recommended projects.

Capital Improvement Program

Total project costs are provided for each project as summarized above and grouped by facility type. These summarized project costs can be found on Table 5-13.

The total project cost includes the baseline construction cost, a contingency, and other costs associated with engineering, administration and construction management. Baseline construction costs for new facilities are based on cost curves, engineering judgment, recent bid prices and historical trends and are not based on detailed engineering design and analysis. Therefore, the construction cost estimates are considered to range from +50 percent to -30 percent of the expected bid price. Baseline construction costs for the projects will reflect an Engineering News Record (ENR) construction cost index representing costs for June 2012 (ENR 9291). Assumptions are based on normal construction; unusual construction must be addressed individually. Contractor overhead and profit are included in the costs. Because full knowledge of site-specific conditions for each proposed project is limited at the master planning stage, a 20 percent contingency will be applied to the Baseline Construction Cost to account for unforeseen events and unknown conditions. A cost equal to 20 percent of the construction cost (including contingencies) will be applied to account other costs for additional items such as engineering, administration, legal, and construction management costs.

Staging and prioritization of the projects and development of the 10-year Capital Improvement Program is presented in Section 8.

TABLE 5-13
RECOMMENDED DISTRIBUTION SYSTEM IMPROVEMENTS

Project Description	Quantity	Units	Baseline Construction Cost[a]	Contingency Cost[b]	Engineering/ Admin/Legal /CM Costs[c]	Total Cost
Distribution System						
1. New 18-inch pipeline in Park Road for Zone I for Arsenal area	2,500	LF	$350,000	$70,000	$84,000	$504,000
2. New 24-inch transmission main in Park Road for Zone I - Reliability	1,550	LF	$247,000	$50,000	$60,000	$357,000
3. Replace 6-inch DIP in Jefferson Street from Grant Street to Park Road	850	LF	$77,000	$15,000	$18,000	$110,000
4. New 12-inch main in Adams Street from Grant Street to Bayshore Road	500	LF	$55,000	$11,000	$13,000	$79,000
5. New 12-inch pipeline in Military West for Zone I	4,175	LF	$459,000	$92,000	$110,000	$661,000
6. New 8-inch water main to loop Drolette Way with Corrigan Court	250	LF	$23,000	$5,000	$6,000	$34,000
7. New 12-inch Zone III pipeline to serve Pressure Zone 3-A	1,200	LF	$132,000	$26,000	$32,000	$190,000
8. New 36-inch Reliability Transmission Main	2,800	LF	$504,000	$101,000	$121,000	$726,000
9. New 12-inch Vallejo-Benicia Inter-tie Connection	8,200	LF	$2,440,000	$480,000	$580,000	$3,500,000
10. P-2 Pump station MCC Replacement	1	LS	$208,000	$42,000	$50,000	$300,000
11. Recoating of R-1 Reservoir (interior & exterior)	1	LS	$208,000	$42,000	$50,000	$300,000
12. Recoating of R-2 Reservoir (interior & exterior)	1	LS	$208,000	$42,000	$50,000	$300,000
Raw Water Transmission System						
36-inch RWTL CP Improvements	1	LS	$280,000	$55,000	$65,000	$400,000
36-inch RWTL Improvements - Valve Replacement	1	LS	$140,000	$28,000	$32,000	$200,000

[a] Construction costs based on an ENR Index of 9291 for June 2012 (20 cities average).
[b] Contingency at 20% of baseline construction costs.
[c] Engineering/Admin/Legal/Construction Management Costs at 20% of sum of baseline construction cost and contingency.

SECTION 6 – WATER TREATMENT PLANT

Section 6 summarizes an evaluation of the City of Benicia Water Treatment Plant. The evaluation was conducted at six levels, including: 1) plant capacity; 2) regulatory compliance and safety; 3) treatment process performance, 4) sludge treatment and disposal; 5) electrical systems and controls; and 6) operations. Capital improvements identified for the water treatment plant will be incorporated into the Capital Improvement Program in Section 8. The treatment plant evaluation included the following tasks:

- Reviewing updated water demand projections and determining whether plant capacity will need to increase
- Determining regulatory compliance status
- Assessing treatment process performance as compared to established standards, operational goals, and voluntary targets
- Evaluating sludge treatment and disposal facilities and operations
- Conducting an electrical engineering review of existing electrical panels, switchgear, and control systems
- Identifying necessary operational improvements
- Recommending capital improvement projects

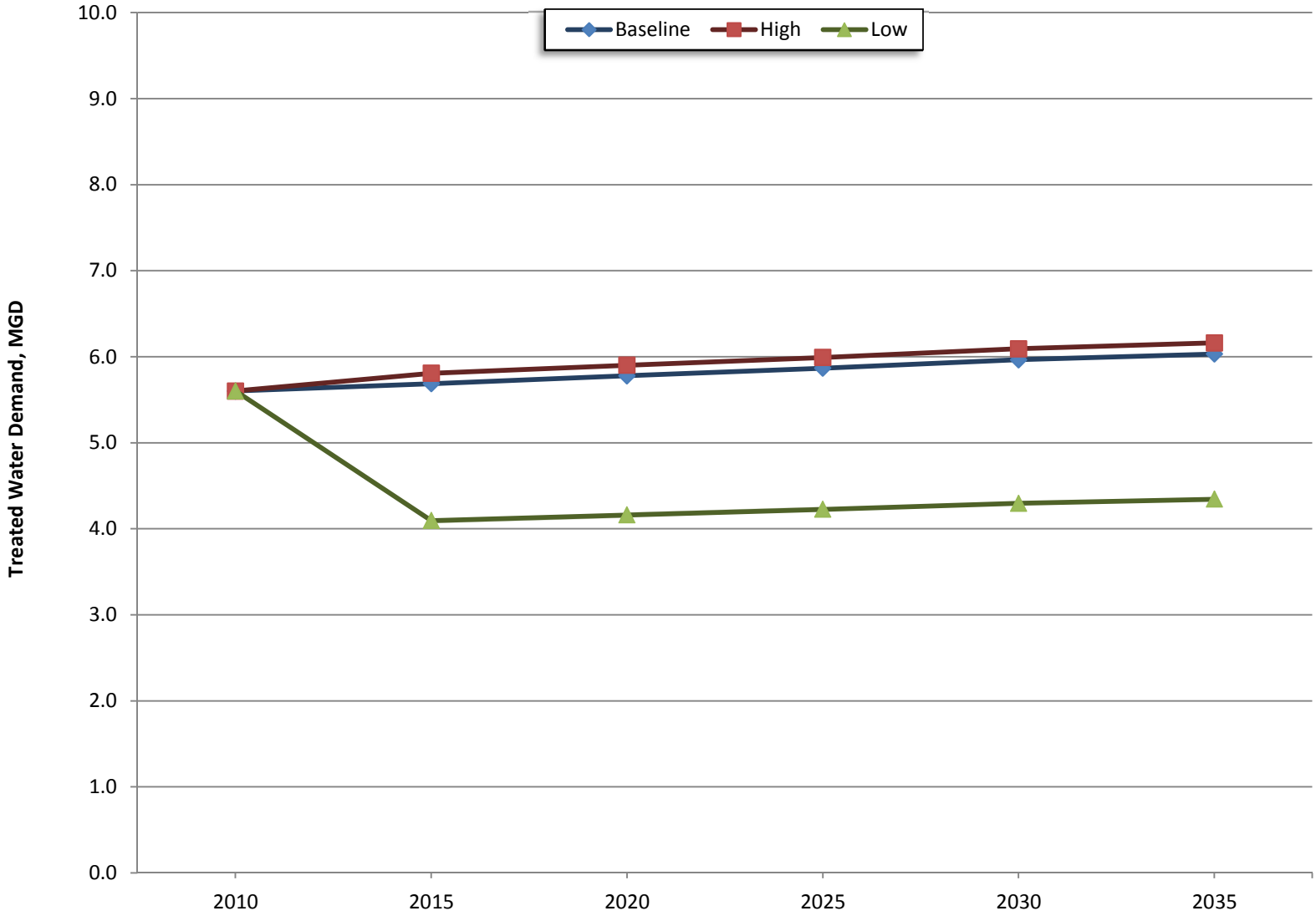
CAPACITY REQUIREMENTS

The City of Benicia Water Treatment Plant has a current production capacity of 12 mgd. The plant was expanded from 6 mgd to 12 mgd in 1989, and at that time it was determined that two additional 6 mgd expansions would be required in order to meet future treated water demands for the City. The staging of these future expansions was based on high treated water demand estimates developed for the 1990 Master Plan and were scheduled to be completed prior to 1994, and by the year 2003, respectively. Since that time, however, growth, and treated water demands associated with anticipated development north of the City have not met projections. The maximum day treated water flow recorded at the plant to date has been 10 mgd (total amount of water treated in a 24-hour period). As a result, the planning of future expansions of the Benicia Water Treatment Plant should be modified.

Shown in Figure 6-1 are the revised maximum day treated water demand projection curves based on demands developed in Section 2. The curves shown represent baseline, low, and high treated water demand projections for the City. Based upon these demand projections, water treatment plant expansion is not necessary.

REGULATORY COMPLIANCE ASSESSMENT

Included as Appendix B is a technical memorandum identifying gaps between regulatory requirements (current and pending) and existing facilities. The following specific items are discussed in the memorandum: 1) disinfection byproducts; 2) fluoridation; 3) chemical storage; 4) sludge lagoons; and 5) the regulatory setting for proposed projects. Based upon information presented in the memorandum, observations during plant visits, and discussions with operators,



CITY OF BENICIA

2012 WATER SYSTEM MASTER PLAN

TREATED WATER MAXIMUM DAY DEMANDS

FIGURE 6-1

several improvements are recommended for regulatory compliance and safety. These improvements are summarized below.

Table 6-1 identifies regulatory-driven improvement projects anticipated for the City of Benicia Water Treatment Plant. These improvements are based upon an independent assessment of the regulatory challenges facing future operations of the existing water treatment plant facilities, and available information regarding impending new laws and regulations.

TABLE 6-1
SUMMARY OF IMPROVEMENTS FOR REGULATORY COMPLIANCE

Regulatory Requirement	Source/Reference	Recommended Improvement
Reduce concentrations of disinfection byproducts	Federal Stage 2 DBPR [1]	Install magnetic ion exchange system
Separate incompatible materials that could react violently if mixed	California Fire Code [2]	Chemical tank farm improvements
Prevent unauthorized discharges of wastewater and sludge	General NPDES Permit [3]	Re-line sludge lagoons
Maintain chlorine gas risk management plan	Federal RMP Rule [4]	Convert from chlorine gas to sodium hypochlorite solution

Each of the improvements is described below.

Install Magnetic Ion Exchange System. With careful treatment plant operation and strategic seasonal use of North Bay Aqueduct and Putah South Canal waters, the City has demonstrated the ability to comply with current and pending disinfection byproducts regulations. Adequate removal of organic precursors within the existing water treatment plant, however, requires elevated coagulant doses and generates large quantities of sludge. The sludge lagoons are heavily loaded, and disposal of dried sludge has been expensive. To address this issue, City staff is considering installation of a magnetic ion exchange system to remove dissolved organic carbon upstream of existing flocculation and sedimentation units.

Additional study is needed prior to design and implementation. A life-cycle cost analysis should be conducted to confirm that the costs associated with magnetic ion exchange will be less than the costs of current practices. Pilot testing should be conducted to verify process performance, operational parameters, and brine waste generation rates. Brine waste obtained from pilot testing or existing full-scale facilities should be used to evaluate disposal options. Because the City of Fairfield utilizes the same water sources as Benicia and is in the process of studying (pilot testing) magnetic ion exchange, Benicia staff should request information and attempt to benefit from lessons learned in Fairfield.

Chemical Tank Farm Improvements. The chemical tank farm at the City water treatment plant is equipped with a secondary containment system, but certain tanks within the secondary containment system contain chemicals (e.g. sodium hydroxide and hydrofluosilicic acid) which appear to be incompatible. Adequate separation of these tanks should be provided as part of a chemical tank farm improvements project. A detailed evaluation of secondary containment system capacity, structural integrity, and remaining service life of chemical tanks should also be conducted. Replacement of four older chemical storage tanks is anticipated.

City staff has identified several chemical use changes that should be considered in planning and design of the tank farm improvements project, including: 1) conversion from chlorine gas to sodium hypochlorite solution, 2) using polyorthophosphate in lieu of caustic soda for corrosion control, and 3) increasing the alum storage capacity. Two sodium hypochlorite tanks, a polyphosphate tank, and an alum tank should be added.

Re-Line Sludge Lagoons. Soil cement lining has been installed in two of the existing lagoons (4 and 5). Following the next sludge removal, the lining in these lagoons should be assessed to confirm that the soil-cement is performing adequately. Based upon the findings, the City should proceed with lining upgrades for the other four lagoons (1, 2, 3, and 6).

Convert from Chlorine Gas to Sodium Hypochlorite Solution. To avoid the costs of maintaining a chlorine gas risk management program and complying with process safety requirements, the existing gas chlorination system should be replaced with a liquid sodium hypochlorite system. For the sodium hypochlorite system, two alternatives were considered: 1) purchasing commercial-grade sodium hypochlorite solution; and 2) generating sodium hypochlorite solution on-site. It is generally considered that due to greater capital cost, complexity, and potential waste disposal issues associated with on-site generation, the use of commercial-grade sodium hypochlorite solution is preferable. Prior to selecting either of the two liquid sodium hypochlorite system, it is recommended that a comprehensive comparison be prepared, including discussions on costs, maintenance, and ease of operation.

WATER TREATMENT PLANT PERFORMANCE EVALUATION

Water treatment plant operational data from 2011 were reviewed in detail, and treatment process performance was assessed relative to the following three sets of criteria: 1) the water quality goals presented in the 1996 Water System Master Plan [5], 2) Partnership for Safe Water (PSW) Phase IV performance goals [6], and 3) California Code of Regulations, Title 22 performance standards for conventional filtration facilities [7]. Findings are summarized below.

Coagulation, Flocculation, and Sedimentation Process Performance

Performance criteria for the coagulation, flocculation, and sedimentation processes are summarized in Table 6-2. The criteria focus upon the turbidity and pH of sedimentation basin effluent (i.e. applied water).

TABLE 6-2
SUMMARY OF PERFORMANCE CRITERIA
COAGULATION, FLOCCULATION, AND SEDIMENTATION PROCESSES

Parameter	Value
Partnership for Safe Water, Phase IV Performance Goals	
Settled water turbidity, when raw water turbidity ≤10 NTU	<1.0 NTU 95 percent of the time
Settled water turbidity, when raw water turbidity >10 NTU	<2.0 NTU 95 percent of the time
1996 Water System Master Plan	
Settled water turbidity	<2 NTU
Settled water pH	>5.5 and <7.0 [a]

[a] No longer applicable. This performance criterion is appropriate for enhanced coagulation of North Bay Aqueduct water. When treating Putah South Canal water, an optimal alum dose typically results in a pH of 7.0-7.2.

Operational logs were reviewed to determine whether these criteria were satisfied during 2011, and the findings are summarized in Table 6-3. In general, the processes performed well. The data suggest that the treatment facilities and operators handled high raw water turbidities well but, due to adverse weather conditions and other factors, several minor process upsets occurred during the year.

TABLE 6-3
COAGULATION, FLOCCULATION, AND SEDIMENTATION PROCESSES
PERFORMANCE REVIEW - 2011

Parameter	Units	Min	Avg	Max	Percent of samples meeting criteria
Settled water turbidity when raw water turbidity is ≤10 NTU	NTU	0.1	0.6	5.4	90
Settled water turbidity when raw water turbidity is >10 NTU	NTU	0.1	0.9	4.3	98
Settled water turbidity, overall	NTU	0.1	0.8	5.4	99

Filtration Process Performance

According to California Code of Regulations, Title 22, Section 64657.30, combined filter effluent turbidity shall be less than or equal to 0.3 NTU in at least 95 percent of the measurements taken each month. Facilities meeting this requirement are given credit for at least

99 percent (2-log) *Cryptosporidium* removal. In addition, the PSW Phase IV Performance Goals indicate that combined filter effluent turbidity should be less than 0.10 NTU 95 percent of the time.

Operational logs were reviewed to determine whether these criteria were satisfied during 2011, and the findings are summarized in Table 6-4. The filters consistently met the California and PSW criteria. During the year, no combined filter effluent turbidity results exceeded 0.3 NTU and only three results (out of more than 2,000) exceeded 0.1 NTU.

TABLE 6-4
COMBINED FILTER EFFLUENT TURBIDITY SUMMARY - 2011

Parameter	Value
Minimum, NTU	0.02
Average, NTU	0.03
99th percentile, NTU	0.04
Maximum, NTU	0.26

Disinfection Process Performance

Disinfection process goals presented in the 1996 master plan appear to be outdated and are no longer used by plant staff (probably due to conflict with current disinfection byproducts limits). These goals essentially directed plant operators to accomplish the following: 1) maintain a residual chlorine concentration of greater than or equal to 1.5 mg/L when the water temperature is less than 14°C, 2) maintain a residual chlorine concentration of greater than or equal to 1.8 mg/L when the water temperature is greater than or equal to 14°C, and 3) maintain a pH of less than or equal to 8.5 within the disinfectant contact units.

The PSW Phase IV Performance Goals indicate that actual CT values should be greater than or equal to the CT values needed to achieve required levels of *Giardia* and virus inactivation. The City is required to provide 1.5-log *Giardia* inactivation and 3.0-log virus inactivation.

Operational logs were reviewed to determine whether these goals were met during 2011, and the findings are summarized in Table 6-5. The PSW disinfection process goal was met consistently. Data from the logs suggest that the plant was fine-tuned throughout the year for simultaneous compliance with the following: 1) *Giardia* and virus inactivation requirements, and 2) maximum contaminant levels for trihalomethanes and haloacetic acids. Essentially, while temperature and pH fluctuated, plant personnel provided 1.5-log *Giardia* inactivation and 3.0 log-virus inactivation with as little chlorine as practically possible. Current practice is to maintain a free chlorine residual in the range of 0.9 to 1.0 mg/L in water leaving the plant.

TABLE 6-5
DISINFECTION PROCESS PERFORMANCE DATA SUMMARY - 2011

Parameter	Min	Avg	Max
$CT_{actual} : CT_{required}$	1.03	2.13	4.58
Residual chlorine concentration (mg/L) when temperature is < 14°C	0.70	0.92	1.06
Residual chlorine concentration (mg/L) when temperature is ≥ 14°C	0.38	0.92	1.24
pH	6.70	8.28	9.00

SLUDGE TREATMENT AND DISPOSAL

Sludge handling practices were reviewed with the goal of identifying and evaluating improvement alternatives. The following items are summarized below: 1) existing sludge dewatering facilities and operations; 2) the current solids disposal procedure and applicable requirements; and 3) improvement alternatives and recommendations.

Sludge Dewatering Facilities and Operations

At the City water treatment plant, filter backwash water is discharged into a holding basin. The holding basin has a capacity of approximately 227,000 gallons - sufficient to contain water from two filter backwashes. The basin was designed to attenuate surges of backwash water into downstream units, and the inlet and outlet have baffles. Backwash water flows from the holding basin into a diversion structure where it mixes with sedimentation basin sludge. The diversion structure is equipped with eight gates and a weir that are used to divert the mixture into six lagoons for dewatering.

A sludge treatment and disposal process flow diagram is presented in Figure 6-2, and sludge lagoon information is presented in Table 6-6. The lagoons were constructed with a clay and aggregate base lining (six inches of aggregate base over two feet of clay). In 2006, soil-cement lining was installed in lagoons 4 and 5. Lagoons 1, 2, and 3 are equipped with a concrete baffle to prevent short-circuiting, and lagoons 4, 5, and 6 have underdrain piping. Severe leakage has been reported from lagoons 1 and 3. Due to their orientation in relation to prevailing winds, lagoons 3, 5, and 6 are vulnerable to damage due to wave action. The leeward end of Lagoon 4 is equipped with a concrete splash wall. Lagoon 1 receives overflows from the diversion structure.

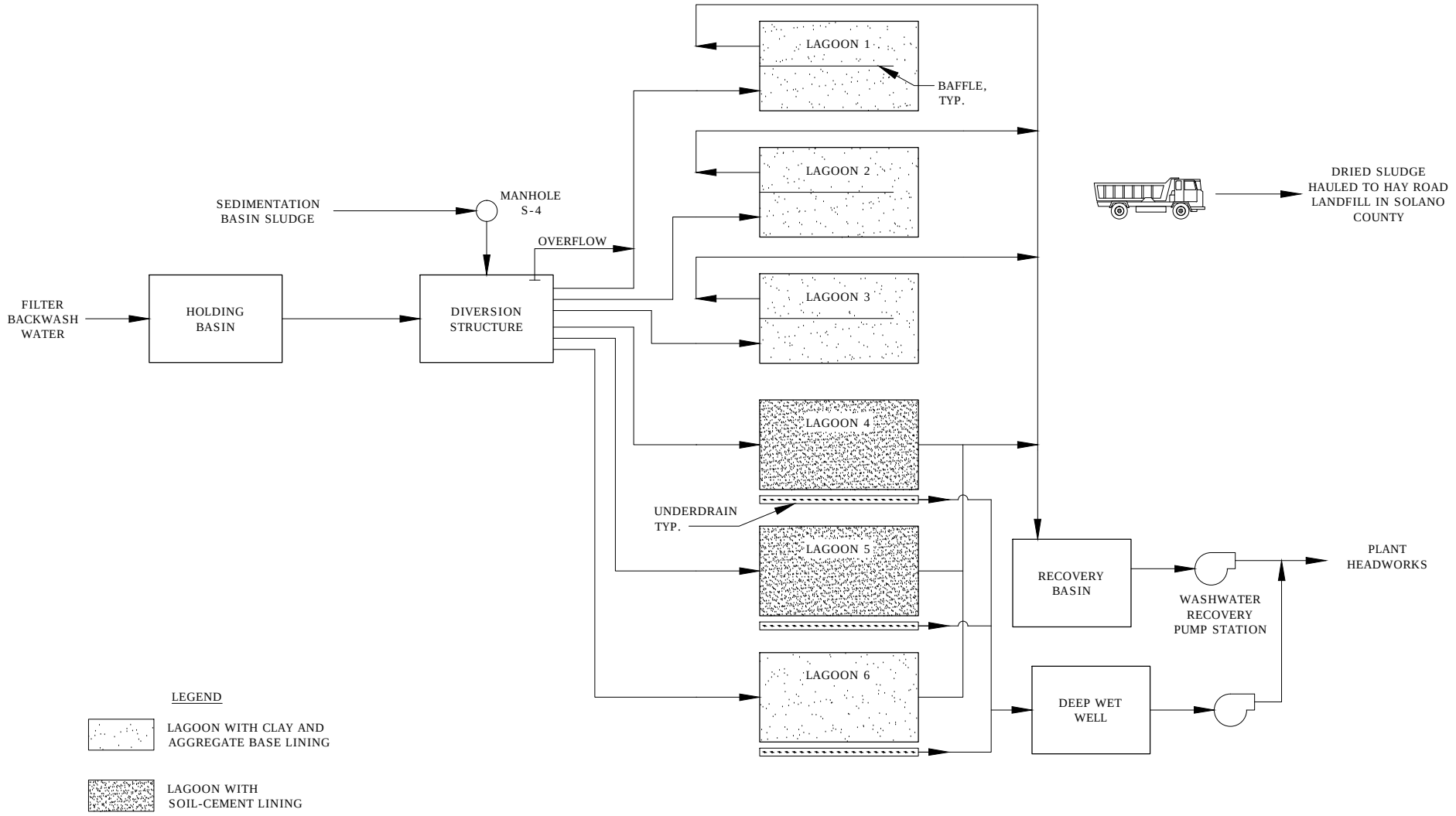


FIGURE 6-2

CITY OF BENICIA
2012 WATER SYSTEM MASTER PLAN

SLUDGE TREATMENT AND DISPOSAL PROCESS FLOW DIAGRAM

NV5 BEYOND ENGINEERING

TABLE 6-6
SLUDGE LAGOON SUMMARY

Parameter	Value
Lagoons, total	6
Capacity of each lagoon, gallons	600,000
Lagoons equipped with a center baffle	3
Lagoons with clay and aggregate base lining	4
Lagoons with soil-cement lining	2
Lagoons equipped with underdrain piping	3

Solids settle and accumulate in the bottoms of the lagoons. Supernatant and underdrain water flow by gravity to a 150,000-gallon recovery basin. The basin contents are pumped to the headworks of the treatment plant and mixed with raw water. The recovered water turbidity goal is <2.0 NTU, and plant influent is not allowed to contain more than 10 percent recovered water [8].

After a lagoon has been in service and accepting sludge for one year, the lagoon is removed from service and the solids are allowed to dry. (Attempts to keep lagoons in service for two years have been unsuccessful due to excessive sludge accumulation and extended drying time.) In a typical year, three lagoons are in use and three are drying.

Solids Disposal Procedure and Applicable Requirements

On average, approximately 1,300 cubic yards of dried solids are removed from lagoons by a contractor each year. A brief summary of dried solids removal data for 2002-2011 is presented in Table 6-7.

TABLE 6-7
DRIED SOLIDS REMOVAL DATA, 2002-2011

Parameter	Min	Avg	Max
Lagoons emptied per year	2	3.1	4
Truckloads of solids hauled per year	28	54	107
Volume of solids hauled to landfill, cubic yards per year	658	1,262	2,461
Solids removal cost, $ per year	16,534	28,921	47,187

The solids are hauled to the Hay Road Landfill, which is located approximately 35 miles from the water treatment plant, and used as alternative daily cover. To determine compliance with the Hay Road Landfill acceptance criteria [10], the solids are tested for CAM 17 priority metals (the

17 heavy metals listed in California Code of Regulations, Title 22, Section 66261.24), Title 22 hazardous waste acute toxicity, and elective analytes including pH, percent solids, and aluminum.

Improvement Alternatives and Recommendations

The existing solids handling facilities and operational strategy may need improvement to address two potential issues: 1) inadequate lagoon lining; and 2) high solids disposal cost. Severe leakage has been reported from two of the lagoons, and three lagoons have side slopes that are not adequately protected from wave action. The City spends an average of approximately $30,000 annually for sludge removal and disposal, and City staff is searching for ways to reduce this cost.

Considering these problems, the following improvement alternatives have been identified:

Upgrade Lagoon Linings. As mentioned previously, soil cement lining has been installed in lagoons 4 and 5. Following the next sludge removal, the lining in lagoons 4 and 5 should be assessed to confirm that the soil-cement is performing adequately. Based upon the findings, the City should proceed with lining upgrades for lagoons 1, 2, 3, and 6. Liner alternatives should be considered, if necessary. Soil-cement, clay with aggregate base, and paver stones over chlorosulfonated polyethylene (Hypalon®) are acceptable to City staff.

Modify/Augment Water Treatment Processes to Reduce Sludge Production. The City is practicing enhanced coagulation to remove total organic carbon (TOC) and comply with disinfection byproducts regulations. A secondary effect of enhanced coagulation is greater sludge production, and the rate of sludge production depends upon volume of water treated, coagulant dose, amount of TOC removed, and other factors. To mitigate this secondary effect, the US Environmental Protection Agency (USEPA) recommends employing acid, acidified coagulant, or polymers to reduce the necessary coagulant dose [11]. The City already appears to be implementing this recommendation. Specifically, the City utilizes acidified alum and cationic polymer.

To remove dissolved organic carbon (DOC) and further reduce sludge production, City staff are considering installation of a magnetic ion exchange system upstream of existing flocculation and sedimentation units. Such a system may potentially reduce the necessary coagulant dose by 30 to 80 percent and reduce sludge production by 20 to 60 percent [12].

The magnetic ion exchange system would produce a brine waste. Handling and disposal alternatives for this waste would likely include but not be limited to the following: 1) evaporative dewatering followed by landfill disposal; 2) evaporative dewatering and mixing with alum sludge, followed by landfill disposal; 3) hauling liquid waste to a municipal or industrial wastewater treatment facility, or 4) discharging liquid waste through a pipeline to the City of Benicia wastewater treatment plant or other approved facility. Bench and pilot-scale magnetic ion exchange studies at the City water treatment plant, if conducted, should include waste analyses to assess compliance with the Hay Road Landfill acceptance criteria. The acceptance criteria do not include a specific salinity limitation at this time.

ELECTRICAL SYSTEMS AND CONTROLS

The water treatment plant receives transformed power to 480 Volt, 3-phase from PG&E. In the basement of the Operations Building is the facility main switchboard which contains feeder breakers, motor starters, controls, and low voltage panels sized to provide power to all of the electrical equipment and buildings located on-site. In addition, the Chemical Building is equipped with an emergency generator sized to accommodate a large portion of the electrical load in the event of a power outage.

The overall electrical distribution network is aging. While not quite reaching end-of-life, some distribution equipment is more than 40 years old. This poses the following problems: 1) time between failures lessens with age; and 2) price and effort to source replacement parts increase greatly with age.

Operations Building

In general, the Operations Building is in need of more low-voltage panels, transformers, and receptacles to accommodate additional equipment. Switchboards and motor control centers (MCCs) in the basement are 480 Volt, 3-phase and were installed in various stages and years. This makes one gear different from the next in both age and manufacture. According to operations staff, replacement parts are expensive and difficult obtain. Motors, instrumentation, and other electrical equipment in this building area are either new or recently-serviced and not in need of replacement in the near future.

The existing PLC for the water treatment plant was manufactured by General Electric and the supervisory control and data acquisition (SCADA) is handled via Intellution iFIX. PLC replacement is recommended. For any new or retrofit projects at the plant, SCADA-ready equipment should be installed to more fully incorporate status, alarms, and control points into the SCADA system.

Chemical Building

Equipment in the Chemical Building is in need of replacement. Of greatest concern are the electromechanical relay-based controls for the chemical feed equipment. This equipment is unreliable and less efficient than newer technology. It is recommended that a new programmable logic controller (PLC) and supporting equipment be installed. The recently replaced metering and sample pumps coupled with PLC control will provide greater ease of operation, higher efficiency, and proper integration and remote control capabilities with the plant SCADA system. An evaluation and upgrade of the current ventilation system in the chemical feed room should be completed prior to installation of new equipment due to fluorosilicic acid off gassing.

OPERATIONAL IMPROVEMENTS

Projects that have been identified by plant personnel to improve operations, control costs, and increase reliability are summarized below.

Conversion to Polyorthophosphate. To reduce the cost of corrosion control, convert from caustic soda to polyorthophosphate.

Maintenance Shop. After the removal of the chlorine gas system, the City will convert the existing Chlorine Room into an expanded maintenance shop for equipment maintenance, tool storage, and repair of meters and instrumentation. This project will be accomplished by City staff and will not be identified as a capital improvement project.

Replace Backwash Tank 1. Demolish Backwash Tank 1 and construct a new 200,000-gallon storage tank to provide water for filter backwashing when Backwash Tank 2 is out of service for re-coating or other maintenance procedures.

Chlorine Contact Tank Re-Coating. Re-coat interior and exterior of chlorine contact tank.

SUMMARY OF RECOMMENDED IMPROVEMENT PROJECTS

Recommended improvement projects are summarized in Table 6-8**.** The table was developed from evaluations of the water treatment plant facilities and operations, discussions with City staff, and review of previous City master plans and capital improvement plans. The total project costs include baseline construction cost, a 20 percent construction contingency, and a 20 percent project contingency for engineering, administrative, legal, and construction management costs.

TABLE 6-8
WATER TREATMENT PLANT IMPROVEMENT PROJECTS TO BE CONSIDERED

Project Description	Baseline Construction Cost	Contingency Cost[a]	Engineering, Administrative, Legal, and Construction Management Costs[b]	Total Cost
WTP PLC Replacement	$140,000	$28,000	$32,000	$200,000
Chemical Building Electrical Systems and Controls	$480,000	$95,000	$115,000	$690,000
Chemical Tank Farm Improvements	$590,000	$118,000	$142,000	$850,000
Magnetic Ion Exchange System (6 mgd)	$2,440,000	$485,000	$585,000	$3,510,000
Convert from Chlorine Gas to Sodium Hypochlorite Solution	$208,000	$42,000	$50,000	$300,000
Conversion to Polyorthophosphate	$105,000	$20,000	$25,000	$150,000
Re-Line Sludge Lagoons	$1,111,000	$222,000	$267,000	$1,600,000
Replace Backwash Tank 1	$295,000	$60,000	$70,000	$425,000
Re-Coating of Chlorine Contact Tank (Interior and Exterior)	$210,000	$40,000	$50,000	$300,000

[a] Contingency at 20% of baseline construction costs.
[b] Engineering/Admin/Legal/Construction Management Costs at 20% of sum of baseline construction cost and contingency

REFERENCES

1. *Stage 2 Disinfectants and Disinfection Byproducts Rule*, Federal Register, Volume 71, Number 2, USEPA, January 4, 2006.

2. *Secondary containment for hazardous materials liquids and solids*, California Fire Code, CCR, Title 24, Part 9, Section 8003.1.3.3.

3. *General Waste Discharge Requirements for Dishcarges from Surface Water Treatment Facilities for Potable Supply*, California Regional Water Quality Control Board, San Francisco Bay Region, Order No. R2-2009-0033, NPDES Permit No. CAG382001.

4. *Chemical Accident Prevention Provisions*, 40 CFR, Part 68.

5. *City of Benicia, 1996 Water System Master Plan*, prepared by Montgomery Watson, September 1996.

6. *Guidelines for Phase IV Application for the Excellence in Water Treatment Award*, Partnership for Safe Water, revised March 2011.

7. *Surface Water Treatment*, CCR, Title 22, Division 4, Chapter 17.

8. *Lagoon and Recovery System Operation*, City of Benicia Water Treatment Plant Standard Operating Procedure #32, revised July 2006.

9. *Alum Sludge Hauling Costs by Year, Actual vs. Estimate*, table prepared by City of Benicia, with data for the period from 2000-2011.

10. *Sampling Requirements and Acceptance Criteria*, prepared by Recology for the Hay Road and Ostrom Road facilities, revised December 2010.

11. *Enhanced Coagulation and Enhanced Precipitative Softening Guidance Manual*, USEPA, 815-R-99-012, May 1999.

12. *Magnetic Ion Exchange Pretreatment for DBP Rule Compliance*, presentation by Barbara Martin, AWWA California-Nevada Section Conference, April 8, 2009.

SECTION 7 – SUSTAINABILITY AND CLIMATE CHANGE

By definition, Sustainability is "meeting the needs of the present without compromising the ability of future generations to meet their own needs". Incorporating sustainability into the water system master plan ensures that the City of Benicia remains a good steward of their water resources.

The City has continuously implemented a water conservation program for more than 20 years. The City's on-going commitment to address sustainability and reduce global warming impacts related to the Water System Master Plan is addressed in this chapter. Effects of climate change resulting from operation of the City water supply system can be influenced in three general areas 1) reducing the operation of facilities by reducing demand; 2) increasing the efficiency of facilities that use energy; and 3) obtaining energy from renewable sources.

The City has a very detailed and goal oriented Climate Action Plan (CAP). The plan inventoried City energy users and concluded that almost 25 percent of the City Government's greenhouse gas (GHG) emissions result from the electricity required to pump, treat, and deliver clean potable water (the subject of this water system master plan) and to collect and treat wastewater (see Wastewater System Master Plan).

The Climate Action Plan established the following three objectives for the City water and wastewater systems (WW). Each objective has several strategies and those are also noted throughout this chapter as they apply:

- Objective WW-1: Reduce the Amount of Water Consumed 20% by 2020
- Objective WW-2: Reduce the Amount of Emissions Resulting from Pumps and Lift Stations
- Objective WW-3: Reduce the Amount of Emissions Resulting from Water and Wastewater Plant Operations 95% by 2020

The following sections will address approaches to meeting CAP objectives through water demand management, increasing water facility efficiencies, and using renewable energy resources.

WATER DEMAND MANAGEMENT

Water demand management should focus on the following three measures to influence the efficient use of water and help meet CAP *Objective WW-1: Reduce the Amount of Water Consumed by 20% by 2020* including:

Measure 1 - Conservation
Measure 2 - Volume Reduction
Measure 3 - Timing of Water Use

Measure 1: Conservation (Efficiency)

In the past few years, three pieces of landmark legislation were adopted by the State of California that will significantly influence (reduce) future water demands by increasing

conservation. It should be noted that indoor water conservation will also have a direct impact and significantly reduce flows to the wastewater treatment plant further reducing GHGs. The legislation directly affecting future water demands are:

- CALGreen (Part 11 of Title 24)
- SB 407
- Model Landscape Ordinance

Each of the three pieces of legislation is described below.

CALGREEN. These regulations are part of the California Building Standards Code, Title 24, and are known as the California Green Building Standards Code or CALGreen. The purpose of this code is to encourage sustainable construction practices.

The requirement found in part 11 of Title 24 is a 20 percent reduction from baseline use with voluntary goals for 30, 35, and 40 percent reductions. The requirement may be met by either prescriptive or performance methods summarized as follows:

Prescriptive Method (plumbing fixtures requirements):

- 2.0 gpm showerheads (United States Environmental Protection Agency (EPA) Water Sense Label)
- 1.8 gpm bathroom and kitchen faucets (EPA Water Sense Label)
- 1.28 gal/flush toilets (EPA Water Sense Label)
- 5.0 gallons/cycle – Dishwashers (Energy Star Label)
- 6.0 gallons/cu ft - Washing Machines (Energy Star Label)

or

Performance Method: Demonstrate baseline water use is reduced by 20 percent.

In addition, Title 24 now requires weather-based irrigation controllers (WBICs) to reduce outdoor water use if landscaping is provided by the builder.

CALGreen is not to be confused with Senate Bill 7-7 (SBx7-7) which is referred to as 20x2020. The SBx7-7 legislation was introduced to achieve a 20 percent reduction of statewide per capita water use by the year 2020. This legislation requires each urban retail water supplier to develop targets to reduce per capita water use by 2015 and 2020. CALGreen, by requiring water efficient fixtures in buildings, will assist the water suppliers to achieve their targets.

SB407. This legislation establishes requirements for residential and commercial real property built on or before January 1, 1994, and includes requirements for replacing plumbing fixtures that are not water conserving. SB 407 is briefly summarized as follows:

- January 2014 – All building alterations must include replacing plumbing fixtures with water efficient fixtures.

- January 2017 – Seller or transferor of single-family residential or multi-family must disclose to purchaser requirement to replace plumbing fixtures with water efficient fixtures.
- January 2019 – All noncompliant fixtures in multi-family must be replaced.

Model Landscape Ordinance (AB 1881). This legislation required local agencies, not later than January 1, 2010, to adopt the updated Model Ordinance, or a local landscape ordinance that is at least as effective in conserving water as the updated model ordinance. (The ordinance can be found in Title 23 Waters Division 2. Department of Water Resources Chapter 2.7 - Model Water Efficient Landscape Ordinance.) According to the legislation, if the local agency has not adopted the updated Model Ordinance, or a local ordinance, therefore by reference the updated Model Ordinance will be applicable within the jurisdiction of the local agency. The City of Benicia has not formally adopted either the Model Ordinance or a local ordinance, therefore by reference, the updated Model Ordinance is applicable. Studies have estimated that the landscape ordinance will reduce outdoor water demands by 25 percent on average statewide.

Measure 2: Volume Reduction

The City's Urban Water Management Plan outlines many of the water reduction programs that the City currently implements, and the Climate Action Plan includes additional potential strategies which are noted. Some programs are coordinated though the Solano County Water Agency (SCWA). The following are some of the key programs:

Existing Programs

- Billing on a tiered water rate system (CAP *Strategy WW-1.6. Incentivize Water Conservation*)
- Education programs in schools and for water users
- Residential Water Survey Program
- Water audit program for commercial, industrial, and institutional (CAP *Strategy WW-1.7 Develop a Business Outreach Program*)
- Feasibility studies for recycled water projects
- Retrofits for City parks with weather based irrigation controllers
- SCWA Smart Irrigation Controller Rebate Program
- Rebates to encourage homeowners to upgrade to more efficient water fixtures (CAP *Strategy WW-1.5. Incentives for Residential Plumbing Fixtures Upgrades*; SCWA High-Efficiency Washer Rebate Program and High Efficiency Toilet Rebate Program)
- SCWA Water Efficient Landscaping Rebate Program (CAP *Strategy WW-1.1 Cash for Grass Rebate Program*)

Potential Programs

- Permitting for Gray Water Reuse Systems (CAP Strategy WW-1.2)
- Implement Residential Rainwater Collection (CAP Strategy WW-1.3)
- Require Commercial Rainwater Collection (CAP Strategy WW-1.4)
- Water Reuse Project (CAP Strategy WW-3.3) – see additional discussion below

Master Plan Recommendation: Continue to implement existing programs.

Master Plan Recommendation: Continue to educate homeowners and promote the benefits upgrading water efficient fixtures. Encourage the use of the SCWA rebate programs. (CAP *Strategy WW-1.5. Incentives for Residential Plumbing Fixture Upgrades*.)

Master Plan Recommendation: Continue to educate homeowners and promote the benefits reducing irrigated landscaping. Encourage the use of the SCWA rebate program, Water-Efficient Landscaping Rebate Program, as outlined in CAP *Strategy WW-1.1. Cash for Grass Rebate Program*.

Water Reuse. Developing a recycled water system that distributes either raw or recycled water for use in place of treated potable water could significantly reduce potable water demand and would have multiple benefits. Recycled water represents a locally controlled water source where the treatment level can be matched with water quality requirements for the anticipated use. The quality of typical potable water often far exceeds water quality requirements for uses such as irrigation, toilet flushing, and some industrial processes. Substitution of recycled water for these uses would free up potable water for other more appropriate uses, or reduce overall potable water demand. Accordingly, recycled water use can reduce or eliminate the need for additional imported raw water for treatment to potable water standards or for direct industrial use.

While the additional treatment processes at the wastewater treatment plant to produce a high level (tertiary) of recycled water for unrestricted reuse would likely be energy intensive, that additional energy use would be offset directly by the reduced amount of raw water that must be purchased by the City, conveyed to the water treatment plant, treated to meet drinking water standards, and distributed. Use of recycled water would also result in a reduction in the discharge of wastewater, currently treated only to secondary standards, to the bay (reducing pollution of the ecosystem) and reduced need to pump wastewater at high tide.

Water Reuse at the Valero Refinery: In 2008 the City and the Valero Refinery entered into a partnership to evaluate a project to supply up to two million gallons per day of recycled water from the City's wastewater treatment plant to the refinery for use as cooling tower make-up water. Using recycled water instead of water from the City's raw water supply would increase the raw water available for the City to treat, and essentially increase the reliability of the City's potable water supply. It would also reduce the total amount of water that needs to be purchased by the City and conveyed thus further reducing GHG emissions associated with that transmission. Unfortunately, the project cost was prohibitive.

Water Reuse for Irrigation: The industrial use alternative for recycled water was evaluated over urban irrigation because the refinery represents a relatively large, year-round demand. Urban irrigation sites, such as parks and sports fields, are located throughout the City, and would require an extensive new recycled water distribution system that would be costly to install. The irrigation demand is also considerably smaller in volume and seasonal in need when compared to the Valero alternative. However, from a sustainability standpoint, the use of recycled water in lieu of potable water for irrigation makes sense.

Consideration should be given to irrigating the Benicia Community Park on the north side of town with non-potable water. The complex is not too far from the raw water conveyance pipelines that feed both Lake Herman and the Valero Refinery. The use of raw water could replace the use of potable water currently irrigating the fields. For large single point users like this, it might also be worth considering if groundwater is available, and if a well could provide water for irrigation. This would eliminate treatment of raw water to drinking water standards for irrigation use, and help reduce maximum day demands on the potable water system.

Master Plan Recommendation: Prepare a feasibility study for irrigation of the Benicia Community Park with raw water.

Measure 3: Timing of Water Use

Indoor water use remains relatively constant year-round. However, outdoor irrigation demands can increase average daily demands by several times during warm and windy summer months. Much of the water system is sized to meet these maximum day demands, driven primarily by outdoor water use. There are several potential strategies related to timing of use that can reduce water system facility demands. Because there is a direct link between water demand and the energy used to supply that demand, if maximum day demands can be reduced, then the size of pumps and treatment required to meet that demand can also be reduced.

As an emergency measure, the City regulates outdoor irrigation to occur during evening and nighttime hours. This reduces water wasted by evaporation and also reduces maximum water demand loads on the water treatment and delivery systems since household and commercial use occur primarily during the day.

Another City implemented emergency strategy is to require even numbered addresses to water three days a week and odd numbered houses to water the other three days a week. This can reduce the summer maximum day demands by up to half; essentially meeting half of the outdoor irrigation demands each day.

Many communities are implementing restricted outdoor landscape irrigation during all summers, not specifically during emergency conditions. Effectively managing the timing of water use allows water system facilities to be optimized, and can reduce or defer future construction costs and promote water rate stability. A comprehensive education program in both the schools and for the water users would explain the importance of complying with summer watering restrictions (save water and help reduce future rate increases). Compliance could be enforced by issuing citations. A comparison of maximum day use for non-restricted summer use vs. a summer of restricted use would likely show significant reductions of peak usage.

Master Plan Recommendation: Continue to regulate outdoor irrigation during emergency water shortage situations. In the future, re-evaluate the adoption a summer water restriction ordinance, to reduce overall water demand by reducing peak usage on maximum days. In addition, the City should continue to encourage conservation with suggestions of incorporating xerophytic landscaping for residential and commercial properties.

INCREASE EFFICIENCY OF WATER SUPPLY SYSTEM FACILITIES

Increased efficiency of water treatment, transmission, and distribution facilities reduces energy used at pump stations. Therefore, reduction of associated greenhouse gas emission will lead to meeting CAP *Objective WW-2: Reduce the Amount of Emissions Resulting from Pumps and Lift Stations*.

The City should generally specify the most energy efficient pumps and equipment available. Although the capital cost may be slightly higher, the payback over the life cycle in both reduced operating costs and reduction in GHGs (not currently monetized) will help meet the City's Climate Action Plan objectives. In addition, as noted above, influencing the timing of water use to reduce maximum day demands will allow pumps, equipment, and other facilities to be specified to operate in a narrower range and thus be more efficient.

USE ENERGY GENERATED BY RENEWABLE ENERGY RESOURCES

Renewable energy is energy generated from naturally replenishing resources, such as sunlight, wind, tides, geothermal heat, and biomass. The use of renewable energy sources in place of fossil fuels substantially reduces greenhouse gas emissions. The City has continually sought to improve the operational and system efficiency for its water delivery and treatment plant operations and influence water demand, recognizing that increasing the efficiency of water treatment plant operation and reducing demand will help contribute to meeting CAP *Objective WW-3: Reduce the Amount of Emissions Resulting from Water and Wastewater Plant operations 95% by 2020*.

However, changing the source of the energy used to operate the facilities can have a substantially more significant impact in reaching the 95 percent reduction in emissions goal. The following CAP strategies are also directly related:

- Strategy WW-3.1. Install Renewable Energy Systems
- Strategy E-2.3. Renewable Energy For City Facilities

The opportunity to produce renewable energy on City owned sites has been the subject of a considerable amount of investigation and study in recent years, as well as implementation. In 2008 and 2009, the City conducted feasibility studies on potential wind and solar power generation for the water and wastewater facilities, and solar potential at the Benicia Community Center. The following is a summary of those studies as they pertain to the water system master plan facilities.

Wind and Solar Potential Analysis

In 2009, the City commissioned a solar and wind analysis for water and wastewater treatment facilities that identified nine facilities with significant annual energy consumption. The study summarized the annual energy consumption at each site (in kilowatt hours) and annual electric bill. Of those nine facilities, the study considered the solar potential using photo voltaics (PV) at six of the sites and wind at one site. The study estimated the cost of the PV, the annual energy

savings, and the percentage of the energy load that could be met using PV for each site. Both wind and PV were evaluated for the Water Treatment Plant and PV for the pump stations.

The study concluded that a 250 kW wind turbine at the water treatment plant could supply 37 percent of the plant's annual electricity demand. The energy savings would translate into a GHG reduction of about 49 metric tons of CO_2 per year (456 lbs CO_2 per MWh). In addition, the study found that two pump stations are potentially viable sites for wind turbines, although a detailed analysis of these sites was not included in the scope of this study.

The study also concluded that if 410 kW (DC) of photo voltaics were installed at the Water Treatment Plant they could meet 95 percent of the plant's energy demand generating 610,600 kWh/yr.

PV projects at the Water Treatment Plant and Pump Stations 1, 2 and 3 have been completed. The installation of the solar systems will help the City to meet their goal of 95 percent reduction of emissions. The City is tracking GHG reductions for each of the new solar installations. At this time, it is too early to report any of the collected data.

Technological advances related to both PV and wind have been ongoing since the 2008/2009 studies were completed. PV and wind have both become more efficient and the capital cost per kW generated has decreased. In addition, funding mechanisms have expanded, with the formation of multiple private organizations prepared to invest in the capital cost of renewable energy generation. Rebate options may have also changed. Even if there is not a direct cost savings for the energy, the City should continue to pursue nonrenewable energy options to meet its CAP objectives.

Master Plan Recommendation: Continue to pursue the installation of either PV or wind energy generation at City sites.

CLIMATE CHANGE AND ADAPTATION

Climate change and other impacts that occur as a result of global warming present potential challenges for water supply. The City is committed to meet the challenges of climate change by preparing for potential future changes. The City supported the passage of AB 32, the Global Warming Solutions Act, which requires California to cut its greenhouse gas emissions by 25 percent by 2020 and has adopted its own Climate Action Plan. To help mitigate global climate change, the City has aggressive goals to save energy by increasing water facility efficiency, reducing demand with water conservation measures, and reducing the City's role in global warming by considering energy sources that are renewable. Significant quantities of energy are required for the City's water supply system which includes pumping for transmission and distribution, as well as the energy required for treatment processes. In addition, air pollutants are generated by the energy consumed at the treatment facility and pump stations. To meet future challenges of diminished supplies, the City must prepare for both emergency situations, as well as long term goals.

Climate Change Effects

Possible outcomes of global climate change include sea level rise, a decrease in snow pack, and increased drought. It has been predicted that Northern California's water supply system will likely change in several ways.

Sea Level. The sea level is expected rise in the San Francisco Bay, due to the melting of the glaciers and polar ice caps. Sea level rise may lead to increased coastal flooding and saltwater intrusion into local groundwater basins and the freshwater San Francisco Bay-San Joaquin Delta levee system. The water distribution system in the downtown area and along the shoreline is most at risk due to a rise in sea water level. Pipelines could be subjected to saturated soils causing corrosion of materials and the possibility of contaminating the drinking water with this groundwater intrusion.

Snow Pack. Snow pack in the Sierra Nevada Mountains is expected to decrease because of increased air temperatures. This snow pack is a significant source of the water supply for Northern California. A decreased snow pack decreases the volume of water available for export to Solano County. In addition, warmer temperatures lead to an earlier snow melt.

Precipitation. Precipitation patterns are expected to change. The rainy seasons are expected to be shorter in duration and greater in intensity, which could contribute to flooding in some areas.

Increase Water Supply Storage

Increasing the capacity of Lake Herman by either raising the dam parapets or excavating/dredging the lake could be considered. This would allow more water to be captured and retained in the reservoir in the winter due to heavy rains and reduce the "discharge" of water from the reservoir that currently occurs when inflows exceed storage capacity plus outflow demands.

Master Plan Recommendation: Prepare a feasibility study to increase the capacity of Lake Herman.

Emergency Action Plan

The City has a 30 day emergency water supply available from storage in Lake Herman. This water supply could be fully utilized in case of a long-term decreased supply, temporary interruption in the raw water supply coming through the NBA and/or Cordelia water lines, or the failure of the raw water transmission main to the treatment facility.

As part of an emergency action plan, the City should identify locations and availability of pumps and pipelines that could be used to convey water from other sources. The City should pursue agreements with other water purveyors, for example the City of Vallejo, for emergency connections. The City currently has excess capacity at the treatment plant. A two-way pipeline could benefit both Cities if a key supply is interrupted for any reason such as an earthquake, drought, or equipment (pump or pipeline) failure.

Master Plan Recommendation: Continue to pursue interagency agreements and emergency connections to increase the water system reliability.

SECTION 8 – CAPITAL IMPROVEMENT PROGRAM

Presented in this section is the Capital Improvement Program (CIP) based on the analysis of the water transmission, distribution, and treatment systems summarized in Sections 5 and 6. In this section, the recommended projects will be developed into a 10-year CIP to represent the staged implementation of water system improvements in the distribution system and at the water treatment plant.

WATER DISTRIBUTION SYSTEM

Recommended Improvement Projects

The recommended improvement projects and cost estimates resulting from the analysis of the distribution system are shown in Tables 8-1 and 8-2. Most of the recommended improvement projects are necessary to correct current deficiencies or will immediately improve system operation, performance, and reliability (redundancy), if implemented.

Each project will provide benefit to existing or future customers, or both. For each project listed in the CIP, the designation of a benefit to new or existing customer is determined to assist the City in assigning equitable water rates and connection fees.

The recommended improvements projects in the distribution system can be grouped into three areas:

Pipeline improvements: construction of new pipelines and replacement of existing pipelines. Replacement pipeline projects will benefit only existing customers; the additional pipelines will benefit both new and future customers.

Pump station improvements: capacity and maintenance improvements at the pump stations. The capacity-related improvements at the pump stations will benefit future customers; the maintenance-related improvements will benefit both new and existing customers.

Future development projects: facilities required for serving future developments – Seeno property and the area north of the WTP. These facilities will only benefit new customers.

Capital Improvement Program

The CIP for the water distribution system is shown in Tables 8-1 and 8-2. Table 8-1 shows the projects that will benefit existing customers, to be funded by the water operations fund. Table 8-2 shows the projects that will benefit new customers, to be funded by connection fees. These connection fee project costs are shared with existing customers, and therefore the costs are split equally between Tables 8-1 and 8-2.

The projects identified in CIP Tables 8-1 and 8-2 resulted from the most recent budget preparation concluded prior to completion of this master plan update. The projects listed in Section 5 are staggered over the 10 year period to spread costs to each fiscal year in an effort to balance annual costs. The timing of projects may change as priorities shift, or funding is impacted.

Some projects have been placed in the 20-year horizon for future planning purposes. These items include the Benicia-Vallejo Inter-tie and routine maintenance projects such as reservoir recoating.

When the 1996 Water Master Plan was published, major developments were planned for the Seeno Property and the area north of the City's WTP. All plans for these developments have been on hold due to current economic conditions. In 1996, it was expected that 20 acres of Seeno property would be developed by 2010 and the remaining 520 acres developed by 2015. It was also anticipated that 83 acres north of the WTP would be developed by 2015. Again, no development plans are in progress.

The storage and pumping capacities identified in this master plan represent the total capacities required at buildout for these expected developments based on land use designations. Preliminary design of these facilities will be conducted at a later date when planning efforts are initiated. Specific facilities will be designed in accordance with approved development plans. These facilities will be funded by developers. The costs and timing of the new future developments are yet to be determined.

WATER TREATMENT PLANT

Recommended Projects

The recommended improvement projects and cost estimates at the treatment plant are summarized in Table 8-3.

The treatment plant was evaluated in three general categories:

- water treatment plant performance
- sludge treatment and disposal
- electrical systems and controls

The facilities in each category were reviewed based on the condition of the existing equipment, current capacity, and the ability to meet existing or future anticipated regulations. A particular attention was paid to the ease of operating and maintaining the facility.

Capital Improvement Program

The 10-Year CIP for the Benicia Water Treatment Plant is presented in Table 8-3. All of the projects in Table 8-3 benefit new and existing customers; therefore, the total project costs are divided equally between new and existing customers.

The water treatment plant has undergone improvements commencing in 2006 with modifications to the flocculation basins, sedimentation basins, filters and sludge lagoons. The water treatment plant is currently able to meet the demands of the City. Due to economic conditions in the past few years, development has slowed significantly and residents have reduced their consumption rates either because they are practicing conservation or because they are attempting to decrease the household utility costs.

The highest priority operational improvements have been included in the CIP table and should be implemented as funding is available.

The water treatment plant projects identified in CIP in Table 8-3 resulted from the most recent budget preparation concluded prior to completion of this Master Plan Update. Projects not completed from the previous CIP were either deleted (no longer necessary) or re-entered into this current list of projects. Electrical and instrumentation upgrades take a high priority in FYs 2013-2015. In subsequent years 2015-2017, conversion from chlorine gas to liquid sodium hypochlorite is planned along with improvements to the chemical tank farm. The major project slated for the treatment plant is construction of the magnetic ion exchange system (MIEX) expected to begin in FY 2017.

The remaining projects listed in Section 6 are staggered over the 10-year period to spread costs in each fiscal year as much as possible. The timing of projects may change as priorities shift, or funding is impacted. On a 20-year horizon, several projects are listed including large maintenance items such as reservoir recoating and non-urgent, but desired facilities such as a maintenance shop.

TABLE 8-1
WATER DISTRIBUTION SYSTEM
10-YEAR CAPITAL IMPROVEMENT PROGRAM
OPERATIONS FUND

Project Number	Project	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-32	Total
Distribution System											
1	New 18-inch transmission main in Park Road for Zone 1 (Armory to Oak Road)	$504,000									$504,000
2	New 24-inch DIP in Park Road for Zone I (Reliability)					$357,000					$357,000
3	Replace 6-inch DIP in Jefferson Street (Grant Street to Park Road)		$110,000								$110,000
4	New 12-inch DIP in Adams Street (Grant Street to Bayshore Road)		$39,500[a]								$39,500
5	New 12-inch DIP in Military West (West 6th Street to Plaza de Oro)			$330,500[a]							$330,500
6	New 8-inch DIP to loop Drolette Way with Corrigan Court				$17,000[a]						$17,000
7	New 12-inch DIP in Zone III to serve Pressure Zone 3-A				$95,000[a]						$95,000
8	New 36-inch transmission main (Reliability from WTP to East 2nd Street)					$726,000					$726,000
9	Benicia-Vallejo Inter-tie									$3,500,000	$3,500,000
10	P-2 Pump Station MCC Replacement				$300,000						$300,000
11	Recoating of R-1 Reservoir (interior & exterior)									$300,000	$300,000
12	Recoating of R-2 Reservoir (interior & exterior)									$300,000	$300,000
Raw Water Transmission System											
	36-inch RWTL CP Improvements	$200,000	$200,000								$400,000
	36-inch RWTL Improvements	$200,000									$200,000
	Totals	**$904,000**	**$349,500**	**$330,500**	**$412,000**	**$1,083,000**	**$0**	**$0**	**$0**	**$4,100,000**	**$7,179,000**

[a] This cost represents half of the total project cost. The project cost is shared equally with the Connection Fee Fund (see Table 8-2)

TABLE 8-2
WATER DISTRIBUTION SYSTEM
10-YEAR CAPITAL IMPROVEMENT PROGRAM
CONNECTION FEE FUND[a]

Project Number	Project	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-32	Total
4	New 12-inch DIP in Adams Street (Grant Street to Bayshore Road)		$39,500[b]								$39,500
5	New 12-inch DIP in Military West (West 6th Street to Plaza de Oro)			$330,500[c]							$330,500
6	New 8-inch DIP to loop Drolette Way with Corrigan Court				$17,000[d]						$17,000
7	New 12-inch DIP in Zone III to serve Pressure Zone 3-A				$95,000[e]						$95,000
	Totals	**$0**	**$39,500**	**$330,500**	**$112,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$482,000**

[a] The cost for each of these projects represents half of the total project cost. The project cost is shared equally with the Operations Fund (see Table 8-1)
[b] Total project cost is estimated at $79,000.
[c] Total project cost is estimated at $661,000.
[d] Total project cost is estimated at $34,000.
[e] Total project cost is estimated at $190,000.

TABLE 8-3
WATER TREATMENT PLANT
10-YEAR CAPITAL IMPROVEMENT PROGRAM
OPERATIONS FUND

Project	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-32	Total
WTP PLC Replacement	$200,000									$200,000
Chemical Building Electrical Systems and Controls		$690,000								$690,000
Chemical Tank Farm Improvements			$250,000	$600,000						$850,000
Magnetic Ion Exchange System (6 mgd)					$800,000	$2,710,000				$3,510,000
Conversion from Chlorine Gas to Sodium Hypochlorite			$300,000							$300,000
Conversion to Polyorthophosphate							$150,000			$150,000
Re-Line Sludge Lagoons									$1,600,000	$1,600,000
Replace Backwash Tank 1									$425,000	$425,000
Recoating of Chlorine Contact Tank (interior & exterior)									$300,000	$300,000
Totals	**$200,000**	**$690,000**	**$550,000**	**$600,000**	**$800,000**	**$2,710,000**	**$150,000**	**$0**	**$2,325,000**	**$8,025,000**

APPENDIX A

WATER SUPPLY AGREEMENTS

Appendix A-1	State Water Project Contract with SCWA
Appendix A-2	Settlement Water Agreement with DWR
Appendix A-3	Vallejo Agreement
Appendix A-4	SID Agreement
Appendix A-5	State Water Project Reliability – SCWA
Appendix A-6	Solano Project Reliability – SCWA
Appendix A-7	Settlement Water
Appendix A-8	NBA Maximum Flow Allocation – SCWA

APPENDIX A-1

STATE WATER PROJECT CONTRACT WITH SCWA

MEMBER UNIT CONTRACT BETWEEN SOLANO COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT AND THE CITY OF BENICIA

THIS CONTRACT was made on October 22, 1985, by and between **SOLANO COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT,** a governmental agency created and existing under and by virtue of Chapter 1656 of the 1951 Statutes of the State of California, as amended, hereinafter referred to as "Agency," and the **CITY OF BENICIA,** a municipal corporation of the State of California, hereinafter referred to as "the Member Unit."

WHEREAS, the State of California, acting by and through its Department of Water Resources, and Agency have entered into and subsequently amended a water supply contract (hereinafter referred to as "the State contract") whereby the State will supply certain quantities of water to Agency from the State Water Resources Development System, and providing that Agency will make certain payments to the State and setting forth the terms and conditions of such supply and such payment; and

WHEREAS, the lands and inhabitants of the Member Unit are in need of additional water for beneficial uses and desire to obtain a supplemental supply of water to be made available to Agency under the State contract;

NOW, THEREFORE, the parties hereto mutually agree as follows:

1. **Previous Contracts Superseded.**

The Member Unit Contract of the parties dated July 18, 1979, and Amendment No. 1 thereto dated April 9, 1985, are hereby rescinded and superseded by this contract.

2. **Term of the Contract.**

This contract shall become effective on the date first above written and shall remain in effect throughout the term of the State contract and any extension thereof.

3. **Definitions.**

As used herein, unless otherwise distinctly expressed or manifestly incompatible with the intent hereof, the terms defined in Article 1 of the State contract have the same meanings as therein set forth. The words "Member Units" mean all the governmental entities that enter into contracts with Agency for project water.

4. **Applicability of the State Contract.**

(a) All the rights and obligations of each of the parties hereto are and shall be subject to all the applicable terms, conditions and limitations in the State contract. The Member Unit hereby acknowledges receipt of a copy of the State contract and all amendments thereto to date which are respectively numbered 1, 2, 5, 6, 7, 9 and 10.

(b) The provisions of Articles 31, 32, 33, 34, 35, 40, 41, 42 and 44 of the State contract, with the word "Agency" substituted for the word "State" whenever the latter appears and the words "Member Unit" substituted for the word "Agency" wherever the latter appears, are hereby incorporated herein as though set forth in full at this point.

(c) The provisions of subdivision (p) of Article 45 of the State contract are incorporated herein as though set forth in full at this point. The Member Unit shall carry out all elements of Agency's water conservation program applicable to the Member Unit and shall do all acts and things to be done by the Member Unit as set forth in said subdivision (p).

5. **Limitations on Obligations of Agency.**

Agency shall be under no obligation to provide water service, or to make project water available to the Member Unit from the North Bay Aqueduct except during such times and as to the extent and in the quality and manner that the State makes project water available to Agency under the State contract. Agency shall not be liable to the Member Unit in the event of delay, interruption, discontinuance or quality deterioration of the water supply to be made available to Agency under the State contract, except to the extent that such delay, interruption, discontinuance or quality deterioration is the result of the fault of Agency.

6. **Shortages.**

If at any time there occurs a shortage from any cause in the quantity of project water made available to Agency so that the total quantity made available to Agency is less than the total of all quantities of project water contracted for by this Member Unit and other member units, Agency shall apportion the project water available among all member units in such manner as Agency shall determine to be equitable. In making such determination, Agency shall consult with all its member units and shall be guided by, but not limited to, consideration of the following factors with respect to each member unit: other supplies of water available to the member unit; the quantities of water normally used by the member unit for domestic, municipal, industrial, commercial and other purposes, and the relative ability of the member unit to reduce the quantity of water it uses; and the impact various reductions of water supply will have on the economy, public health and welfare.

7. **Water Service to Member Unit.**

(a) Commencing with the year of initial delivery of project water to Agency through the North Bay Aqueduct, Agency shall make available for delivery to the Member Unit the amounts of project water shown in Table A, attached hereto and incorporated

herein. The amounts of project water shown on Table A for each year are sometimes referred to in this contract as "the Member Unit's annual entitlements." The amount of project water shown for 2004 and each succeeding year is sometimes referred to herein as "the Member Unit's maximum annual entitlement."

(b) In no event shall Agency be obligated to deliver project water to the Member Unit at a rate of flow in excess of that portion of the capacity of the North Bay Aqueduct allocated to Agency as the Member Unit's maximum annual entitlement bears to the total maximum entitlements of all Member Units to whom a supply of project water will be made available from the North Bay Aqueduct.

8. **Deliveries to Member Unit, Payment for Delivery Structures and Measuring Devices.**

(a) Project water made available to the Member Unit pursuant to this contact shall be delivered to the Member Unit at such location on the North Bay Aqueduct as is requested by the Member Unit and approved by the Department of Water Resources. The Member Unit shall pay all of the costs of the delivery structure for the delivery of project water to it and shall deposit with Agency, prior to the commencement of construction of the delivery structure, the amount of money estimated by the Department of Water Resources to be sufficient to cover the costs thereof. If the delivery structure is also used by another member unit, the costs shall be allocated among the member units on a proportionate use basis.

(b) The Member Unit shall pay all the costs of acquiring and installing devices and equipment to measure deliveries of water to the Member Unit hereunder. Prior to such acquisition and installation, the Member Unit shall deposit with Agency the amount of money estimated by the Department of Water Resources to be sufficient to cover such costs.

(c) The Member Unit shall transmit to Agency schedules showing the amounts, times, and rates of delivery of project water desired by the Member Unit, as and when required by Agency, to comply with Section 12 of the State contract.

9. **Responsibility of Handling Water and Indemnification.**

The Member Unit shall be responsible for the carriage, handling and control of water delivered hereunder after the water has passed the delivery structures referred to in subdivision (a) of Section 8. Neither Agency, the State of California, nor any of their respective officers, agents or employees shall be liable for any damage or claim of damage of any nature, including, without limitation, property damage, personal injury, or death arising out of or connected with the control, carriage, handling, use, disposal or distribution of such water beyond said delivery structures, and the Member Unit shall indemnify and hold harmless the State of California and Agency and their respective officers, agents and employees from any such damages or claims of damage.

10. **Place of Use.**

Project water delivered to the Member Unit pursuant to this contract shall not be sold or otherwise disposed of by the Member Unit for any use outside the Member Unit's water service area and sphere of influence of the Member Unit, as established from time to time by the Local Agency Formation Commission of Solano County, without the prior written consent of Agency, which consent shall not be unreasonably withheld.

11. **Payment for Water.**

The Member Unit shall pay Agency the rate for project water established pursuant to Section 12 hereof for all project water furnished to and received by the Member Unit during each year throughout the term of this contract, but for not less than the quantity shown on Table A for that year. The Member Unit shall

make said payments not later than the due date stated on Agency's invoices. The due date shall not be earlier than 30 days after receipt of Agency's invoice by the Member Unit nor more than 30 days prior to the date Agency is obligated to disburse said payment pursuant to the State contract.

12. **Project Water Rate.**

(a) The project water rate shall be established by Agency for each year. Except as provided in subsection (b) of this Section 12, the water rate shall be $20.50 per acre-foot or the rate charged by the United States Bureau of Reclamation for municipal and industrial water from the Solano Project delivered in the Putah South Canal, whichever is the greater.

(b) The project water rate may be increased over the amounts established pursuant to subsection (a) of this Section 12 to the extent necessary to produce an amount of money which, when added to the water rate payments by all the other member units and the revenue from Agency's State Water Project Tax, hereinafter referred to as "the tax," and Agency's reserve fund, shall be sufficient to enable the District to make all payments to the State of California as and when they are due and payable and to maintain all required reserves, pursuant to the State contract.

(c) To the extent necessary to avoid an increase in the project water rate in accordance with subsection (b) of this Section 12, Agency shall levy the tax on both secured and unsecured property during each fiscal year from 1985-1986 through 1999-2000, at a rate of not more than two cents per $100 of total assessed valuation and during each fiscal year from 2000-2001 through 2034-2035 at a rate of not more than one cent per $100 of total assessed valuation. The tax in fiscal year 1985-1986 shall be levied on all taxable property in the territory of Agency. In subsequent years Agency may, to the extent it is legally permissible for it to do so, levy the tax on all taxable property within a zone of benefit that shall include within its boundaries at least the Suisun Marsh and the corporate territory, sphere of influence and

water service area of each member unit and of the Solano Irrigation District and the Maine Prairie Water District. If either the City of Rio Vista or the City of Dixon enters into a member unit contract with Agency for a water supply from the North Bay Aqueduct, the corporate territory, water service area, and the sphere of influence of such city shall be included in the zone of benefit.

(d) Nothing herein shall preclude Agency from using, or require Agency to use, taxation, assessment or other methods of finance to meet its obligations under the State contract, or to pay other project-related costs on behalf of itself or any member unit.

13. **Release.**

The Member Unit hereby releases, quitclaims, and rescinds any and all claims it may have against Agency, any of its member units, and/or any other entity arising in any manner out of the selection of the route of the North Bay Aqueduct from the Delta to the Member Unit's turnout.

14. **Reduction of Member Unit's Entitlement.**

(a) Agency reserves the right, from time to time prior to January 1, 2020, to reduce the Member Unit's annual entitlement to project water set forth in Table A and its corresponding payment obligation pursuant to Section 11 hereof for the purpose of making available a supply of project water for the Cities of Rio Vista and Dixon, and for unincorporated areas of Solano County. The total amount by which the Member Unit's entitlement shall be reduced is 37.5 percent of the total quantity of water Agency makes available to each of the Cities of Rio Vista and Dixon and to unincorporated areas of Solano County. The conditions of making a water supply available to Rio Vista or Dixon are that the city enters into a member unit contract prior to January 1, 1986, and that the contract provides for a maximum annual entitlement of not more than 1,500 acre-feet if the tax is levied within a zone of benefit, but

not more than 1,333 acre -feet if the tax is levied on all taxable property in Solano County. The conditions of making water available to unincorporated areas of Solano County are that the total maximum annual entitlement does not exceed 1,333 acre-feet and that the tax is levied on all taxable property in Solano County. The amount by which the Member Unit's entitlement is reduced may vary, but shall not diminish from year to year, and shall in no event exceed an ultimate total annual reduction of 1,500 acre-feet. The initial reduction in annual entitlement shall not exceed 300 acre-feet and the increase in the reduction in any year shall not exceed 300 acre-feet unless the Member Unit otherwise agrees.

(b) Agency shall give the Member Unit notice of each reduction of its annual water entitlements at least five (5) years prior to the effective date of the reduction, which date shall be the first day of January.

(c) Agency shall include in the Member Unit Contracts of the Cities of Fairfield and Vallejo a section similar to this Section 14.

IN WITNESS WHEREOF, the parties have executed this contract by their respective officers therewith duly authorized as of the date first above written.

SOLANO COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

Attest:

Linda Terra
Secretary

By Don Pippo
Chairman, Board of Directors

CITY OF BENICIA, A Municipal Corporation of the State of California

Attest:

Frances D. Greco
City Clerk

By Marilyn Ostrander
Mayor

Table A

Annual Entitlements of Water from North Bay Aqueduct City of Benicia

Year	Total Annual Amount in Acre Feet
1987	10,500
1988	10,860
1989	11,220
1990	11,600
1991	12,000
1992	12,320
1993	12,730
1994	13,130
1995	13,540
1996	13,950
1997	14,350
1998	14,760
1999	15,170
2000	15,570
2001	15,980
2002	16,390
2003	16,800
2004 and each succeeding year thereafter for the term of this contract as a Maximum Annual Entitlement	17,200

APPENDIX A-2

SETTLEMENT WATER AGREEMENT WITH DWR

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

SETTLEMENT AGREEMENT AMONG THE DEPARTMENT OF WATER RESOURCES OF THE STATE OF CALIFORNIA, SOLANO COUNTY WATER AGENCY, AND CITIES OF FAIRFIELD, VACAVILLE, AND BENICIA FOR PURPOSES OF WATER SUPPLY

This Agreement is made and entered into as of the 19th day of May, 2003, pursuant to the provisions of the California Water Resources Development Bond Act, the Central Valley Project Act and other applicable laws of the State of California, among the State of California, acting by and through the Department of Water Resources ("the Department"), the Solano County Water Agency ("SCWA"), a California water agency formed under the laws of California, and the Cities of Fairfield, Vacaville, and Benicia (collectively "the Cities") for purposes of settling issues of water supply.

RECITALS

A. On February 23, 1998, the Cities filed separate applications (Fairfield 30680, Benicia 30681, and Vacaville 30682) with the California State Water Resources Control Board ("SWRCB"), pursuant to Water Code sections 11460-11465 to divert and use surface water in their service areas for purposes of providing additional water supplies and to improve water supply reliability to meet water demands and development objectives in their General Plans.

B. The Cities are each implementing water conservation measures as a means of reducing their respective demand for water, but each City still requires an additional water supply.

C. The City of Fairfield, as lead agency, in May 2002, certified a Final Environmental Impact Report ("FEIR") on the Cities of Fairfield, Vacaville and Benicia Water Rights Appropriations Project (prepared by the City of Fairfield and dated March 2002).

D. The FEIR analyzes the potential environmental effects resulting from the proposed appropriation of water diverted from Barker Slough using available capacity of the existing Barker Slough Pumping Plant ("Barker Slough") and the North Bay Aqueduct ("NBA").

E. The Department constructed and operates the NBA as part of the State Water Project ("SWP"), for purposes of supplying water under its water supply contracts with SCWA and Napa County Flood Control and Water Conservation District.

F. The Cities have water supply contracts with SCWA to obtain SWP water through the NBA.

G. The Parties desire to avoid disputing the issues of appropriation during a SWRCB water rights hearing and therefore intend to execute a Settlement Agreement that will provide a water supply to the Cities. In turn, the Cities will withdraw their applications before the SWRCB.

H. In order to convey water provided by this Settlement Agreement, SCWA, acting on behalf of the Cities, and the Department intend to enter into, concurrent with this Agreement, a separate Agreement for conveyance of non-Project Water by a SWP contractor.

NOW, THEREFORE, the Parties mutually agree as follows:

1. PURPOSE

This Agreement is to settle water supply issues and avoid adversarial hearings before the SWRCB regarding the Cities' water rights applications.

2. DEFINITIONS

When used in this Agreement, the following definitions shall apply:

a. "Balanced Conditions" are defined for the Sacramento-San Joaquin Delta in the "Agreement Between the United States of America and the State of California for Coordinated Operation of the Central Valley Project and the State Water Project," dated November 24, 1986 ("COA") as the periods when it is agreed by the U.S. Bureau of Reclamation and the Department that releases from upstream Central Valley Project ("CVP") and SWP reservoirs plus unregulated flow approximately equal the water supply needed to meet Sacramento Valley inbasin uses, plus exports.

b. "Excess Conditions" are defined for the Sacramento-San Joaquin Delta in the COA as those periods when it is agreed by the U.S. Bureau of Reclamation and the Department that releases from CVP and SWP upstream reservoirs plus unregulated flow exceed Sacramento Valley inbasin uses, plus exports.

c. "Project Water" shall mean water made available for delivery to the SWP contractors by SWP conservation facilities and transportation facilities included in the SWP system.

d. "Settlement Water" shall mean the amount of water provided under the terms of this Agreement by the Department to SCWA, for use by the Cities.

e. "SCWA Long-Term Water Supply Contract" shall mean Water Supply Contract No. 160260 Between the State of California Department of Water Resources and Solano County Water Agency, as amended.

f. "Standard Term 91" is defined in the SWRCB Water Right Decision 1594 (Nov. 1983) and Order WR 84-2 (Feb. 1984).

g. "Sacramento Valley inbasin uses" is defined by the COA and means legal uses of water in the Sacramento Basin, including water required to meet Sacramento-San Joaquin Delta water quality standards.

3. AMOUNT AND ACCOUNTING OF SETTLEMENT WATER

a. The Department shall make available Settlement Water to SCWA:

i. During Excess Conditions, and

ii. During Balanced Conditions when Standard Term 91, as described in Article 3(b), below, is not in effect.

b. The Department shall not be required to make Settlement Water available pursuant to this Agreement when the SWRCB requires other water users to curtail diversions pursuant to Standard Term 91. The Department will provide notice to SCWA and the Cities that diversions under this Agreement are curtailed consistent with the periods of curtailment established by the SWRCB under Standard Term 91.

c. The maximum amount of Settlement Water the Department shall provide SCWA for use by the Cities in any calendar year shall be 31,620 acre-feet.

d. The quantity of Settlement Water actually delivered through the NBA to SCWA in any year shall depend upon the Cities' actual demands, hydrology,

and the availability of capacity to convey the Settlement Water pursuant to the "Agreement for Conveying Settlement Water through the North Bay Aqueduct by the Department of Water Resources to the Solano County Water Agency for the Cities of Fairfield, Vacaville, and Benicia" executed concurrently with this Agreement, attached as Exhibit A and incorporated herein by this reference ("Conveyance Agreement").

e. Settlement Water shall be for use within the Cities' respective spheres of influence ("SOI"), as they may be modified, and shall not be transferred outside the combined SOIs of the Cities as presently shown on the attached Exhibit B, incorporated herein by this reference and as later modified, without the Department's approval.

f. Settlement Water made available pursuant to this Agreement shall be diverted under water rights held by the Department for the SWP but the Settlement Water shall not be considered Project Water.

4. CONVEYANCE AND SCHEDULING OF SETTLEMENT WATER

a. Conveyance and scheduling of Settlement Water by the Department shall be pursuant to the Conveyance Agreement.

b. SCWA shall schedule the Settlement Water consistent with applicable terms of the SCWA Long-Term Water Supply Contract.

5. PAYMENT FOR SETTLEMENT WATER

a. Payment shall be made by SCWA, in accordance with Article 6 below, for that quantity of Settlement Water pumped at Barker Slough during Balanced Conditions. The charge for such water shall be an amount equivalent to the

Delta Water Rate in 2002, plus 3 percent compounded annually for future years, or the Delta Water Rate in each year, whichever is less.

b. For Settlement Water delivered during Excess Conditions, no payment shall be required except for conveyance costs pursuant to the Conveyance Agreement.

6. TIME AND METHOD OF PAYMENT (INVOICING PROVISIONS)

a. At the end of each month, the Department will bill SCWA for Settlement Water pumped at Barker Slough during Balanced Conditions. All payments shall be due within 30 days after the date of the Department's billing, and interest shall be charged if payments are delinquent by more than 30 days.

b. SCWA shall pay the Department accrued interest on all overdue payments at the penalty interest rate specified in Article 32 of the SCWA Long-Term Water Supply Contract per month from the due date to the date of payment.

7. CONDITIONS PRECEDENT

a. The terms of this Agreement, except for Article 7(b) below, shall have no effect until completion of the following:

i. The Cities have withdrawn Applications 30680, 30681, and 30682 that are before the SWRCB.

ii. A document pursuant to the California Environmental Quality Act ("CEQA"), if necessary, is completed and Notices of Determination are filed by the City of Fairfield as lead agency and the Department as a responsible agency, and any material changes in the project or in this Agreement that are required to comply with requirements of CEQA

have been made and agreed to by the Department, SCWA, and the Cities.

iii. The Department has obtained any necessary permits or biological opinions pursuant to State and Federal Endangered Species Acts ("ESA"), in order to address any potential impacts to endangered species that might occur as a result of using the NBA to convey Settlement Water under this Agreement.

b. The Parties shall diligently pursue completion of the Conditions Precedent upon execution of this Agreement.

8. MATERIAL CHANGES IN SWP COSTS

a. In the event the Department incurs additional material SWP costs to comply with any new or revised permit terms or conditions, including but not limited to biological opinions under ESA, resulting from this Agreement, the Parties agree that such costs shall be paid as follows:

i. SCWA and the Cities shall be responsible for additional material SWP costs incurred by the Department and attributable to the Settlement Water and will receive a credit as an offset against such costs from the payments made for Settlement Water pursuant to Article 5(a), plus 3 percent per annum, which represents the time-value of money previously paid to the Department.

ii. Any additional material SWP costs exceeding the credits given SCWA and the Cities will be paid by SCWA to the Department, as provided in Article 6. In that event, SCWA and the Cities shall receive credits

equal to the amount paid by SCWA to the Department, plus 3 percent per annum, which represents the time-value of money previously paid. These credits will be applied as an offset against future payments for Settlement Water under Article 5(a).

iii. SWCA shall maintain accounts pursuant to this Article and shall submit such accounts to the Department by January 31 each year or upon the Department's request. The accounts shall show a historical record of all SCWA payments pursuant to this Article and Article 5(a), costs applied against such payments, and the credit balance available from such payments.

b. "Additional material SWP costs" do not include costs that would be recoverable through the Transportation Charge for the NBA under the SWP long-term water supply contracts.

c. The Parties shall recognize that this Agreement may not be the sole cause of new or revised permit terms or conditions referenced in this Article, and SCWA and the Cities will be responsible only for costs caused by the Settlement Water which consequently may be a portion of the resulting total material SWP costs. In that event, SCWA and the Cities' cost share shall be determined in an equitable and proportional manner.

d. Should the Parties dispute any of the additional material SWP costs attributed to SCWA and the Cities or the payment of such costs, then the Parties shall submit the matter to arbitration as provided in Article 23(b).

9. TERM OF AGREEMENT

The term of this Agreement shall be from the date specified in the first paragraph of page 1 of this Agreement and shall remain in effect until December 31, 2035, but with option for continued service as follows:

a. By written notice to the Department at least six months prior to the expiration of the term of this Agreement, the SCWA and the Cities may elect to receive continued service after expiration of said term under the following conditions unless otherwise agreed to:

   i. Service of Settlement Water in amounts provided in Article 3.

   ii. Service of Settlement Water at no greater cost to the SCWA and the Cities than would have been the case had this Agreement continued in effect.

   iii. Service of Settlement Water under the same physical conditions of service, including time, place, amount and rate of delivery as provided for herein and as provided in the Conveyance Agreement.

   iv. Service of Settlement Water with the option to utilize the SWP transportation facilities as provided in Articles 18(c) and 55 of the SCWA Long-Term Water Supply Contract, to the extent such options are then applicable.

b. Other terms and conditions of the continued service shall be reasonable and equitable and shall be mutually agreed upon. In the event that said terms and conditions provide for continued service for a limited number of years only, the SCWA and the Cities shall have the same option to receive continued

service here provided for upon the expiration of that and each succeeding period of continued service.

10. LIMITATIONS ON FUTURE WATER RIGHT APPLICATIONS

During the term of this Agreement, and any subsequent renewals thereof, no City shall file an application for water under the Area-of-Origin statutes (Water Code § 11460, *et seq.*) for the amount of water needed to meet the existing and future demands for that City as described in the FEIR for the Cities' Water Rights Appropriation Project as a maximum annual diversion of 11,800 acre-feet for the City of Fairfield; 10,500 acre-feet for the City of Benicia; and 9,320 acre-feet for the City of Vacaville; or a total maximum diversion of all Cities of 31,620 acre-feet.

11. TERMINATION OF AGREEMENT

The Parties may terminate this Agreement by written agreement of all the Parties. If terminated, the Cities may apply for water as if this Agreement had not been entered into.

12. CALIFORNIA ENVIRONMENTAL QUALITY ACT

a. The Parties shall ensure that the requirements of CEQA are met before this Agreement becomes effective. If it is determined that additional environmental documentation is necessary, to supplement the FEIR prepared by the City of Fairfield, Fairfield will be the lead agency for purposes of any supplemental environmental review, and the Department, the City of Vacaville, the City of Benicia, and SCWA will be responsible agencies. The Cities shall be responsible for defending litigation arising pursuant to CEQA

findings made by the lead agency and relevant documents that the lead agency has prepared.

b. The Parties acknowledge that this Agreement does not and cannot commit them to a definite course of action regarding the implementation of this Agreement before they have complied with CEQA to the extent required.

13. REASONABLE COOPERATION

The Department, the Cities and SCWA will reasonably cooperate and provide mutual assistance to each other in obtaining any approvals or permits that may be required to perform the obligations under this Agreement. Should there be any obligation to consult or obtain a permit under either the State or Federal ESA, the Department shall initiate the consultation process.

14. OPINIONS AND DETERMINATIONS

Where the terms of this Agreement provide for action to be based upon the opinion, judgment, approval, review, or determination of any Party, such terms are not intended to be and shall never be construed as permitting such opinion, judgment, approval, review, or determination to be arbitrary, capricious, or unreasonable. Whenever the Department exercises its discretion in operation of the SWP, pursuant to this Agreement, or the Conveyance Agreement, the Department shall do so in a reasonable and equitable manner and shall act in good faith to not arbitrarily restrict nor interfere with water deliveries to the Cities pursuant to this Agreement and the Conveyance Agreement.

15. WATER RIGHTS NOT AFFECTED

This Agreement shall not be construed as a waiver of the Cities' legal claim to water pursuant to Water Code sections 11460-11465 or to limit the Cities' right to file any other application or petition with regard to water rights for other purposes or for additional quantities of water to meet future demands of the Cities which exceed the demand that can be met by the diversion of 31,620 acre-feet nor shall it limit the Department's right to challenge any such claims or actions by the Cities.

16. NO WAIVER OF RIGHTS OUTSIDE OF THIS AGREEMENT

All elements of this Agreement shall be treated as a settlement of a dispute between the Department and the Cities, and as such, neither the Cities, the Department, nor SCWA have waived any right that it otherwise may have outside of this Agreement. This Agreement shall not be considered an amendment to SCWA's Long-Term Water Supply Contract, including Table A of that Contract. This Agreement shall not be construed to limit or modify the Department's authority under the SCWA Long-Term Water Supply Contract. This Agreement shall not be regarded as a precedent for future agreements and shall not bind the Department's future activities with respect to other non-Project Water supply or conveyance proposals.

17. GOVERNING LAW

This Agreement shall be interpreted and enforced pursuant to the laws of the State of California.

18. AMENDMENT

This Agreement may be amended by written mutual agreement of the Parties.

19. ASSIGNS AND SUCCESSORS OBLIGATED

This Agreement shall be binding upon and inure to the benefit of the assigns or successors-in-interest of the Parties herein. No assignment shall be made without the prior written consent of the other Parties. Such consent shall not be unreasonably withheld.

20. ADDITIONAL DOCUMENTS

Each Party agrees to make, execute and deliver any and all documents and to join in any application or other action reasonably required to implement this Agreement.

21. NOTICE

Any and all communications or notices in connection with this Agreement shall be in writing and either hand-delivered or sent by United States first class mail, postage prepaid, or by facsimile or electronic mail followed by written notice sent by U.S. mail, and addressed as follows:

Chief
State Water Project Analysis Office
Department of Water Resources
Post Office Box 942836
Sacramento, California 94236-0001

General Manager
Solano County Water Agency
508 Elmira Road
Vacaville, California 95687

Director of Public Works
City of Fairfield
1000 Webster Street
Fairfield, California 94533-4883

Director of Public Works
City of Vacaville
650 Merchant Street
Vacaville, California 95688

Director of Public Works
City of Benicia
250 E. "L" Street
Benicia, California 94510

The Parties may change the foregoing addresses by providing written notice in compliance with this Article.

22. CONSTRUCTION AND INTERPRETATION

The Parties agree and acknowledge that this Agreement has been arrived at through negotiation, and that each Party has had a full and fair opportunity to revise the terms of this Agreement. Consequently, the normal rule of construction that any ambiguities are to be resolved against the drafting Party shall not apply in construing or interpreting this Agreement.

23. RESOLUTION AND DISPUTES

a. Except as provided below by Article 23(b), should any dispute arise concerning any provision of this Agreement, or the Parties' rights and obligations there under, the Parties shall meet and confer in an attempt to resolve the dispute. The costs associated with mediation of a dispute shall be shared equally between the Parties. Prior to commencing any legal action, the Party commencing such action shall provide the other Parties 30 days' written notice of such action; provided, that such notice

shall not be required where a delay in commencing an action would prejudice the interests of the Party that intends to file suit. During the 30-day notice period, the Parties shall attempt to resolve the dispute.

b. If after good faith efforts to reach agreement, the Parties fail to agree on terms to cover costs of any material changes in SWP costs described by Article 8 of this Agreement, then the Parties shall submit the matter to a panel of arbitrators. The panel of arbitrators shall be established by a mutually agreed upon date and shall be composed of one representative of the Department, one representative of the Cities, and a third mutually agreed upon arbitrator who shall act as chair of the panel. If no agreement can be reached on selection of the third arbitrator, the third person shall be appointed in the manner provided by Section 1281.6 of the Code of Civil Procedure. The panel may settle disagreements and shall make binding decisions regarding the amount and method of payment of costs to resolve the dispute arising from Article 8. The arbitration shall be completed within 14 days from the date of establishing the panel, unless the time is extended by mutual agreement of all the Parties. The expenses of the Department's representative shall be paid by the Department, the expenses of the Cities representative shall be paid by the Cities, and the expenses of the chair of the panel shall be paid one-half by the Department and one-half by the Cities.

24. SUPPORTING RESOLUTIONS

Each Party represents that it has legal authority to enter into this Agreement and to perform its obligations hereunder. SCWA and the Cities of Fairfield, Vacaville, and Benicia shall each submit to the Department, concurrent with execution of this Agreement, a duly authorized resolution or other document evidencing that authority and authorizing the person executing this Agreement to do so.

IN WITNESS WHEREOF, the Parties hereto have made and entered into this Agreement on the date specified in the first paragraph of page 1 of this Agreement.

Approved as to Legal Form and Sufficiency:

Chief Counsel
Department of Water Resources

CC 5/14/03

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

Director

MAY 19 2003

SOLANO COUNTY WATER AGENCY

Signature

Vice Chair
Title

March 13, 2003
Date

CITY OF FAIRFIELD

Signature

Mayor
Title

3/17/03
Date

CITY OF VACAVILLE

Signature

MAYOR
Title

MARCH 13, 2003
Date

CITY OF BENICIA

Signature

MAYOR
Title

3/18/03
Date

Attachments: Exhibit A Agreement for Conveying Settlement Water through NBA
Exhibit B Map of Cities' Spheres of Influence

2 of 7

EXHIBIT A

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

AGREEMENT FOR CONVEYING SETTLEMENT WATER THROUGH THE NORTH BAY AQUEDUCT BY THE DEPARTMENT OF WATER RESOURCES TO THE SOLANO COUNTY WATER AGENCY FOR THE CITIES OF FAIRFIELD, VACAVILLE, AND BENICIA

This Conveyance Agreement is made and entered in as of the 19th day of May 2003, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the Department of Water Resources of the State of California ("the Department"), and the Solano County Water Agency ("SCWA") on behalf of the Cities of Fairfield, Vacaville and Benicia (collectively "the Cities"), existing and acting pursuant to the laws of the State of California.

RECITALS

A. The purpose of this Conveyance Agreement is to establish the terms and conditions under which the Department will convey, through the North Bay Aqueduct ("NBA"), Settlement Water made available by the Department under the "Settlement Agreement Among the Department of Water Resources of the State of California, the Solano County Water Agency, and the Cities of Fairfield, Vacaville and Benicia for Purposes of Water Supply" ("Settlement Agreement"),

e. "Settlement Water" means the amount of water provided under the terms of the Settlement Agreement by the Department to SCWA, for use by the Cities.

f. "SCWA Long-Term Water Supply Contract" means Water Supply Contract No. 160260 Between the State of California Department of Water Resources and Solano County Water Agency, as amended.

g. "State Water Project" or "SWP" means the project developed pursuant to the provisions of the California Water Resources Development Bond Act.

2. TERM OF AGREEMENT

This Conveyance Agreement shall be coterminous with the Settlement Agreement, except as provided in Article 10, and is subject to and incorporates by reference Articles 7 (Conditions Precedent) and 12 (California Environmental Quality Act) of the Settlement Agreement.

3. CONVEYANCE

The Department agrees to convey Settlement Water from the Delta through the existing facilities of the NBA to Reaches 1, 2 and 3A of the NBA for SCWA on behalf of the Cities subject to the terms and conditions of this Conveyance Agreement, and the Cities are third-party beneficiaries with the ability to enforce the terms and conditions of this Conveyance Agreement. The Cities may, at their option, request that the Department modify existing facilities of the NBA, if required, in order to convey Settlement Water, subject to reimbursing the Department for the costs of the modifications.

4. AVAILABLE CAPACITY IN THE NBA

Available capacity in the NBA will be determined by the Department, subject to Article 12 below, pursuant to the following:

a. The amounts, times and rates of conveyance shall be consistent with the SCWA and Napa County Flood Control and Water Conservation District ("NCFCWCD") Long-Term Water Supply Contracts, the Department's determination of overall conveyance ability in the NBA (including but not limited to any regulatory or water quality restrictions limiting NBA pumping), planned SWP operations and maintenance for the NBA, and Delta conditions as specified in Articles 2 and 3 of the Settlement Agreement.

b. Priority to the use of the NBA to deliver Settlement Water shall be consistent with the SCWA and NCFCWCD Long-Term Water Supply Contracts, with Settlement Water being classified as Non-Project Water.

c. The Department will not pump Settlement Water into the NBA from any source other than the intake of the NBA, presently at the Barker Slough Pumping Plant ("Barker Slough"). Because the source of Settlement Water is the same as the source of SWP water in the NBA, the commingling of Settlement Water with SWP water in the NBA is not expected to diminish the beneficial use or quality of either. The Department will not pump water through the NBA, including Settlement Water, should the Department determine that cessation of pumping is necessary to protect the NBA from a significant water quality impact.

5. CONVEYANCE SCHEDULE

SCWA shall be responsible for requesting the delivery of Settlement Water with the Department, and the Department shall process the request in the same manner as requests under SCWA's Long-Term Water Supply Contract, as follows:

a. Preliminary Water Delivery Schedule Request: On or before October 1 of each year, SCWA shall submit in writing to the Department a preliminary water delivery schedule request, indicating the amounts, times, rates of delivery and points of delivery for Settlement Water desired by SCWA, on behalf of the Cities during each month of the following year. Upon receipt of the preliminary water delivery schedule request, the Department shall review the proposed times and rates of delivery to SCWA for consistency with Article 4 of this Conveyance Agreement. When appropriate, SCWA shall provide subsequent revisions of this water delivery schedule request to the Department, as needed.

b. Notice of Water Delivery and Conveyance Availability: The Department shall notify SCWA of the Department's ability to convey Settlement Water as soon as possible prior to the date when conveyance becomes available.

c. Weekly Schedule Requests: Following the Department's notice of conveyance availability, SCWA shall submit a weekly schedule request to the Department's Delta Field Division and shall concurrently fax the

schedule request to the State Water Project Analysis Office, of the Department, for approval pursuant to Article 4 of this Conveyance Agreement. SWPAO shall notify SCWA in a timely manner consistent with the SCWA Long-Term Water Supply Contract if SWPAO does not approve SCWA's schedule request.

d. Except as specifically provided in the Conveyance Agreement, water delivery schedules, revisions, and approvals shall be in accordance with the SCWA Long-Term Water Supply Contract.

6. CONVEYANCE LOSSES

At present, the Department does not assign conveyance losses to NBA water deliveries. In the event that during the term of this Conveyance Agreement the Department conducts operational studies in coordination with NBA contractors and determines conveyance losses along the NBA, the Parties agree that subsequent deliveries of Settlement Water will be subject to such losses, and the quantity of Settlement Water, pumped by the Department at Barker Slough, will be reduced at the downstream points of delivery to account for the determined losses in a manner identical to SWP water, also conveyed through the NBA. Payments for Settlement Water will be based on the quantity pumped at Barker Slough.

7. RESPONSIBILITIES FOR DELIVERY AND DISTRIBUTION OF SETTLEMENT WATER

The Department is providing conveyance service only and is not responsible for the use, effects, or disposal of Settlement Water beyond SCWA's points of

delivery in Reaches 1, 2 and 3A of the NBA. Settlement Water delivered pursuant to this Conveyance Agreement shall be subject to Article 13 of the SCWA Long-Term Water Supply Contract.

8. CHARGES

SCWA shall pay the Department the following SWP charges associated with the delivery of Settlement Water from the Delta to Reaches 1, 2 and 3A of the NBA, in accordance with the SCWA Long-Term Water Supply Contract:

a. A contract preparation fee of $2,000 to cover the Department's costs for the preparation and execution of this Conveyance Agreement;

b. An administrative fee for each month Settlement Water is scheduled for conveyance, as determined each year by the Department for the year of delivery consistent with charges to other SWP contractors for administration of other similar conveyance agreements. This fee will cover the Department's costs to administer the Settlement Agreement and this Conveyance Agreement, including maintenance of records, preparation of conveyance schedules, and preparation of billings. The administrative fee for similar conveyance agreements during 2002 is $250.00 per month;

c. A monthly fee for the Variable Operation, Maintenance, Power, and Replacement (OMP&R) Components of the Transportation Charge to Reaches 1, 2 and 3A and Off-Aqueduct Facilities Charges for the year of delivery for each acre-foot delivered;

d. Any identified demonstrable increase in non-power costs, resulting from the delivery of Settlement Water, pursuant to this Conveyance Agreement that would otherwise be borne by the SWP contractors not signatory to this Conveyance Agreement or by the Department and are not addressed elsewhere in this Conveyance Agreement and, further, that would not be applied to the NBA Capital or Minimum OMP&R Components of the Transportation Charge under the Department's long-term water supply contracts.

e. Charges will be updated as necessary, and will be consistent with the Department's Long-Term Water Supply Contracts.

f. The Department shall apply costs consistent with the Department's long-term water supply contract policy to the NBA Capital or Minimum OMP&R components of the Transportation Charge. There shall be no adjustment in the proportional use of facility factors for repayment of the NBA capital or minimum OMP&R required as a result of the terms of this Conveyance Agreement or the Settlement Agreement.

9. BILLINGS AND PAYMENTS

a. Upon execution of this Conveyance Agreement, the Department will bill SCWA for the $2,000 contract preparation fee under Article 8(a) of this Conveyance Agreement. SCWA will be billed for the monthly administrative charges under Article 8(b) of this Conveyance Agreement.

b. The Department will bill SCWA for all payments and fees in Articles 8(b–d) on a monthly basis. All payments shall be due within 30 days after the

date of the Department's billing, and interest shall be charged if payments are delinquent by more than 30 days.

c. SCWA shall pay the Department accrued interest on all overdue payments at the penalty interest rate specified in Article 32 of the SCWA Long-Term Water Supply Contract per month from the due date to the date of payment.

10. AGREEMENT TERMINATION

The Parties may terminate this Conveyance Agreement by mutual written agreement.

11. AGREEMENT NOT A PRECEDENT

This Conveyance Agreement shall not be regarded as a precedent for future agreements and shall not bind the Department's future activities with respect to other Non-Project Water conveyance proposals. No waiver by either Party of any provision of this Conveyance Agreement shall be deemed a waiver of any other provision or of any subsequent breach by either Party of the same or any other provisions.

12. OPINIONS AND DETERMINATIONS

Where the terms of this Conveyance Agreement provide for action to be based upon the opinion, judgment, approval, review, or determination of either Party, such terms are not intended to be and shall never be construed as permitting such opinion, judgment, approval, review, or determination to be arbitrary, capricious, or unreasonable. Whenever the Department exercises its discretion in operation of the SWP pursuant to the Settlement Agreement or this

Conveyance Agreement, the Department shall do so in a reasonable and equitable manner and shall act in good faith to not arbitrarily restrict or interfere with water deliveries to the Cities pursuant to the Settlement Agreement and the Conveyance Agreement.

13. RESOLUTION OF DISPUTES

Should any dispute arise concerning any provision of this Conveyance Agreement, or the Parties' rights and obligations there under, the Parties shall meet and confer in an attempt to resolve the dispute. The costs associated with mediation of a dispute shall be shared equally between the Parties. Prior to commencing any legal action, the Party commencing such action shall provide the other Party 30 days' written notice of such action; provided, that such notice shall not be required where a delay in commencing an action would prejudice the interests of the Party that intends to file suit. During the 30-day notice period, the Parties shall attempt to resolve the dispute.

14. LIABILITY

Except for damage or loss resulting from willful misconduct or negligence by the Department, its employees, officers or agents, or reduction in allocation of SWP water to SWP contractors due to implementation of the Settlement Agreement, SCWA agrees to hold the Department harmless from any direct or indirect loss, liability, cause of action, or claim and to indemnify the Department for all costs, damages, and liabilities arising out of this Conveyance Agreement, including any claims raised by the Cities.

15. UNCONTROLLABLE FORCES

If the Department is precluded in whole or in part from conveying Settlement Water as a result of uncontrollable forces, it is relieved from the obligation to convey the water to the extent it is reasonably unable to complete the obligation, due to the uncontrollable force. Uncontrollable forces shall include, but are not limited to, earthquakes, fires, tornadoes, floods and other natural disasters. SCWA shall not be entitled to recover any administrative costs paid nor conveyance costs for Settlement Water that was delivered either before or notwithstanding the occurrence of the uncontrollable force.

16. NOTICES

All oral, email and facsimile transmissions of notices, schedules, or requests, made in connection with this Conveyance Agreement, shall be confirmed in writing and shall be deemed properly served if delivered in person or sent by registered United States mail, postage prepaid. All notices, schedules or requests shall be sent to:

Chief
State Water Project Analysis Office
Department of Water Resources
Post Office Box 942836
Sacramento, California 94236-0001
(916) 653-4313

General Manager
Solano County Water Agency
508 Elmira Road
Vacaville, California 95687
(707) 451-2852

IN WITNESS WHEREOF, the Parties hereto have made and entered into this Agreement on the date specified in the first paragraph of page 1 of this Agreement.

Approved as to legal form
and sufficiency:

CC 5/14/03

Chief Counsel
Department of Water Resources

5/14/03

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

Director

MAY 19 2003

SOLANO COUNTY WATER AGENCY

Duane Kuo
Signature

Vice Chair
Title

March 13, 2003
Date

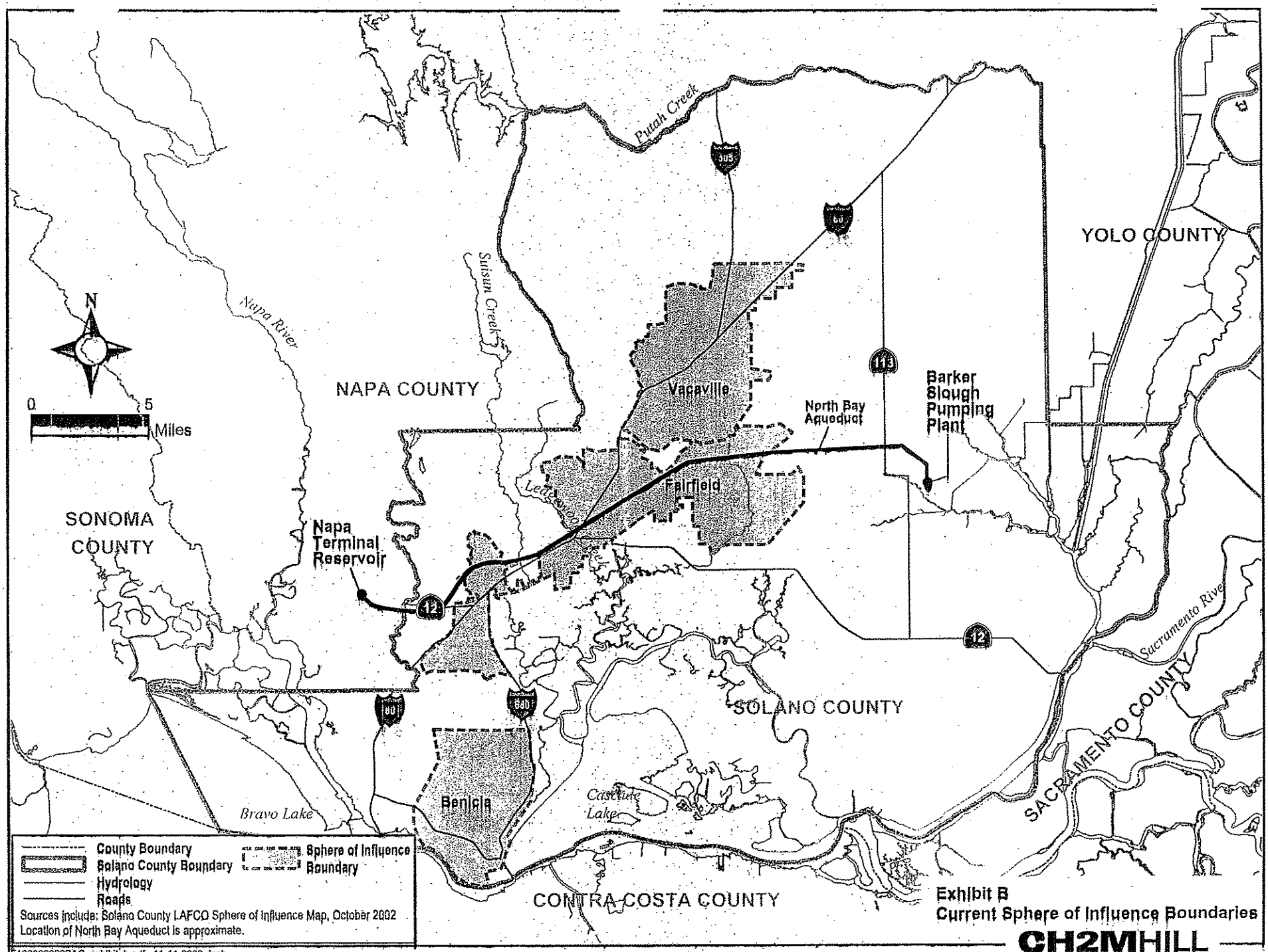


Exhibit B
Current Sphere of Influence Boundaries

CH2MHILL

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AGREEMENT WITH FAIRFIELD, VACAVILLE AND BENICIA FOR CONVEYANCE OF SETTLEMENT WATER THROUGH THE NORTH BAY AQUEDUCT

THIS AGREEMENT WITH FAIRFIELD, VACAVILLE AND BENICIA FOR CONVEYANCE OF SETTLEMENT WATER THROUGH THE NORTH BAY AQUEDUCT ("Agreement") is made as of this 13th day of March, 2003 by and between the Solano County Water Agency ("Agency"), a political subdivision of the State of California and the Cities of Fairfield, Benicia, and Vacaville (collectively, "Cities"), each political subdivisions of the State of California.

A. RECITALS.

1. WHEREAS, on February 23, 1998 the Cities filed separate applications with the California State Water Resources Control Board ("State Board") pursuant to Water Code §§11460-11465 to divert and use surface water in their service areas for the purpose of providing additional water supplies and to improve water supply reliability to meet water demands and development objectives in their General Plans.

2. WHEREAS, in order to avoid an adversarial water rights hearing before the State Board and to settle the Cities' water rights claims, DWR and the Cities executed a Settlement Agreement and a Conveyance Agreement, which provide the Cities with up to 31,620 acre feet per year of Settlement Water from the State Water Project. The Cities, in return for this settlement, agreed to withdraw their water right applications before the State Board.

3. WHEREAS, DWR constructed and operates the NBA as part of the SWP for purposes of supplying water under its water supply contracts with the Agency and the Napa County Flood Control and Water Conservation District.

4. WHEREAS, the Cities each have existing Member Unit Contracts with the Agency to receive a supply of NBA project water through the Agency.

5. WHEREAS, the Agency has entered into the Conveyance Agreement with DWR on behalf of the Cities setting forth the procedures for conveying Settlement Water through the NBA facilities. The Cities are not parties to the Conveyance Agreement but are designated third-party beneficiaries.

6. The Cities and the Agency enter into this Agreement to provide for the Cities to reimburse the Agency for all costs associated with conveying Settlement Water as set forth in the Conveyance Agreement and to provide a process for the Cities to order and schedule water supply made available through the Settlement Agreement through the Agency.

7. WHEREAS, on May 21, 2002 Fairfield, as lead agency pursuant to the California Environmental Quality Act, certified a final Environmental Impact Report on the Cities' water rights appropriation project. On February 18, 2003, Fairfield certified an addendum to the final Environmental Impact Report addressing the Settlement Agreement, Conveyance Agreement and this Agreement.

B. DEFINITIONS

As used in this Agreement, the following definitions shall apply:

1. AGENCY shall mean the Solano County Water Agency.

2. BENICIA shall mean the City of Benicia.

3. CONVEYANCE AGREEMENT shall mean that agreement entitled "Agreement for Conveying Settlement Water Through the North Bay Aqueduct by the Department of Water Resources to the Solano County Water Agency for the Cities of Fairfield, Vacaville, and Benicia" executed on _____, 2003.

4. DWR shall mean the California Department of Water Resources.

5. FAIRFIELD shall mean the City of Fairfield.

6. MASTER CONTRACT shall mean Water Supply Contract No. 160260 Between the State of California Department of Water Resources and the Solano County Water Agency for water supply from the State Water Project, as amended.

7. MEMBER UNIT CONTRACT shall mean the contract(s) for water supply from the NBA between the Agency and individual cities within Solano County who have elected to receive water from the NBA.

8. NBA shall mean the North Bay Aqueduct of the State Water Project.

9. NON-PROJECT WATER shall have the same definition as used in Article 1(kk) of the Master Contract, water made available for delivery to the Agency that is not Project Water as defined in Article 1(j) of the Master Contract.

10. PRIORITY AGREEMENT shall mean that agreement between the Cities, the Agency and Vallejo entitled "Agreement Regarding Priorities for Non-

Project Water Transported Through the North Bay Aqueduct," executed on _____, 2003.

11. SETTLEMENT AGREEMENT shall mean that agreement entitled "Settlement Agreement among the Department of Water Resources of the State of California, The Solano County Water Agency, and the Cities of Fairfield, Vacaville and Benicia for purposes of Water Supply" executed on _____, 2003.

12. SETTLEMENT WATER shall mean the water supply provided by DWR to the Agency through the Settlement Agreement for use by the Cities.

13. SWP shall mean the State Water Project, described as the State Project Facilities in Water Code §12934(d) as expanded from time to time.

14. VACAVILLE shall mean the City of Vacaville.

15. VALLEJO shall mean the City of Vallejo.

16. VALLEJO PERMIT WATER shall mean that water available pursuant to a 1948 priority License held by Vallejo (Application 12286, License 7848) to appropriate 31.52 cfs year round.

C. AGREEMENT

1. TERM AND EFFECTIVE DATE OF AGREEMENT

This Agreement shall become effective as of the effective date of the Settlement Agreement (pursuant to Section 7.a. of the Settlement Agreement) and shall remain in effect so long as both the Settlement Agreement and the Conveyance Agreements are in effect.

2. SCHEDULING OF SETTLEMENT WATER

Annually on or before September 15, each of the Cities shall submit respectively to the Agency a preliminary water delivery schedule request, indicating the amounts, times, rates and point of delivery for Settlement Water. The Cities shall provide subsequent revisions to the water delivery schedule as requested by the Agency. The Agency will notify the Cities when the Agency is notified of DWR's ability to convey Settlement Water pursuant to Section 5.b. of the Conveyance Agreement. Once conveyance becomes available in the NBA for Settlement Water, as determined pursuant to Section 5.b. of the Conveyance Agreement, the Cities shall submit weekly schedule requests to the Agency for the Agency's submittal to DWR pursuant to Section 5.c. of the Conveyance Agreement. The Agency shall notify the Cities if any schedule request for Settlement Water is disapproved, and will involve the Cities in the process for resolving any dispute with DWR regarding the scheduling for conveyance of Settlement Water.

3. WATER CLASSIFICATION

The Cities acknowledge that DWR has classified Settlement Water as Non-Project Water, the priority of which is governed by Article 12(f) of the Master Contract. The priority of Settlement Water to Vallejo Permit Water or other Vallejo non-project water in the NBA is specified in the Priority Agreement.

4. CONVEYANCE LOSS

The Cities acknowledge that DWR may impose conveyance losses on Settlement Water pursuant to Section 6 of the Conveyance Agreement.

5. CHARGES

a. Within thirty (30) days of execution of this agreement, each of the Cities shall pay to the Agency Six Hundred Sixty-Seven Dollars ($667.00) to reimburse the Agency for DWR's cost for preparation and execution of the Conveyance Agreement.

b. Each of the Cities shall reimburse the Agency one-third of the administrative fees charged to the Agency by DWR pursuant to Section 8.b. of the Conveyance Agreement.

c. Each of the Cities shall reimburse Agency for that city's share, as determined by the Agency, of the fee for the Variable Operations, Maintenance, and Replacement components of the Transportation Charge and the Off Aqueduct Facility Charges for the Settlement Water pursuant to Section 8.c.of the Conveyance Agreement.

d. Each of the Cities shall reimburse the Agency for that city's share, as determined by the Agency, of the payment for Settlement Water determined pursuant to Section 5.a. of the Settlement Agreement.

e. Each of the Cities shall reimburse the Agency for that city's share, as determined by the Agency, of any charges assessed to the Agency by DWR pursuant to Section 8.d. of the Conveyance Agreement.

6. PAYMENT PROCEDURES

The Agency will bill the Cities for the charges described in Section 5.b-d above after the end of the calendar year in which the water is delivered. If full payment of the charges identified in Section 5 of this Agreement is not received within thirty (30) days of billing by the Agency, the delinquent city shall remain obligated to pay the full amount due, plus interest on the full amount due at an annual interest rate equivalent to the interest earned on investments in the State of California Treasurers Office of Local Agency Investment Fund, plus two percent (2%), based on the most current reported interest rate for the time period during which the payment is not paid.

7. DELIVERY RESTRICTIONS

The Cities acknowledge that delivery of Settlement Water is dependent on all the factors specified in the Settlement and Conveyance Agreements. The Agency's obligation under this Agreement to furnish and convey Settlement Water is limited to the times and to the extent that DWR makes water and facilities required to furnish water available to the Agency pursuant to the Master Contract and/or any of the other agreements referenced in this Agreement.

8. NO IMPACT ON NBA PROJECT WATER

Nothing in this Agreement, or any of the other agreements referenced herein shall alter or affect the rights of the Cities or any of Agency's other

Member Units to receive water pursuant to and as specified in their Member Unit Contracts.

9. LIMITATIONS ON AGENCY OBLIGATIONS

The Agency shall not be liable for failure to perform any portion of this Agreement to the extent that such failure is caused by the failure of DWR to perform any obligation imposed on it by the Master Contract or the Settlement and Conveyance Agreements; provided, however, that the Agency shall diligently and promptly pursue all rights and remedies reasonably available to it to enforce the rights of the Agency against DWR relative to such failure to perform.

10. SHORTAGES

If at any time there occurs a shortage from any cause in the quantity of Settlement Water made available to Agency so that the total quantity made available to Agency is less than the total of all quantities of Settlement Water scheduled for by the Cities, Agency shall apportion the Settlement Water available among the Cities in proportion to the Cities' respective maximum rights to Settlement Water, specifically: 37.3% Fairfield, 33.2% Benicia, and 29.5% Vacaville.

11. APPLICABILITY OF MASTER CONTRACT.

This Agreement is subject to the obligations and limitations imposed upon the Agency by the Master Contract and the Settlement and Conveyance Agreements. Nothing in this Agreement shall relieve the Cities of the

obligation to schedule and make payments for water delivered pursuant to their Member Unit Contracts.

12. RESPONSIBILITY OF HANDLING WATER AND INDEMNIFICATION

Settlement Water made available to the Cities pursuant to this Agreement and the Settlement and Conveyance Agreements shall be delivered to the Cities at the location specified in Section 8 of their Member Unit Contracts. The Cities shall be responsible for the carriage, handling and control of water delivered under this Agreement after the water has passed the delivery point. Except for damage or loss resulting from the willful misconduct or negligence by the Agency, its employees, officers or agents, neither the Agency nor its officers, agents or employees shall be liable for any damage or claim of damage of any nature, including, without limitation, property damage, personal injury, or death arising out of this Agreement or connected with the control, carriage, handling, use disposal or distribution of such water beyond said delivery point, and the Cities shall indemnify and hold harmless the Agency and its officers, agents and employees from any such damage or claims of damage. In addition, the Cities will reimburse the Agency for the cost of any and all indemnification incurred by the Agency pursuant to Section 14 of the Conveyance Agreement.

13. NOTICES

All notices that are required, either expressly or by implication, to be given by any party to the other under this contract shall be delivered, faxed, e-

mailed or mailed, United States first-class postage prepaid, to the addresses then specified in the Member Unit Contracts for the applicable city. Notice shall be deemed given (a) two calendar days following mailing via regular or certified mail, returned receipt requested, (b) one business day after deposit with any one day delivery service assuring "next day" deliver, (c) upon actual receipt of notice, or (d) upon confirmed transmission, if by facsimile or email, whichever is earlier.

14. ASSIGNMENT PROHIBITED

The provisions of this Agreement shall apply to and bind the successors and assigns of the respective parties, but no assignment or transfer of this Agreement, or any part thereof or interest therein, shall be valid until and unless approved by the Agency in writing.

15. ENTIRE AGREEMENT

This Agreement constitutes the entire agreement between the Cities and the Agency with regard to its subject matter. Any amendment, including oral modification, must be reduced to writing and signed by all parties to be effective.

IN WITNESS WHEREOF, the parties hereto have hereunto affixed their names the day and first year hereinabove written.

SOLANO COUNTY WATER AGENCY

By _____ Attest: _____

CITY OF FAIRFIELD

By _____ Attest: _____

CITY OF VACAVILLE

By _____ Attest: _____

CITY OF BENICIA

By _____ Attest: _____

3.f7

AGREEMENT REGARDING PRIORITIES FOR NON-PROJECT WATER TRANSPORTED THROUGH THE NORTH BAY AQUEDUCT

THIS AGREEMENT REGARDING PRIORITIES FOR NON-PROJECT WATER TRANSPORTED THROUGH THE NORTH BAY AQUEDUCT ("Agreement") is made as of this 18th day of March, 2003 by and between the Solano County Water Agency ("Agency"), a political subdivision of the State of California and the Cities of Fairfield, Benicia, Vallejo and Vacaville (collectively, "Cities"), each political subdivisions of the State of California.

A. RECITALS.

1. WHEREAS, the Cities each have Member Unit Contracts with the Agency to receive a water supply from the NBA.

2. WHEREAS, the Agency is responsible for administering the Master Contract, including scheduling all water supplies available to the Agency and its Member Units from the NBA including, but not limited to Vallejo Permit Water and Settlement Water.

3. WHEREAS, Cities of Fairfield, Vacaville, and Benicia have entered into a Settlement Agreement that provides them with the right to receive up to 31,620 acre-feet per year of Settlement Water through the NBA from the State Water Project.

4. WHEREAS, the Agency has entered into a Conveyance Agreement with DWR in order to set forth the procedures for conveying Settlement Water through the NBA facilities. The Cities are not parties to the Conveyance Agreement but are designated third-party beneficiaries.

5. WHEREAS, the Agency and Cities of Fairfield, Vacaville, and Benicia have entered into a Local Conveyance Agreement to govern how the Agency will administer the Conveyance Agreement and specify scheduling and payment requirements of the Cities of Fairfield, Vacaville, and Benicia for Settlement Water and Settlement Water conveyance.

6. WHEREAS, through its Member Unit Contract with the Agency, Vallejo has an existing contractual right to have Vallejo Permit Water transported through the NBA at a rate not to exceed 31.52 cfs, and not to exceed 17,287 acre-feet annually. The Master Contract recognizes the transportation capacity allocated for Vallejo Permit Water in the NBA.

7. WHEREAS, the Cities and the Agency are entering into this Agreement in order to reach agreement on and clarify the relative priorities for delivery of water supplies through the NBA pursuant to the numerous agreements among the parties and DWR.

B. DEFINITIONS

As used in this Agreement, the following definitions shall apply:

1. AGENCY shall mean the Solano County Water Agency.

2. BENICIA shall mean the City of Benicia.

3. CONVEYANCE AGREEMENT shall mean that agreement between the Agency and DWR entitled "Agreement for Conveying Settlement Water Through the North Bay Aqueduct by the Department of Water Resources to the Solano County Water Agency for the Cities of Fairfield, Vacaville, and Benicia" executed on_____, 2003.

4. DWR shall mean the California Department of Water Resources.

5. FAIRFIELD shall mean the City of Fairfield.

6. LOCAL CONVEYANCE AGREEMENT shall mean that Agreement among the Agency, Fairfield, Vacaville and Benicia for Conveyance of Settlement Water through the North Bay Aqueduct of even date herewith.

7. MASTER CONTRACT shall mean Water Supply Contract No. 160260 Between the State of California Department of Water Resources and the Solano County Water Agency for water supply from the State Water Project, as amended.

8. MEMBER UNIT CONTRACT shall mean those individual contracts for water supply from the NBA between the Agency and cities within Solano County who have elected to receive water from the NBA.

9. NBA shall mean the North Bay Aqueduct of the State Water Project.

10 NON-PROJECT WATER shall have the same definition as used in Article1 (kk) of the Master Contract, water made available for delivery to the Agency that is not Project Water as defined in Article 1(j) of the Master Contract.

11. SETTLEMENT AGREEMENT shall mean that agreement entitled "Settlement Agreement among the Department of Water Resources of the State of California, The Solano County Water Agency, and the Cities of Fairfield, Vacaville and Benicia for purposes of Water Supply" executed on _____, 2003.

12. SETTLEMENT WATER shall mean the water supply provided by the Settlement Agreement by DWR to the Agency for use by Cities of Fairfield, Vacaville, and Benicia.

13. VACAVILLE shall mean the City of Vacaville.

14. VALLEJO shall mean the City of Vallejo.

15. VALLEJO PERMIT WATER shall mean that water available pursuant to a 1948 priority License held by Vallejo under Application 12286, License 7848 to appropriate 31.52 cfs year round.

C. AGREEMENT

1. CONVEYANCE OF VALLEJO PERMIT WATER

The Cities each agree that Vallejo's right to convey up to 31.52 cfs of Non-Project Water through the NBA, including but not limited to Vallejo Permit Water, has a higher priority than any Non-Project Water, including but not limited to Settlement Water, conveyed through the NBA by the Cities of Fairfield, Vacaville and Benicia. The conveyance of any Non-Project Water by Cities of Fairfield, Vacaville, and Benicia shall not infringe upon or restrict Vallejo's right to utilize the 31.52 cfs capacity in the NBA for conveyance of any Non-Project Water by Vallejo.

2. TERM AND EFFECTIVE DATE OF AGREEMENT

This Agreement shall become effective as of the effective date of the Settlement Agreement (pursuant to Section 7.a. of the Settlement Agreement) and shall remain in effect so long as both the Settlement Agreement and the Conveyance Agreement are in effect.

3. PRIORITIES

The Agency recognizes and will follow the priorities set forth in this Agreement when implementing its scheduling duties as described in Article 12 of the Master Contract and in the Conveyance Agreement. Notwithstanding the above, this Agreement is subject to the obligations and limitations imposed upon the Agency by the Master Contract and the Settlement and Conveyance Agreements.

4. NO AFFECT ON MEMBER UNIT CONTRACTS

Nothing in this Agreement, or any of the other agreements referenced in this Agreement, shall affect or alter the rights and priorities of the Cities and Vallejo or any of the Agency's other Member Units to receive water pursuant to and as specified in their Member Unit Contracts.

5. SCHEDULING

Nothing in this Agreement shall relieve the Cities or Vallejo of the obligation to schedule water as set forth in their Member Unit Contracts, the Settlement Agreement, and/or the Local Conveyance Agreement.

6. LIMITATIONS ON OBLIGATION OF AGENCY TO FURNISH WATER.

a. Notwithstanding the priorities set forth in this Agreement, the obligation of the Agency to furnish water hereunder shall be limited to the times and to the extent that water and facilities necessary for furnishing the same are available to the Agency as determined by the Master Contract and/or any of the other agreements referenced in this Agreement.

b. The Agency shall not be liable for failure to perform any portion of this

Agreement to the extent that such failure is caused by DWR's failure to perform any obligation imposed on it by the Master Contract or the Settlement Agreement; provided, however, that the Agency shall diligently and promptly pursue all rights and remedies reasonably available to it to enforce the rights of the Agency, the Cities against DWR relative to such failure to perform.

7. APPLICABILITY OF MASTER CONTRACT

This Agreement is subject to the obligations and limitations imposed upon the Agency by the Master Contract or the Settlement and Conveyance Agreements.

8. NOTICES

All notices required, either expressly or by implication, to be given by any party to the other under this contract shall be delivered, faxed, emailed or mailed, United States first-class postage prepaid, to the addresses specified in the Member Unit Contracts for the applicable city. Notice shall be deemed given (a) two calendar days following mailing via regular or certified mail, returned receipt requested, (b) one business day after deposit with any one day delivery service assuring "next day" deliver, (c) upon actual receipt of notice, or (d) upon confirmed transmission, if by facsimile or email, whichever is earlier.

9. ASSIGNMENT PROHIBITED

The provisions of this Agreement shall apply to and bind the successors and assigns of the respective parties, but no assignment or transfer of this Agreement, or any part thereof or interest therein, shall be valid until and unless approved by the Agency in writing.

10. ENTIRE AGREEMENT

This Agreement constitutes the entire agreement between the Cities and the Agency with regard to its subject matter. Any amendment, including oral modification, must be reduced to writing and signed by all parties to be effective.

IN WITNESS WHEREOF, the parties hereto have hereunto affixed their names the day and first year hereinabove written.

SOLANO COUNTY WATER AGENCY

By Duane Kromm

Attest: DN Oki

CITY OF FAIRFIELD

By Karin MacMillan

Attest: Gina Merrill

****SIGNATURES CONTINUED ON NEXT PAGE***

CITY OF VACAVILLE

By _____

Attest: _____

CITY OF BENICIA

By _____

Attest: _____

****SIGNATURES CONTINUED ON NEXT PAGE***

CITY OF VALLEJO

By _____

David Martinez, City Manager

Attest: _____

Allison Villarante, City Clerk

APPROVED AS TO FORM:

_____

Fred Soley, City Attorney

APPROVED AS TO CONTENT:

_____

Mark Akaba, Public Works Director

Attest: _____

APPENDIX A-3

VALLEJO AGREEMENT

FILE COPY

Original ~~[illegible]~~
Agreements 108
Reg. #399

213-620-9297

AGREEMENT FOR WATER SERVICE

THIS AGREEMENT, made and entered into this 5th day of FEBRUARY, 1962, by and between the CITY OF VALLEJO, a Municipal Corporation, hereinafter called "Vallejo", and the CITY OF BENICIA, a Municipal Corporation, hereinafter called "Benicia";

W I T N E S S E T H

WHEREAS, Vallejo owns and controls water, water rights, rights to water, pipelines for the transmission and distribution of water and treatment and storage facilities and has commenced construction of facilities for transmission of water from Monticello terminal reservoir and now has certain surplus water available for sale outside the territory presently served by the Vallejo Municipal Water System and,

WHEREAS, Benicia has contracted to purchase the water storage, treatment, transmission and distribution system now serving Benicia, has authorized revenue bonds in the total principal amount of One Million Two Hundred Thousand Dollars ($1,200,000) to finance said purchase, and is in need of a firm supply of water in order to take over said system and the responsibility for serving water to its inhabitants.

NOW, THEREFORE, in consideration of the premises and covenants, conditions and agreements hereinafter set forth to be kept and performed by the parties hereto, it is agreed as follows:

1. Point of Water Delivery. Vallejo shall furnish and Benicia shall accept the water at the point of delivery on Benicia's twelve-inch pipeline, southeasterly of the Vallejo-Benicia Township Line, where said pipe joins two six-inch pipes.

Vallejo shall meter water delivered through said point.

2. Computation on fiscal year basis. The year for reckoning minimum and maximum delivery begins on July 1st and ends of June 30th, annually.

3. Rate of Delivery. After completion of the construction of necessary transmission and pumping facilities hereinafter described, Vallejo shall deliver water at a rate not exceeding one million (1,000,000) gallons per day or the capacity of a 75-horsepower pump, whichever is less, and Benicia shall accept not less than 225 million gallons per year or a prorated amount thereof in relation to a period less than one year. If Benicia's demand exceeds the capacity of the 75-horsepower pump herein referred to, and if Vallejo agrees to supply such additional quantity any additional horsepower required must be provided by Benicia, unless the additional requirement results from Vallejo's distribution of water to areas adjoining the twelve-inch line referred to in Paragraph 1, in which event Vallejo shall provide the additional horsepower at its own expense. Such additional horsepower jointly required shall be jointly financed.

4. Vallejo Liability. Vallejo agrees to exercise reasonable diligence and care to effect the delivery of such quantities of water requested by Benicia within the limits of this Agreement out of any water surplus to Vallejo's requirements, but Vallejo shall not be liable for interruption or shortages caused by insufficiency of supply, rights of other users, or for any loss or damage occasioned thereby, nor delay or interruption caused by accident, Act of God, fires, strikes, riots or other causes beyond the control of Vallejo.

5. Benicia's Estimates. Benicia shall deliver to Vallejo an estimate of the quantity of water it will require and a schedule of drafts thereof during the following calendar month, at least fifteen (15) days before the beginning of each month; and, further, whenever the rate, time or quantity of draft is

expected to vary from said schedule, Benicia shall notify Vallejo of its revised requirement at least seventy-two (72) hours in advance of each such anticipated variance.

6. Meter. Vallejo shall furnish, install and maintain a six-inch meter at the point of delivery and record the readings of the same each month. Said meter's record shall be conclusive as to quantities of water furnished except as hereinafter provided. Said meter shall be checked for accuracy by representatives of Benicia and Vallejo within five (5) days after date of written requests of either; provided, however, that no two (2) such consecutive checks shall be separated by an interval of less than thirty (30) days. If the meter is found to be registering inaccurately by two (2) percent or more, charges for water shall be adjusted accordingly for the period, not exceeding thirty (30) days, the meter was in error.

7. Pump and Appurtenances. Not less than sixty (60) days prior to the date Benicia specifies for commencement of said water delivery, Benicia shall furnish to Vallejo at Lake Chabot Pump Station the seventy-five (75) horsepower pump, together with the hardware, fittings and valves, electrical switches and other appurtenances thereto, from Benicia's pump station in southern Napa County. Vallejo shall install said pump and equipment in said pump station and construct the pipelines and tie-ins necessary to deliver water through the existing twelve (12) inch pipe to the above-mentioned delivery and metering point. Benicia warrants said pump and materials to be furnished as being in good and servicable condition and any failure or failures thereof occurring within twelve (12) months after installation not attributable to faulty installation or neglect shall be repaired and/or replaced at Benicia's expense.

8. Connection Charge. Benicia shall pay to Vallejo, simultaneously with the execution of this Agreement, the sum

of Four Thousand Five Hundred and Seventy Five Dollars ($4,575.00) as a connection charge.

Deleted by Amendment #2

9. Use of 12 Inch Line. In consideration of authority to use said twelve (12) inch pipeline for delivery of water to areas adjoining it, Vallejo hereby transfers to Benicia permission to occupy, with said line, property owned by Vallejo upon which property the line is now located. Vallejo shall maintain and operate the pump, pipelines and meter at its cost and expense during the term of this Agreement. However, Vallejo's obligation for maintenance shall be limited to the repair and/or replacement of those parts of the facility requiring attention due to normal wear only. Any relocation, replacement and/or major improvement or rehabilitation shall be the responsibility of Benicia.

Amendment Attached

10. Option and Election to Buy Treated or Untreated Water. Benicia may purchase at its option either treated water as the same is customarily produced in Vallejo's water treatment plant, or untreated water in the following manner. For a period of one year from the date of commencement of water deliveries, the water supplied shall be treated. Benicia may at any time after one year from the date of commencement of service under this Agreement elect to receive untreated water in lieu of treated water; but may not change again without Vallejo's consent. Such election shall be made by written notice served on Vallejo at least twelve (12) months prior to the date the change is desired. In the event such election is made, all provisions of this Agreement, except those expressly limited to one type of water or the other, shall apply to both types.

11. Treated Water - Rates. Vallejo shall sell and Benicia shall pay for all treated water delivered at the rate of Twenty Four and One Tenth Cents ($0.241) per one thousand (1,000) gallons, subject, however, to the provisions of Paragraph 16. Commencing with the first day of the month following

10:

the completion of the pumping and transmission facilities referred to in Paragraph 7 hereof, and continuing for the period of this Agreement, or until the commencement date for the taking by Benicia of untreated water under Paragraph 10, whichever occurs first, Benicia shall pay monthly to Vallejo the sum of Four Thousand Five Hundred Seventeen and 08/100 Dollars ($4,517.08), and Vallejo shall credit said payments to Benicia's account for water delivered as provided herein. In any event, Benicia shall pay for the amount of water delivered as of the current billing date. All treated water provided by Vallejo under this Agreement shall be suitable for all domestic use, and shall meet the standards of the State Department of Public Health and the Solano County Department of Public Health, and Vallejo assumes full responsibility for providing and maintaining its quality to such standards.

12. Untreated Water - Rates. Vallejo shall sell and Benicia shall pay for all untreated water delivered pursuant to any Benicia election to take untreated water under Paragraph 10, at the rate of Twelve and One-Half Cents ($0.12 1/2) per one thousand (1,000) gallons, subject, however, to the provisions of Paragraphs 16 and 17. Commencing with the date of commencement for the taking by Benicia of untreated water, Benicia shall pay monthly to Vallejo Two Thousand Three Hundred Forty Three and 75/100 Dollars ($2,343.75), and Vallejo shall credit said payments to Benicia's account for water delivered, as provided herein. In any event, Benicia shall pay for the amount of water delivered as of the current billing date.

13. Untreated Water - Quality. It is expressly understood and agreed by Benicia that any untreated water furnished hereunder is not fit for human consumption, and Benicia hereby indemnifies and holds Vallejo harmless for any damage or claim for injury or illness to any person, livestock or other living thing which may in any way arise from the use of said untreated

water. This Agreement, insofar as it relates to untreated water, shall terminate if the State Department of Public Health or the Solano County Department of Public Health at any time demands that Vallejo cease the delivery of untreated water to Benicia. If required by the State or County Departments of Public Health, Benicia shall, at its own expense, install an approved backflow prevention device or any other additional facility required by those two agencies as a condition to continuance of the delivery of untreated water by Vallejo. The termination of this Agreement insofar as untreated water is concerned shall in no way affect the supply of treated water hereunder.

14. Billing and Payment. Vallejo shall bill Benicia before the tenth (10th) day of each month, and Benicia shall pay the amount billed within fifteen (15) days thereafter.

15. Suspension of Service in Case of Default. Should Benicia default payment of any sum due as provided herein, Vallejo may suspend the delivery of water to Benicia during the period of such default.

Revised - Per Amendment #2

16. Review of Costs. Vallejo will periodically review the cost of furnishing water as provided herein and is hereby empowered to notify Benicia of any increase or decrease of the price for water not later than the last day of March in any year. Such review and adjustment shall be made in the manner now followed by Vallejo and the United States Navy in establishing costs and price adjustments under their agreement for service to Mare Island Navy Yard. Any price change so determined shall become effective during the July following such notice and continue for not less than the succeeding two (2) contract years, and Benicia shall be obligated to pay the same.

17. Monticello Water. Both Vallejo and Benicia have rights and commitments to purchase water from the Monticello project. In the event Vallejo constructs pipeline facilities

10.9

to obtain water from this source, the cost of water delivered to Benicia under this Agreement may be increased or decreased on the basis of a cost analysis made as described in Paragraph 16. However, it is recognized that Benicia has commitments to purchase certain amounts of Monticello water and to pay for the same whether or not used. Accordingly, if and when Vallejo has facilities for taking water from this source, Vallejo will, if requested by Benicia, accept Benicia's allotment of water at Monticello terminal Reservoir within quantity limits of this Agreement and transport to Benicia a like quantity of water as satisfaction of Vallejo's commitments under this Agreement. Rate for such water shall be determined as the then calculated cost of treating and transporting said water to Benicia, if treated water is taken by Benicia, or transporting only if untreated water is taken by Benicia. Vallejo reserves the right to prescribe the times and rates of flow at which said water shall be accepted from Monticello terminal reservoir.

18. Modification and Termination. Vallejo's obligation to provide water and Benicia's obligation to pay for same under the terms of this Agreement shall commence not sooner than November 1, 1962, and upon completion of the construction of the necessary transmission and pumping facilities described in Paragraph 7, and shall continue in effect until November 1, 1997; provided, however, that this Agreement may be modified or terminated by mutual agreement at any time; and provided, further, that it may be unilaterally terminated upon one year's notice by Benicia when Benicia has provided facilities for an adequate new water supply.

Amendment attached

19. Notices. Any notice required under this agreement to either party shall be deemed to have been given when deposited in the United States mail in a sealed envelope, postage prepaid, and addressed as follows:

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To the City of Vallejo
Office of the City Manager
City Hall
Vallejo, California

To the City of Benicia
Office of the City Clerk
City Hall
Benicia, California

Either party may change its address by giving the other party written notice of its new address.

20. Successors and Assigns. This agreement shall inure to the benefit of and be binding upon each of the parties and their successors in interest.

21. Councilmen of Each Party Have Read Agreement. The members of the city council of each city assert that they have read and understand this Agreement.

IN WITNESS WHEREOF the parties hereto have hereunto affixed their names by their representatives thereunto duly authorized, all in the day and year first above written.

CITY OF VALLEJO, a municipal corporation,

BY _____
City Manager

ATTEST:

_____
City Clerk

CITY OF BENICIA, a municipal corporation,

BY _____
Mayor

ATTEST:

_____
City Clerk

APPROVED AS TO FORM: _____
City Attorney

APPROVED AS TO CONTENTS: _____
Public Works Director

APPROVED AS TO CONTENTS: _____
Water Superintendent

FUNDS AVAILABLE: _____
Finance Director

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AMENDMENT

That certain AGREEMENT FOR WATER SERVICE dated February 5, 1962, by and between the CITY OF VALLEJO, a Municipal Corporation, and the CITY OF BENICIA, a Municipal Corporation, is hereby amended as follows.

Paragraph 10 of said AGREEMENT FOR WATER SERVICE is hereby amended to read:

10. Option and Election to Buy Treated or Untreated Water. Benicia may purchase at its option either treated water as the same is customarily produced in Vallejo's water treatment plant, or untreated water in the following manner. For a period of one year from the date of commencement of water deliveries, the water supplied shall be untreated. Benicia may at any time after one year from the date of commencement of service under this Agreement elect to receive treated water in lieu of untreated water; but may not change again without Vallejo's consent. Such election shall be made by written notice served on Vallejo at least twelve (12) months prior to the date the change is desired. In the event such election is made, all provisions of this Agreement, except those expressly limited to one type of water or the other, shall apply to both types.

Paragraph 18 of said AGREEMENT FOR WATER SERVICE is hereby amended to read:

18. Modification and Termination. Vallejo's obligation to provide water and Benicia's obligation to pay for same under the terms of this Agreement shall commence not sooner than November 1, 1962, and upon completion of the construction of the necessary transmission and pumping facilities described in Paragraph 7, and shall continue in effect until ~~November 1, 2000;~~ June 30th, 2003; provided, however, that this Agreement may be modified or terminated by mutual agreement at any time; and provided, further, that it may be unilaterally terminated

upon one year's notice by Benicia when Benicia has provided facilities for an adequate new water supply.

DATED this 9 day of april, 1962.

CITY OF VALLEJO, a Municipal Corporation

By _____
City Manager

ATTEST:
_____
City Clerk

CITY OF BENICIA, a Municipal Corporation

By _____
Mayor

ATTEST:
_____
City Clerk

APPROVED AS TO FORM: _____
CITY ATTORNEY

APPROVED AS TO CONTENTS: _____
PUBLIC WORKS DIRECTOR

APPROVED AS TO CONTENTS: _____
WATER SUPERINTENDENT

FILE COPY

AMENDMENT NO. 2
TO THE 1962 VALLEJO/BENICIA WATER AGREEMENT

That certain Agreement for Water Service dated 5 February 1962, and as amended on 9 April 1962, by and between the CITY OF VALLEJO, a Municipal Corporation, and the CITY OF BENICIA, a Municipal Corporation, is hereby amended to read:

Paragraph No. 1 of said Agreement for Water Service is hereby amended to read as follows:

1. Point of Water Delivery. Vallejo shall furnish and Benicia shall accept the water at the Monticello Terminal Reservoir and/or at the southern boundary of the Sky Valley Project when that Project is constructed and Tentative Map 88-10 is met, or at any combination of points of delivery. Benicia will be responsible for maintenance and operation of all facilities at Terminal Reservoir, and at any other points of diversion where facilities are owned and operated by Benicia, necessary to pump water into Benicia. Benicia shall provide a mechanism acceptable to Vallejo for measuring the volume of water taken at any point.

Paragraph No. 2 of said Agreement for Water Service is hereby amended to read as follows:

2. Computation on Yearly Basis. The year for reckoning minimum and maximum delivery begins on March 1st and ends on February 28th, annually.

Paragraph No. 3 of said Agreement for Water Service is hereby deleted and a new Paragraph No. 3 is added to read as follows:

3. Rate of Delivery. Vallejo shall deliver water to the City of Benicia in a quantity not to exceed 1,100 acre feet per year from all connection points. Depending upon point of delivery of Benicia's choosing, Vallejo shall not be required to deliver water at a rate which exceeds the normal capacity of its water system. Vallejo shall maintain a capacity to furnish up to 3 million gallons per day for service to Benicia at the southern boundary of that certain point in Sky Valley, known as the "Sky Valley Project", when said project is constructed.

Paragraph No. 6 of said Agreement for Water Service is hereby amended to read as follows:

6. Meter. Benicia shall provide a mechanism acceptable to the City of Vallejo at Terminal Reservoir for measuring the consumption of water. Should Benicia elect to take service from any other point in the City of Vallejo's system, Benicia will be responsible for furnishing and installing a meter acceptable to the City of Vallejo. If Benicia takes service from Vallejo's treated water system for fifty (50) days, or less, in any one year, Benicia will not be subject to the water service charges normally assessed for service in Vallejo. Should Benicia's usage

exceed fifty (50) days in any one year, Benicia will be subject to Vallejo's water service charge. Said meter's record shall be conclusive as to quantities of water furnished except as hereinafter provided. Said meter shall be checked for accuracy by representatives of Benicia and Vallejo within five (5) days after date of written requests of either; provided, however, that no two (2) such consecutive checks shall be separated by an interval of less than thirty (30) days. If the meter is found to be registering inaccurately by two percent (2%) or more, charges for water shall be adjusted accordingly for the period the meter was in error, not exceeding thirty (30) days.

Paragraph No. 7, Pump and Appurtenances, of said Agreement for Water Service is hereby deleted in its entirety.

Paragraph No. 8 of said Agreement for Water Service is hereby amended to read as follows:

8. Connection Charge. Benicia shall pay to Vallejo for any connection to the City of Vallejo's system, other than the connection at Terminal Reservoir, all charges imposed by the City of Vallejo for similar service within Vallejo.

Paragraph No. 9, Use of 12 Inch Line, of said Agreement for Water Service is hereby deleted in its entirety.

Paragraph No. 11 of said Agreement for Water Service is hereby amended to read as follows:

11. Treated Water - Rates. Vallejo shall sell and Benicia shall pay for all treated water delivered at the "Outside City Limits Rates" in effect when the water is taken. All treated water provided by Vallejo under this Agreement shall be suitable for all domestic use, and shall meet the standards of the State Department of Public Health and the Solano County Department of Public Health, and Vallejo assumes full responsibility for providing and maintaining the quality to such standards at the point of intertie with Benicia's water system.

Paragraph No. 12 of said Agreement for Water Service is hereby amended to read as follows:

12. Untreated Water - Rates. Vallejo shall sell and Benicia shall pay for all untreated water delivered at Terminal Reservoir an amount equal to Vallejo's cost for the following items. These costs shall be reviewed yearly.

Paragraph No. 16 of said Agreement for Water Service is hereby amended to read as follows:

1.	Cost of water	$15.00/AF
2.	Estimated screen maintenance	0.35/AF
3.	Estimated access maintenance	0.08/AF
4.	Additional cost by using permit water:	
	(a) Sludge Management	4.54/AF
	(b) Chemical cost (additional)	3.28/AF
5.	Out of City Limits fee at 10%	2.33/AF
TOTAL COST UNTREATED BERRYESSA WATER		$25.58/AF

16. Review of Costs. Vallejo will periodically review the cost of furnishing untreated water as provided herein and is hereby empowered to notify Benicia of any increase or decrease of the price for water not later than the last day of January in any year. Any price change as determined shall become effective during the July following such notice and continue for not less than the succeeding one (1) contract year, and Benicia shall be obligated to pay the same

Paragraph No. 18 of said Agreement for Water Service is hereby amended to read as follows:

18. Modification and Termination. Vallejo's obligation to provide water and Benicia's obligation to pay for same under the terms of this Agreement shall commence not sooner than 1 March 1989, and shall continue in effect until 28 February 2025; provided, however, that this Agreement may be modified or terminated by mutual agreement at any time; and provided, further, that it may be unilaterally terminated upon one (1) year's notice by Benicia when Benicia has provided facilities for an adequate new water supply.

Except as specifically amended herein, said Agreement shall be and remain in full force and effect.

Dated this 28th day of April, 1988.

(Signatures on Page 4)

CITY OF VALLEJO,
A Municipal Corporation

By _____
EDWARD G. WOHLENBERG
City Manager

ATTEST:

By _____
MILDRED R. WATSON
City Clerk

APPROVED AS TO FORM:

_____
JOHN M. POWERS,
City Attorney

CITY OF BENICIA,
A Municipal Corporation

By _____
Mayor

ATTEST:

By _____
City Clerk

BENWTR

APPENDIX A-4

SID AGREEMENT

SOLANO IRRIGATION DISTRICT / CITY OF BENICIA
SOLANO PROJECT WATER ALLOTMENT TRANSFER AGREEMENT

THIS AGREEMENT is made and entered into on this 3rd day of March, 2009, by and between **SOLANO IRRIGATION DISTRICT**, an irrigation district organized and existing under and by virtue of Division 11 of the Water Code of the State of California (hereinafter referred to as "District"), and the **CITY OF BENICIA**, a general law city formed and existing under the laws of the State of California (hereinafter referred to as "City"). The parties enter into this Agreement for full and adequate consideration, the receipt of which is hereby evidenced and the adequacy is stipulated to and agreed to, as follows:

1. Definitions:

1.1 The phrases "Annual Allotment of Solano Project Water" or "Annual Allotment" shall mean the amount of allocated water District or City has contracted to receive as an annual delivery amount subject to (i) the orders of the Solano County Water Agency ("SCWA") reducing allotment to Participating Agencies under contractually permitted conditions, if any, (ii) other terms of the contract with the SCWA, and (iii) subject to application of the terms and provisions of the Solano Project Member's Agreement as to Drought Measures and Water Allocation executed on March 1, 1999 attached hereto as Exhibit "A" to this Agreement and included herein as if set forth in full ("Drought Measures Agreement"). In the case of District, the total amount of Annual Allotment of Solano Project Water is the amount of 141,000 acre-feet of water and, in addition thereto, assignment by Maine Prairie Water District to the District of 10,000 acre-feet of water, for a total of 151,000 acre-feet of water in each Water Year. In the case of City, it has no Participating Agency Contract and no annual allotment of Solano Project water.

1.2 The phrase "Water Year" means the period of one year commencing March 1 and terminating on the last day of February of the following calendar year.

1.3 The phrase "Renewal of District's Participating Agency Contract" means the renewal of the SCWA Agreement with the District for Participating Agency Contract for Solano Project Water Service dated March 1, 1999 providing for the delivery to District of 141,000 acre-feet of water from the Solano Project during each Water Year as validated in

accordance with Code of Civil Procedure Section 860 in the proceeding of *Solano County Water Agency v. All Persons,* Solano County Action No. 012612, and upon the lapse of its term, for successive periods of twenty-five (25) years or more thereafter (i) without reduction of the quantity of water available to District, and (ii) maintaining the Proportions of Payment Amounts per Acre-Foot payable by District.

1.4 The phrase "Proportions of Payment Amounts per Acre-Foot" shall mean the ratio of $15.00 per acre foot for Solano Project water delivered to Participating Agencies for industrial and municipal water use, and $2.65 per acre foot for Solano Project water delivered for irrigation use, or a ratio of 5.66:1 depending upon the character of use of the respective types of water from the Solano Project under the terms of Participating Agency Contracts.

1.5 The phrase "Voluntary Carryover Amount" and "Restricted Carryover Amount" shall have the meaning as set forth in the Drought Measures Agreement entered into by District and other Participating Agencies of SCWA.

2. Background of Agreement: District is the holder of a contractual right to receive allotments from the Solano Project as a Participating Agency of the SCWA under the terms of a Participating Agency Contract providing for the delivery of and allotment of 141,000 acre-feet of water in each Water Year from the Solano Project to District. The term of that Agreement is until the end of the Master Contract between SCWA and the United States on February 29, 2024. The parties anticipate thereafter that renewal of District's Participating Agency Contract will occur upon the same terms, conditions and quantities of water being delivered to District, including maintenance of the Proportions of Payment Amounts per Acre-Foot. In addition, District receives an assignment of 10,000 acre-feet of Solano Project water in each Water Year pursuant to a written agreement with Maine Prairie Water District. The length of the term of the Maine Prairie Water District Agreement is less than the term of District's Participating Agency Contract for 141,000 acre-feet.

2.1 District and SCWA have entered into an agreement with other Participating Agencies of SCWA providing for taking and diverting less than the full amount of Participating Agency Contract amounts with SCWA during Solano Project drought operating conditions. Under the terms of the Drought Measures Agreement, the Participating Agencies take

less water than their entitlement amounts to prepare for and buttress the operations of the Solano Project during prolonged drought conditions. City is not signatory to the Drought Measures Agreement, but shall be responsible to comply with the terms of the Drought Measures Agreement with regard to the portion of the District's Annual Allotment transferred under this Agreement.

2.2 City has asked District to agree to transfer to City upon and during the existence of certain conditions as set forth in this Agreement a portion of the Annual Allotment of Solano Project Water of District in each Water Year in consideration of the payment of sums of money to District. District has accepted that concept subject to certain conditions and terms, and this Agreement constitutes an agreement to provide for the implementation and enforcement of those transfers of a portion of the District's Annual Allotment of Solano Project Water to City subject to the terms and conditions of this Agreement.

2.3 Permission to and SCWA Notification of Transfer. City is a public agency in Solano County located within the SCWA Service Area as defined in Section 1(c) of the Master Contract. The transfer of a portion of the District's Annual Allotment of Solano Project Water to City is permitted under and subject to the restrictions of Section 7 of District's Participating Agency Contract. Per said Section 7 SCWA is to be notified in writing of any transfer of Solano Project water.

3. Term: Provided neither party has elected to terminate this Agreement pursuant to the provisions herein, the term of this Agreement shall be for so long as all of the following conditions exist: (i) District continues to hold a valid and enforceable Participating Agency Contract or Renewal of a Participating Agency Contract from SCWA or a successor organization holding substantially the same authority and rights, providing for the delivery of 141,000 acre-feet per annum; said amount of 141,000 acre-feet shall include the amounts of Annual Allotment of Solano Project Water agreed to be transferred to City under this Agreement in each Water Year from the Solano Project and is the total available to District before application of and enforcement of the Drought Measures Agreement; and (ii) the amount payable by District continues to conform to the Proportions of Payment Amounts per Acre-Foot (the "Required Terms"). However, the Agreement shall not be terminated if (i) District shall voluntarily accept

an Amended or Renewal Participating Agency Contract providing for delivery of less than 141,000 acre-feet per Water Year or different Proportions of Payment Amounts, or (ii) the conditions of paragraph 3.1 of this agreement shall exist, resulting in reductions of the performance of the parties. The effective date of termination of this Agreement upon District not holding a Participating Agency Contract with the Required Terms shall be the date of commencement of the Water Year following the occurrence of that event or condition. Upon and after the effective date of termination, (i) District shall not be required to transfer portions of the District's Annual Allotment of Solano Project Water to City in any Water Year under the terms of this Agreement, (ii) District shall not be obligated to refund or pay to City any amounts of money paid by City to District previously, and (iii) City shall be excused from any further Annual Payment Amount to District pursuant to Paragraph 5 below.

3.1 Partial Suspension and Termination of Allotment Transfer. If as a result of an act of God, nature, war or civil unrest, or a Court or governmental order, including any order or direction of SCWA in response to any of those conditions ("Force Majeure Conditions") during the term of any Participating Agency Contract in which the Required Terms are otherwise in effect and abided by, the Annual Allotment of water available to District and projected to be delivered to District in a Water Year is less than 141,000 acre feet, the transfer of Annual Allotment of Solano Project water to City under the terms of this Agreement shall be reduced in the same Proportion as the reduction in acre feet to be delivered to District bears to its 141,000 acre-feet Annual Allotment during the period of the Force Majeure Conditions. *Example:* If due to such a described Force Majeure Condition SCWA refuses or fails to deliver the full 141,000 acre-feet scheduled by District and delivers only 95% of that amount ordered by District, City would receive in that Water Year only 95% of the amount set forth in Paragraph 4 hereafter otherwise allocated to City from District's allocation. City shall not receive a credit or refund of any of the "One-Time Payment" to District under Paragraph 5, but the "Annual Payment Amount" under Paragraph 5 shall be reduced in proportion to the reduction in the Amount of Annual Allotment of Solano Project water transferred in that Water Year to City because of and during the existence of the Force Majeure Condition.

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3.2 City Termination. City may elect to terminate this Agreement in whole or in part by providing written notice (the Notice of Termination) that it wishes to terminate this Agreement and the amount of the District's Annual Allotment of Solano Project Water it wishes to terminate the transfer of annually for the remaining term of this Agreement. The termination shall be effective after such written notice commencing with the Water Year that commences more than three (3) years following delivery of the written notice (the Effective Termination Date). Upon and after the Effective Termination Date, City shall be excused from the amount of the Annual Payment Amount multiplied by the number of acre-feet City elects to terminate delivery of annually thereafter. District shall not be obligated to pay, refund or credit to City any of the One-Time Payment Amounts previously paid by City or the Annual Payment Amounts paid during the term of the Agreement or during the three (3) year period following the Notice of Termination prior to the Effective Termination Date attributable to the portion of the District's Annual Allotment of Solano Project Water no longer transferred pursuant to City's termination. The Notice of Termination, once given by City, shall not be rescindable or cancellable for any reason. Reacquisition of an amount terminated could be negotiated through a new Transfer Agreement between District and City. Any Voluntary Carryover or Restricted Carryover water set aside from District's transferred Annual Allotment by City prior to the Effective Termination Date shall remain the property of City.

3.3 If City shall elect to terminate in whole or in part under this Agreement, City shall promptly execute all documents required to terminate in whole or in part the transfer of a portion of the District's Annual Allotment of Solano Project Water under the terms of this Agreement. City shall bear any (i) costs or charges by SCWA or any other governmental agencies that would be due under this Agreement and are incurred upon the transferred portion of the District's Annual Allotment prior to the Effective Termination Date, (ii) any costs or charges of SCWA caused by the termination of transfers of Annual Allotment, and (iii) any direct, one-time costs or charges for the return and reinstatement of a portion of the District's Annual Allotment of Solano Project Water to District on and after the effective date of termination of this Agreement as to Annual Allotment transferred under the terms of this Agreement.

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4. Annual Allotment Transfer Amounts: Subject to the conditions and terms of this Agreement, commencing on March 1, 2009 and on March 1 of each Water Year thereafter, District shall transfer to City in each Water Year in which City complies with the terms and provisions of this Agreement, and this Agreement has not been wholly or partially terminated by City, two thousand (2,000) acre-feet of the District's Annual Allotment of Solano Project Water. District shall schedule the deliveries of this portion of the District's Annual Allotment to City by District foregoing such amount of water deliveries from Lake Berryessa and the Putah South Canal of the Solano Project in favor of City. City shall bear and perform any Restricted Carryover Amount obligations under the Drought Measures Agreement attributable to the portion of the District's Annual Allotment transferred from District to City for each Water Year during the term of this Agreement. Any Voluntary Carryover Amounts or Restricted Carryover Amounts accumulated by District in Water Years prior to the date of the first transfer under this Agreement, attributable to the portion of the District's Annual Allotment transferred under this Agreement, shall remain the sole and exclusive property of District and shall not be transferred to City.

5. Payment: City shall pay to District within thirty (30) days of its execution of the agreement, the sum of $5,000,000.00 computed as 2,000 acre-feet of water/year x $2,500.00 per acre-foot (the "One-Time Payment Amount"). In addition, within thirty (30) days of its execution of the agreement, and each March 1 of each Water Year thereafter, City shall pay the sum of Sixty-Two Dollars and Sixty-Two Cents ($62.62) per acre-foot of the portion of the District's Annual Allotment of Solano Project Water transferred, adjusted by the Consumer Price Index Amount per Paragraph 5.5 below (the "Annual Payment Amount"). The One-Time Payment and the Annual Payment Amount payable per acre-foot to District shall be paid to District without reduction for any Voluntary Carryover Reductions or Restricted Carryover Reductions borne by City from the portion of the District's Annual Allotment transferred in any Water Year.

5.1 Charges of SCWA or Other Governmental Entities. City shall pay all charges of SCWA applied to the Annual Allotment of Solano Project water transferred under the terms of this Agreement to City. District shall pay any taxes, fees, assessments or similar governmental charges levied or imposed by governmental entities other than SCWA upon the

Annual Allotment of Solano Project Water transferred to City. City shall pay any taxes, fees, assessments or similar governmental charges levied or imposed by governmental entities other than SCWA upon the Annual Allotment of Solano Project Water transferred to City which are charged or levied because of its use or disposition by City.

5.2 City Not to Participate in Maine Prairie Transfer to City or Third Party. District relies upon the assignment of 10,000 acre-feet of Solano Project water from Maine Prairie Water District to meet its delivery obligations, and reduction of this quantity will reduce the amount of water available to District to meet its obligations under this contract. City agrees that it will not directly or indirectly acquire, participate in, receive a benefit from, or approve of a transfer of Maine Prairie Water District Annual Allotment of Solano Project Water assigned to District in any Water Year to parties or persons other than District without the prior written consent of District. City agrees that a violation of this provision will constitute a material breach of this Agreement and upon determination that a material breach has occurred, District shall be entitled to elect to reduce the amount of District annual allotment transferred to City by the amount of Maine Prairie Water District Annual Allotment not received by District, with City continuing to pay the Annual Payment Amount or to recover the monetary damages suffered by District as a proximate result of the material breach.

5.3 Payment Dates. The Annual Payment Amount shall be paid on or before March 1 of each Water Year for the amount of Annual Entitlement of Solano Project Water ordered to be transferred by District to City under this Agreement during that following Water Year. Any additional charges due to transfers by City to third parties as specified under Paragraph 5.4 below, if any, attributable to the preceding Water Year ending on the last day of February, shall be payable on each July 1 following the end of the Water Year.

5.4 Additional Charge Due to Third Party Transfer by City. If in any Water Year during the term of this Agreement City shall transfer or forego the use of State Water Project water, or any other water supply water available to City on the effective date of this Agreement for use or application, directly or indirectly, by substitution, foregoance, exchange or transfer, for use and consumption by governmental entities or third parties outside of Solano County, and if City receives consideration in excess of the sum of $250 per acre-foot adjusted by

205 the Consumer Price Index Increase, then in addition to the Annual Payment Amounts, the
206 additional amounts received by City per acre-foot in excess of that amount for the water
207 foregone, transferred, deferred, or relinquished, shall be added to the consideration payable to the
208 District and paid to District on the Payment Date.

209 5.5 Consumer Price Index Increase Amount: The Annual Payment Amount
210 per acre-foot specified in Paragraph 5 above shall be increased or decreased by the percentage
211 change in the Consumer Price Index. The amount of increase or decrease in the United States
212 Department of Labor (or successor division or office) publication of the Consumer Price Index
213 for Urban Wage Earners and Clerical Workers, United States Average (1967 Base) CPI-W,
214 utilizing an index of 612.948 on December 31, 2007 as the base, shall be determined to the
215 preceding December 31 prior to commencement of each Water Year on March 1. The Consumer
216 Price Index Increase Amount shall be applied to the Annual Payment Amount and paid to
217 District for each acre-foot of Annual Allotment of Solano Project Water transferred in that Water
218 Year commencing March 1.

219 6. California Environmental Quality Act: The approval and execution of this
220 Agreement is contingent upon certification of the CEQA document by District and each of City
221 and District's findings and determinations as a lead agency or responsible agency under CEQA.
222 Pursuant to Section 15051(d) of the California Environmental Quality Act Guidelines ("CEQA"),
223 District is designated as the Lead Agency under CEQA for this Agreement and will prepare an
224 Initial Study and Checklist and whatever environmental documentation is required, including an
225 Environmental Impact Report if significant environmental impacts are identified for the Project.
226 The Project is agreed to be and is described as follows: "A proposed Agreement to accomplish
227 annual transfers of a quantity of Solano Irrigation District's Annual Allotment of Solano Project
228 Water to the City of Benicia in the amount of 2,000 acre-feet per year and the payment of
229 consideration from City to District for that transfer. The water quantities transferred will be
230 delivered in Lake Berryessa and the Putah South Canal and will be utilized by City primarily to
231 assure yield through drought periods for the existing City water service area, to enhance water
232 quality to City customers within the existing City water service area, to reduce water treatment
233 costs of City, to reduce energy consumption for water treatment, and to provide supplies for

234 replacement of reduced sources of State Water Project water due to State Water Project operating
235 conditions. The monies paid by City to the District shall be utilized by District to enhance its
236 system to maximize existing resources through construction of water conservation and
237 conjunctive use projects to (i) repair, replace, rehabilitate and install at new locations the
238 groundwater pumping capacity of District previously existing, (ii) to install and or replace
239 existing canal transmission facilities with impervious materials or to install pipe in the place of
240 earthen ditches and canals used to deliver District water, (iii) to cause return flow and drainage
241 recapture structures and pumping facilities to be repaired, refitted and expanded in capacity, and
242 (iv) other related expenditures to insure reliable and sustainable water supply deliveries. City is
243 designated as a Responsible Agency. District will bear the costs of completing the CEQA process
244 in regard to the transfer of water to City pursuant to this Agreement but may elect to terminate
245 the CEQA process at any time, and City shall have no claim against District for expense nor any
246 right to compel completion of the process.

247 6.1 Once District has prepared the CEQA document, City shall have the
248 obligation to process the document as a responsible agency and to meet any other legal
249 requirements in regard to the application and use of the water transferred hereunder by District to
250 City.

251 6.2 Each party reserves its full and entire discretion and authority regarding
252 whether to or how to approve this Agreement based upon the results of the CEQA process. If
253 there are any comments or legal challenges to District's CEQA process or City's CEQA process
254 by any person or entity that is not a party to this Agreement, then City or District may elect,
255 based upon the exercise of its reasonable and sole discretion, to terminate this Agreement. If
256 either City or District gives notice of its election to terminate this Agreement pursuant to this
257 Paragraph, the costs and expenses of negotiating and preparing this Agreement and the CEQA
258 process shall be borne by the respective party incurring those expenses, and no party shall have a
259 claim against the other party for attorney's fees, expert witness fees, costs or expenses, loss or
260 damage. Neither party shall be required to pursue litigation to the exhaustion of all judicial or
261 administrative proceedings in regard to the issues presented by a CEQA challenge or other form
262 of challenge, nor shall any party be barred from giving its notice of election to not proceed with

263 this Agreement until any challenges are finally resolved, if any.

264 7. Water Quality not Warranted. Water from the Solano Project delivered under this
265 Agreement shall be per the standards and limitations stated in paragraph 21 of the Contract
266 between the United States and Solano County Water Agency dated February 28, 1999. District
267 does not warrant the quality of the Solano Project Water.

268 8. Representations and Warranties of Authority: District represents and warrants
269 that it has the authority and has provided for all preconditions, acts and findings required by law
270 to provide for and enter into and perform the terms and provisions of this Agreement. City
271 represents and warrants that it has the authority and has provided for all preconditions, acts and
272 findings required by law to provide for and enter into and perform the terms and provisions of
273 this Agreement. Should the authority of either City or District be challenged in any legal or
274 administrative proceeding after the effective date of this Agreement, a party so challenged shall
275 indemnify and defend the other party, including paying the costs of attorney's fees, expert
276 witness fees and all other reasonable costs of defense of the other party from any claimed lack of
277 authority, power or authorization to enter into and perform the terms and provisions of this
278 Agreement.

279 9. Effective Date: The effective date of this Agreement shall be the date that the last
280 of the Board of Directors of District and the City Council of City shall have approved execution
281 and executed this Agreement, and SCWA has acknowledged notification of the transfer. Both
282 District and City shall upon the Effective Date of this Agreement execute such notices to SCWA
283 as shall be reasonably required to provide for the annual transfer of a portion of District's Annual
284 Allotment. After the Effective Date, upon termination of this Agreement or any portion of the
285 transfer of Annual Allotment, both District and City shall promptly execute and deliver notices to
286 SCWA in regard to the return of said portions of Annual Allotment amounts to District's
287 account, except that any amounts placed in a Voluntary Carryover Account or Restricted
288 Carryover Account during the term of this Agreement by City attributable to the waters
289 transferred by District will remain the sole and exclusive property of City.

290 10. Written Notice: Written notice under the terms of this Agreement shall be
291 provided to City and District at the following addresses by fax notice and by first class mail, as

292 follows:

293 If to District:

294 Solano Irrigation District
295 Attn: General Manager
296 508 Elmira Road
297 Vacaville, CA 95687
298 Facsimile: (707) 448-7347

299 If to City:

300 City of Benicia
301 Attn: Director of Public Works
302 250 East L Street
303 Benicia, CA 94510
304 Facsimile: (707) 747-1637

305 Notice shall be deemed effective and served five (5) calendar days following deposit in first class
306 mail.

307 11. Payment Form: All payments shall be made in lawful monies and currency of the
308 United States and shall be immediately payable and drawable by District.

309 12. Time is of the Essence. Time is of the essence in the performance of this
310 Agreement and of every term and provision thereof.

311 13. Parties to Act in Good Faith. Each of the parties agrees to act in good faith to
312 implement and to allow for the performance of the obligations and the rights specified herein,
313 and each party agrees not to do any act which would impair or make more difficult or impossible
314 the performance of this Agreement and of every right or term thereof.

315 14. No Assignment: The provisions of this Agreement shall apply to and bind the
316 successors and assigns of the respective parties hereto, but no assignment or transfer of this
317 Agreement or any part thereof or interest therein by any party shall be valid unless and until
318 approved in writing by the other party.

319 15. No Other Representations or Warranties: There are no other terms, conditions,
320 promises, or warranties either implied or explicit other than are contained within the written
321 terms of this Agreement.

322 16. Amendment or Modification: No amendment, modification or waiver of any
323 rights or terms of this Agreement shall be made except by a writing executed by each party

indicating on its face the intent to amend this Agreement.

17. Execution in Counterparts: This Agreement may be executed in several duplicate counterparts, each of which shall be an original.

18. SCWA Acknowledgement: SCWA executes this agreement for the purpose of acknowledging notification of the same per Section 7(a) of District's Participating Agency Contract. Each Party shall have the right to enforce the terms of this Agreement against the other Party.

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SOLANO IRRIGATION DISTRICT ("DISTRICT"):

Dated: 03/03/2009

ROBERT HANSEN, President
Board of Directors

Dated: 3-3-09

DAVID M. MANSFIELD, General Manager

CITY OF BENICIA ("CITY"):

Dated: 4/23/09

ELIZABETH PATTERSON, Mayor

Dated: 4/24/09

LISA WOLFE, City Clerk

Dated: 4-22-09

HEATHER McLAUGHLIN, City Attorney

SOLANO COUNTY WATER AGENCY ("SCWA"):

This Agreement has been received by the Solano County Water Agency ("SCWA"), which acknowledges notification of the subject transfer and concurs with the conformance of the transfer with the requirements and restrictions of the District's Participating Agency Contract.

Dated: 4/29/09

DAVID OKITA, General Manager

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///

State of California)
County of Solano)

On March 3, 2009, before me, Frank Weber, Notary Public, personally appeared **Robert Hansen** and **David M. Mansfield**, who proved to me on the basis of satisfactory evidence to be the persons whose names are subscribed to the within instrument and acknowledged to me that they executed the same in their authorized capacities, and that by their signatures on the instrument the persons, or the entity upon behalf of which the persons acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the forgoing paragraph is true and correct.

WITNESS my hand and official seal.

FRANK WEBER
Commission # 1740813
Notary Public - California
Solano County
My Comm. Expires May 19, 2011

Frank Weber, Notary Public
Commission Number: 1740813
Commissioned In: Solano County, State of California
Date Commission Expires: May 19, 2011
Vendor ID Number: NNA1
Phone Number: 707-455-4032

State of California)
County of Solano)

On April 23, 2009, before me, JAYNE M. YORK, Notary Public, personally appeared **Elizabeth Patterson**, who proved to me on the basis of satisfactory evidence to be the person whose name is subscribed to the within instrument and acknowledged to me that she executed the same in her authorized capacity, and that by her signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the forgoing paragraph is true and correct.

WITNESS my hand and official seal.

JAYNE M. YORK
Commission # 1734784
Notary Public - California
Solano County
My Comm. Expires Apr 20, 2011

Jayne M. York, Notary Public
Commission Number: 1734784
Commissioned In: Solano County, State of California
Date Commission Expires: 4/20/11
Vendor ID Number: NNA1
Phone Number: 707-746-4200

State of California)
County of Solano)

On April 24, 2009, before me, JAYNE M. YORK, Notary Public, personally appeared **Lisa Wolfe**, who proved to me on the basis of satisfactory evidence to be the person whose name is subscribed to the within instrument and acknowledged to me that she executed the same in her authorized capacity, and that by her signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the forgoing paragraph is true and correct.

WITNESS my hand and official seal.

JAYNE M. YORK
Commission # 1734784
Notary Public - California
Solano County
My Comm. Expires Apr 20, 2011

Jayne M. York
_____, Notary Public
Commission Number: 1734784
Commissioned In: Solano County, State of California
Date Commission Expires: 4/20/11
Vendor ID Number: NNA1
Phone Number: 707-746-4200

State of California)
County of Solano)

On 4/22/09, 2009, before me, Diane L. Henry, Notary Public, personally appeared **Heather McLaughlin**, who proved to me on the basis of satisfactory evidence to be the person whose name is subscribed to the within instrument and acknowledged to me that he executed the same in his authorized capacity, and that by his signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the forgoing paragraph is true and correct.

WITNESS my hand and official seal.

DIANE L. HENRY
Commission # 1800006
Notary Public - California
Solano County
My Comm. Expires Jun 1, 2012

Diane L. Henry
_____, Notary Public
Commission Number: 1800006
Commissioned In: Solano County, State of California
Date Commission Expires: 6/1/2012
Vendor ID Number: NNA1
Phone Number: 707-746-4216

State of California)
County of Solano)

On April 29, 2009, before me, Frank Weber, Notary Public, personally appeared **David Okita**, who proved to me on the basis of satisfactory evidence to be the person whose name is subscribed to the within instrument and acknowledged to me that he executed the same in his authorized capacity, and that by his signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the forgoing paragraph is true and correct.

WITNESS my hand and official seal.

FRANK WEBER
Commission # 1740813
Notary Public - California
Solano County
My Comm. Expires May 19, 2011

Frank Weber, Notary Public
Commission Number: 1740813
Commissioned In: Solano County, State of California
Date Commission Expires: May 19, 2011
Vendor ID Number: NNA1
Phone Number: 707-455-4032

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EXHIBIT "A"

Solano Project Member's Agreement as to Drought Measures and Water Allocation executed on March 1, 1999.

SOLANO PROJECT MEMBERS'
AGREEMENT AS TO DROUGHT MEASURES
AND WATER ALLOCATION

THIS AGREEMENT, dated as of March 1, 1999, by and among the Solano Irrigation District, a California Irrigation District (hereinafter referred to as "SID"), Maine Prairie Water District, (hereinafter referred to as "MPWD"), the City of Fairfield, a California municipal corporation (hereinafter referred to as "Fairfield"), the City of Vacaville, a California municipal corporation (hereinafter referred to as "Vacaville"), the City of Suisun City (hereinafter referred to as "Suisun"), and the City of Vallejo, a California municipal corporation (hereinafter referred to as "Vallejo"), individually referred to or collectively referred to in this Agreement as "Party" or "Parties," respectively, is made and entered into and the Parties do, for full and adequate consideration, receipt of which is hereby acknowledged, agree as follows:

Section 1.0: Background Facts

1.1 The Parties are all, through contracts with the Solano County Water Agency ("SCWA"), Participating Agencies of the Solano Project, entitled to annual deliveries of water from the Solano Project in the following amounts:

Name of Party	Annual Entitlement (Acre-Feet ("AF")/Water Year)
Solano Irrigation District	141,000
Fairfield	9,200
Vacaville	5,600
Suisun City	1,600
Maine Prairie	15,000
Vallejo	14,750
Total:	187,150

The present contract between the United States and SCWA for Solano Project water supply ("Solano Project Master Contract") expires in 1999, and negotiations between the United States and SCWA for Solano Project Master Contract renewal and extension are underway, and the Member Unit Parties' contracts with SCWA for the annual entitlements will be extended or renewed.

(Final 1/25/99)

1.2 The Parties wish to provide for this Agreement as to the measures to be used in regard to the accounting of water not used from a Party's annual entitlement from the Solano Project in a year after renewal, and also to provide for contractually agreed-to and enforceable curtailments in the amounts of water taken under the respective Parties' annual entitlements during certain drought conditions. This Agreement provides for the accounting of and preservation of the rights of the Parties to those waters which are voluntarily or mandatorily curtailed.

1.3 The Parties wish to further provide in this Agreement for special measures which SID will implement should the drought conditions deepen and become more severe, resulting in reduction of storage in Lake Berryessa to certain levels despite all reasonable efforts of the Parties.

1.4 The Parties agree that each of the Background Facts in Section 1.0 *et seq.* is true and correct, and a portion of the consideration for this Agreement.

Section 2.0: <u>Definitions</u>.

2.1 The phrase "Storage in Lake Berryessa" shall mean the amount of water stored on the date specified in this Agreement within Lake Berryessa (i) excluding any amounts of water in dead storage which may not be physically released or diverted from Lake Berryessa for any reason, (ii) excluding any amounts of water held on that date in Voluntary Carryover Accounts by the Parties to this Agreement, but (iii) including any amounts of water held in Restricted Carryover Accounts by the Parties on that date. The Storage in Lake Berryessa shall be calculated utilizing the most current elevation capacity curve for Lake Berryessa approved by the United States.

2.2 The phrase "annual entitlements" shall mean the amount of water a Party is entitled to delivery each water year in the amounts set forth in Paragraph 1.1 above, where each "water year" begins on March 1, and ends on the last day of the following February, as set forth in the present contracts.

Section 3.0: <u>Renewal Contracts of Parties</u>

3.1. The Parties agree that the Parties shall each be entitled to renewal of their

Contract with SCWA for the purchase of water from the Solano Project annually on the basis of the annual amounts set forth in Paragraph 1.1 above.

3.2 It shall be a precondition to the enforceability of this Agreement that each of the Parties shall have received and accepted a renewal contract for Solano Project Water in the above amounts from SCWA ("Renewal Participating Agency Contract") and that the terms of those agreements have been accepted by each Party and approved by the United States Department of Interior, Bureau of Reclamation, if such approval is required by the Solano Project Master Contract, and the Renewal Participating Agency Contracts have each been validated in accordance with the provisions of California Code of Civil Procedure section 860, *et seq.* It shall be a further precondition of the enforceability of this Agreement that no material change has been made in the terms and provisions of each Renewal Participating Agency Contract including, without excluding other material changes, that:

3.2.1 The term of all of the Renewal Participating Agency Contracts shall be equivalent to the term of the renewed Solano Project Master Contract; and

3.2.2 The proportions of payment amounts per AF of water available under the Renewal Participating Agency Contracts shall be the same as the existing Contracts of $15.00 per AF for municipal and industrial ("M&I") water use and $2.65 per AF for irrigation use or a ratio of 5.66 to 1, depending on the respective purpose of use; and

3.2.3 There shall be included within all Renewal Participating Agency Contracts provisions permitting each Party to voluntarily retain carryover storage in Lake Berryessa for any unutilized portion of that Party's annual water entitlement under its Renewal Participating Agency Contract under the following conditions:

(a) The amount so voluntarily unutilized on the last day of February shall be added on that date to a carryover account ("Voluntary Carryover Account") for the Party that did not order delivery of the amount of water, but the Party shall pay SCWA for the undelivered water as if the water was delivered to the Party in that year in accordance with the Renewal Participating Agency Contract terms. No additional payment will be required for subsequent use of that water if there is no change in type of use.

(b) Any water in a Party's Voluntary Carryover Account may be utilized by that Party, in addition to all portions of their annual entitlement, in any water year subsequent to the water year in which it is added to the Party's Voluntary Carryover Account, or may be assigned, with approval by SCWA, to another Party to this Agreement, for use by the other Party in the year of non-diversion before its addition to a Party's Voluntary Carryover Account or for use in a subsequent water year from that assignee's Voluntary Carryover Account.

(c) Any water in a Party's Voluntary Carryover Account at the time that Lake Berryessa spills, or at a time in which emergency releases are made from Lake Berryessa for any other reason which releases are not delivered by the Solano Project to SCWA, may be lost as follows: The spill or emergency release shall be charged proportionately to each Party having a Voluntary Carryover Account and subtracted from the Parties' Voluntary Carryover Accounts then having a balance in their accounts to the extent of the spill or emergency release.

Example: Party A has 20,000 AF in its Voluntary Carryover Account, Party Y has 10,000 AF in its Voluntary Carryover Account, and Party X has 2,000 AF in its Voluntary Carryover Account, as these accounts exist at the time the spill condition commences, and these are the only carryover amounts presently in Lake Berryessa. A spill condition occurs in which water is not diverted into the Putah South Canal for beneficial use, or is not credited to a release requirement of the Solano Project in Putah Creek, including carriage losses upstream of Putah Diversion Dam. Each net acre foot spilling shall be charged proportionately to each Party's Voluntary Carryover Account. In the example, the percentages are: Party A, 62.5%; Party Y, 31.25%; Party X, 6.25%. If the net spill was of 16,000 AF, the Voluntary Carryover Accounts of all Parties would be reduced by 50%. If the net spill exceeded 32,000 AF, each Party's Voluntary Carryover Account would have a zero balance.

(d) No monies shall be reimbursable from SCWA to the Parties for the amounts paid for the Voluntary Carryover Account water to SCWA which is spilled.

(e) No evaporation, measurement or carriage loss will be charged upon any Party's Voluntary Carryover Account balance. No Party shall be charged a storage charge upon its Voluntary Carryover Account balances.

Section 4.0: Preparation of Drought Contingency Plans:

4.1 When Storage in Lake Berryessa falls below 800,000 AF as measured on December 1, the Parties will participate with SCWA staff in preparation of a Drought Contingency Plan which shall include reasonable water conservation measures, investigation of potential emergency supplies which could be imported without construction of new conveyance facilities, and other reasonable measures which could reduce the depletion of Storage in Lake Berryessa. Implementation of any of these measures by the Parties and SCWA will only be with the consent of the individual Parties electing to participate, and SCWA will not suspend or supersede provisions of the Participating Agency Renewal Contracts with SCWA. The Drought Contingency Plan shall also address terms and conditions for water sales pursuant to Paragraph 5.6(b). If Storage in Lake Berryessa exceeds 1.1 million AF on the following April 1, development of the Drought Contingency Plan shall be suspended.

Section 5.0 Mandatory Additions to Storage and Carryover Accounts by Parties ("Restricted Carryover Account"):

5.1 When Storage in Lake Berryessa is between 550,000 AF and 800,000 AF as measured on April 1 of any water year, then each of the Parties agrees to forego taking delivery of at least 5% of the Party's annual entitlement. If the Storage in Lake Berryessa is between 450,000 AF and 550,000 AF as measured on April 1, the Parties agree that they will forego taking delivery of at least 10% of their annual entitlements. On the first day of the next water year, a 5% (if Storage in Lake Berryessa had been between 550,000 AF and 800,000 AF the previous April 1) or 10% (if Storage in Lake Berryessa had been between 450,000 AF and 550,000 AF the previous April 1) portion of each Party's annual entitlement shall be credited to what will be called the Party's "Restricted Carryover Account."

5.2 Restricted Carryover shall be classified as either irrigation or M&I. For a Party that delivers only one class of water, 100% of its Restricted Carryover shall be designated of that class. For a Party that delivers both irrigation water and M&I water, the Restricted Carryover shall be segregated into irrigation ("irrigation Restricted Carryover") and M&I ("M&I Restricted Carryover") classes based on the amounts of each class of water acquired by that Party from SCWA during the water year in which the Restricted Carryover was generated.

Example: The Storage in Lake Berryessa is between 550,000 AF and 750,000 AF on April 1. Party A delivers both M&I and irrigation water, and in the current water year acquires 20% M&I and 80% irrigation from SCWA. The 5% of annual entitlement foregone amount deposited in Party A's Restricted Carryover Account the following water year would be classified as 1% M&I Restricted Carryover and 4% irrigation Restricted Carryover.

5.3 Notwithstanding the mandatory foregoance of a portion of its annual entitlement, a Party having a Voluntary Carryover Account balance from voluntary curtailment of use may take any portion of the Voluntary Carryover Account balance from that account in a water year.

5.4 A Party shall not withdraw water from its Restricted Carryover Account until either (a) the Storage in Lake Berryessa on a subsequent April 1 exceeds 800,000 AF, or (b) the Storage in Lake Berryessa on a subsequent April 1 falls below 450,000 AF. If the April 1 Storage in Lake Berryessa exceeds 800,000 AF, the Restricted Carryover Accounts shall convert to or combine with Voluntary Carryover Accounts of the respective Parties. If the April 1 Storage in Lake Berryessa falls below 450,000 AF, the water in Restricted Carryover Accounts will become available to the Member unit Parties as specified in Section 5.6 below.

Example: Party A serves only M&I water and has a Voluntary Carryover Account balance of 2,000 AF on April 1 and no Restricted Carryover Account balance. The April 1 Storage in Lake Berryessa is less than 800,000 AF but more than 550,000 AF. Party A will forego taking delivery of at least 5% of its annual entitlement in the current water year ending on the last day of February. Party A may, up to the last day of February, order and receive 95% of its annual entitlement and an additional 2,000 AF from its Voluntary Carryover Account, bringing its Voluntary Carryover Account to zero on the last day of the water year. The following water year, the Restricted Carryover Account of Party A will have the foregone amount of 5% in it, classified as 100% M&I Restricted Carryover. If the Storage in Lake Berryessa on April 1 of that year exceeds 800,000 AF, Party A's Restricted Carryover Account will convert to a Voluntary Carryover Account, and Party A is entitled to use the water at any time. If the Storage in Lake Berryessa falls below 450,000 AF on April 1 of that year, the water in Restricted Carryover Accounts will become available to the Parties as specified in Section 5.6

below. If the April 1 Storage in Lake Berryessa is any other amount (between 450,000 AF and 800,000 AF), the foregone amount remains in Party A's Restricted Carryover Account and is not available for use.

5.5 After successive water years in which Storage in Lake Berryessa is between 450,000 AF and 800,000 AF on April 1, water will tend to accumulate in the Restricted Carryover Accounts. The above provisions notwithstanding, however, accumulated water in a Party's Restricted Carryover Account (combined M&I and irrigation Restricted Carryover) shall not exceed 50% of that Party's annual entitlement.

Example: Same as last example (Section 5.4) except Party A starts with a Restricted Carryover Account balance of 48% of its annual entitlement. Party A would be required to deposit only 2% of its annual entitlement into its Restricted Carryover Account to bring the Restricted Carryover Account up to the maximum 50% of annual entitlement. Party A may take delivery and use up to 98% of its annual entitlement that water year, excluding any Voluntary Carryover.

5.6 When Storage in Lake Berryessa falls to less than 450,000 AF on April 1, the Parties will not be required to deposit additional water into Restricted Carryover attributable to that water year and water from the Restricted Carryover Accounts will be released to the Parties as follows:

a. The Parties shall have access to their M&I Restricted Carryover Account balances for M&I uses; and

b. The Parties shall have access to their irrigation Restricted Carryover balances for voluntary sale to other Parties for M&I uses based on terms and conditions established through the drought contingency planning process of Section 4.0.

Example: In 2006, Storage in Lake Berryessa is between 550,000 AF and 800,000 AF on April 1 after being above 800,000 AF the previous year. A 5% Restricted Carryover amount is required of all Parties for that water year. Since water orders are submitted to SCWA prior to March 1, the order for that year will be amended to reflect the reduction in available water supply for each of the Parties and the foregone amount will be credited to the Restricted Carryover Accounts on March 1, 2007. On April 1 in each of years 2007 and 2008,

Storage in Lake Berryessa is between 450,000 AF and 550,000 AF. On March 1, 2009, each Party will have 25% of its annual entitlement in its Restricted Carryover Account. On April 1, 2009, Storage in Lake Berryessa falls below 450,000 AF. The Parties will not be required to deposit further water into their Restricted Carryover Accounts that year, and each Party may use any M&I Restricted Carryover in its Restricted Carryover Account for M&I uses that year. Furthermore, Parties with irrigation Restricted Carryover may sell all or any part of that water to other Parties for M&I use pursuant to the drought contingency plan of Section 4.0 above. Any water not sold will remain irrigation Restricted Carryover in the selling Party's Restricted Carryover Account, and such water's disposition will be determined by the April 1 Storage in Lake Berryessa in subsequent years.

5.7 Any amounts of water which are mandatorily foregone and placed into the Restricted Carryover Accounts by the Parties pursuant to Paragraph 5.1 shall be subject to payment of the water charge to SCWA for the foregone amount. No additional payment will be required for subsequent use of that water if there is no change in the type of use.

5.8 In addition to the provisions above, when Storage in Lake Berryessa is less than 400,000 AF on April 1, SID will prepare to implement a voluntary agricultural water marketing program in order to sign up growers who are willing to sell their water allocations for the next water year beginning March 1 of the following year. The water obtained by this voluntary process will be marketed by SID to the Parties to meet M&I water needs of those Parties. The process, methods of determining cost, and conditions governing the marketing to Participating Agencies shall be reasonable and are generally outlined as to form in Exhibit "A" entitled "Solano Irrigation District Drought Impact Reduction Program" (referred to herein as "Program"). The SID Board of Directors may alter and modify the conditions, charges and terms of the Program from time to time, but the purposes of the Program of providing for voluntary relinquishment of agricultural water, while avoiding permanent adverse economic, environmental and social or organizational damage to the agricultural community and to the Parties' M&I users, and retaining the viability of SID, shall be reasonably retained in the Program adopted and implemented by SID. Parties desiring to obtain water from SID for M&I purposes will be provided a reasonable opportunity to comment on any proposed Program changes in advance of their implementation by SID.

5.9 If the Solano Irrigation District Drought Impact Reduction Program shall have been implemented for two or more successive years in the previous three years, and a total of more than 35,000 AF of water are subscribed during the three years to meet M&I water needs of Parties, and on the following April 1 Storage in Lake Berryessa is less than 400,000 AF, the amounts of water to be made available under the Program in that year shall be reduced by SID to a maximum of 5,000 AF.

Example A: Same as last example (Section 5.6), with the additional facts that Storage in Lake Berryessa drops below 400,000 AF on April 1 in years 2010 through 2012, and in year 2009 and 2010, the Program provides for the subscription of 20,000 AF annually for M&I use. Because in the successive years 2009 and 2010 the Program is utilized to provide 35,000 AF or more to M&I users, each Party would have the additional right to participate in the Program in year 2011, but only to the extent of the Party's share of a total Program amount not to exceed 5,000 AF. In year 2012, because more than 35,000 AF were subscribed to under the Program over the past three years and the program was in effect in at least two successive years within the previous three years, the Program shall be reduced again to a maximum of 5,000 AF. If Storage in Lake Berryessa continues below 400,000 AF on April 1, 2013, the 5,000 AF restriction would not be in effect because the Program did not provide 35,000 AF or more to M&I users over the past three years.

Example B: Same as last example, except Storage in Lake Berryessa is above 400,000 AF on April 1, 2010, and therefore the Program is not in effect that year. In year 2011 the program provides for the subscription of 20,000 AF for M&I use. In year 2012, the 5,000 AF restriction would not be in effect because, although the Program provided over 35,000 AF to M&I users over the past three years, the Program was not in effect in at least two successive years during that period. If Storage in Lake Berryessa continues below 400,000 AF on April 1, 2013, the 5,000 AF restriction would be in effect if the 2012 subscription was 15,000 AF or more (so that the combined 2011 and 2012 subscription was 35,000 AF or more).

5.10 Except as provided otherwise by this Section, Restricted Carryover will be treated the same as Voluntary Carryover.

Section 6.0: **No Assignments**

6.1 This Agreement, and the rights, duties and benefits given in it, may not be assigned by a Party to a non-Party without the advance written consent of all other Parties, and any attempted direct or indirect assignment without such consent is void. The amounts of water in a Party's Voluntary or Restricted Carryover Accounts may not be assigned directly or indirectly for the benefit of non-Parties and SCWA must consent to any such assignments between Parties. Approval of assignment of portions of a Party's annual entitlement to water under its Renewal Participating Agency Contract by SCWA shall carry with it the obligation to provide the Restricted Carryover Account amounts attributable to that entitlement.

Section 7.0: **Counterparts**

7.1 This Agreement may be executed in several duplicate counterparts, each of which shall be an original.

Section 8.0: **SCWA Consent**

8.1 The Solano County Water Agency executes this Agreement for the purposes of consenting to the terms hereof. Each Party shall have the right to enforce the terms of this Agreement against any or all other Parties.

SOLANO IRRIGATION DISTRICT

Dated: By: _____
President, Board of Directors

[SEAL] Attest:

_____
Secretary, Board of Directors

Approved as to form:

_____
District Counsel, Solano Irrigation District

MAINE PRAIRIE WATER DISTRICT

Dated: By: Milton Rayn
President, Board of Directors

[SEAL] Attest:

William H Holdener
Secretary, Board of Directors

Approved as to form:

George Barger
District Counsel

CITY OF FAIRFIELD

Dated: By: _____
Mayor

[SEAL] Attest:

_____
Clerk, City of Fairfield

Approved as to form:

_____
City Attorney, City of Fairfield

CITY OF SUISUN CITY

Dated: By: _____
Mayor

[SEAL] Attest:

_____
Clerk of the City of Suisun City

Approved as to form:

_____
City Attorney, City of Suisun City

MAINE PRAIRIE WATER DISTRICT

Dated: By: _____
President, Board of Directors

[SEAL] Attest:

_____
Secretary, Board of Directors

Approved as to form:

_____
District Counsel

CITY OF FAIRFIELD

Dated: By: _____
Mayor

[SEAL] Attest:

_____
Clerk, City of Fairfield

Approved as to form:

_____
City Attorney, City of Fairfield

CITY OF SUISUN CITY

Dated: By: _____
Mayor

[SEAL] Attest:

_____
Clerk of the City of Suisun City

Approved as to form:

_____
City Attorney, City of Suisun City

MAINE PRAIRIE WATER DISTRICT

Dated: By: _____
President, Board of Directors

[SEAL] Attest:

_____
Secretary, Board of Directors

Approved as to form:

_____
District Counsel

CITY OF FAIRFIELD

Dated: By: _____
Mayor

[SEAL] Attest:

_____
Clerk, City of Fairfield

Approved as to form:

_____
City Attorney, City of Fairfield

CITY OF SUISUN CITY

Dated: By: _____
Mayor

[SEAL] Attest:

Sharon Ventura
_____
Clerk of the City of Suisun City

Approved as to form:

_____
City Attorney, City of Suisun City

CITY OF VACAVILLE

Dated: By: _____
Mayor

[SEAL] Attest:

_____
Clerk of the City of Vacaville

Approved as to form:

_____
City Attorney, City of Vacaville

CITY OF VALLEJO

Dated: By: _____
City Manager

[SEAL] Attest:

_____
Clerk of the City of Vallejo

Approved as to form:

_____
City Attorney, City of Vallejo

CONSENTED TO:

SOLANO COUNTY WATER AGENCY

Dated: By: _____
President, Board of Directors

[SEAL] Attest:

_____
Secretary, Board of Directors

Approved as to form:

_____
District Counsel

CITY OF VACAVILLE

Dated: By: _____
Mayor

[SEAL] Attest:

_____
Clerk of the City of Vacaville

Approved as to form:

_____
City Attorney, City of Vacaville

CITY OF VALLEJO

Dated: 3/12/99 By: _____
City Manager

[SEAL] Attest:

_____
Clerk of the City of Vallejo

Approved as to form:

_____
City Attorney, City of Vallejo

CONSENTED TO:

SOLANO COUNTY WATER AGENCY

Dated: By: _____
President, Board of Directors

[SEAL] Attest:

_____
Secretary, Board of Directors

Approved as to form:

_____
District Counsel

CITY OF VACAVILLE

Dated: By: _____
Mayor

[SEAL] Attest:

_____
Clerk of the City of Vacaville

Approved as to form:

_____
City Attorney, City of Vacaville

CITY OF VALLEJO

Dated: By: _____
City Manager

[SEAL] Attest:

_____
Clerk of the City of Vallejo

Approved as to form:

_____
City Attorney, City of Vallejo

CONSENTED TO:

SOLANO COUNTY WATER AGENCY

Dated: By: _____
President, Board of Directors

[SEAL] Attest:

_____
Secretary, Board of Directors

Approved as to form:

_____
District Counsel

EXHIBIT "A"

SOLANO IRRIGATION DISTRICT
DROUGHT IMPACT REDUCTION PROGRAM ELEMENTS

The Program will include the following elements:

1.0 The District's Contract with the Parties requesting Municipal and Industrial Water:

1.1 Proportions in Program: On or about April 1 when it is determined that the amount of water in Storage in Lake Berryessa is less than 400,000 AF, excluding water which is in dead storage and water which is in the voluntary carryover accounts of the Parties to the Agreement, the Parties, including SID, delivering municipal and industrial water in proportion to the average annual amounts of municipal and industrial water ordered and paid for from the Solano Project by those Parties during the preceding five (5) full water years, shall be entitled to participate in the SID Drought Impact Reduction Program ("The Program").

1.2 No Assignment of Proportion of Program Water: All Parties seeking water under the Program for municipal and industrial use shall be entitled to their proportional share of the water made available by the Program. If a Party desires less than their proportional share of the Drought Impact Reduction Program water, they may not assign their relinquished portion of the Program water to any other Party, and the relinquished portion of the water will be divided in accordance with the percentage of the Program water requested by Parties, if any Party requests less than their proportional share.

1.3 District Target Price: On or before May 1, SID will establish and announce a target price per AF for the amount of water which will be deemed relinquished by a Landowner and/or Tenant within SID for the Program in the following water year.

1.4 Additional Costs: In addition to the target price payable to the Landowner and/or Tenant for each acre foot, SID shall establish the additional amounts payable to SID for its operation and maintenance costs, lost water revenues and other reasonable costs to be incurred in implementing the Program. SID will establish the amounts of water which will be allocated to each acre of land under the rules and regulations in the following water year in which the Program is to be implemented and to which the target price and charges of SID would apply if the Landowner and/or Tenant elect to participate in the Program.

1.5 Contract with District: Upon establishing the economic terms of the Program, ninety (90) days notice shall be provided to the Parties serving Municipal and Industrial water of their right to subscribe and contract to the terms of the Program and their right to purchase upon those terms their proportionate share of the Program water in the following water year. The Program water to be made available to the Parties providing for municipal and industrial water service, including SID, shall not exceed twenty thousand (20,000) AF in a water year, or the water allocation from 7,500 acres of SID land, whichever sum is less. A Party declining to or omitting to subscribe to its proportionate share of the Program water may subscribe to a lesser amount of water, or if no election to subscribe is made, their proportionate share shall be divided among the other participants in proportion to requests of the remaining Parties limited by those Parties' proportions established under Paragraph 1.1 above (five years' historic ordering of M & I water from Solano Project). All subscription requests shall be submitted in writing.

1.6 Solicitation Period: Because the terms will be announced and the subscriptions sought approximately 9 months before the relinquishment would commence to take effect, a period of at least 45 days beginning on or before August 1 will be provided for Landowners and Tenants within the boundaries of SID to offer in writing the amounts of water specified and committed to be purchased by the Parties for municipal and industrial purposes in the following water year under the Program.

1.7 Solicitation Complete - Finalization of Contract Amounts: If sufficient Landowner and/or Tenant participants are received within the initial 45-day period by SID, a final binding contract for these amounts shall be delivered by the Parties to SID for the purchases, and SID will submit contracts to the participating SID landowners and/or tenants for the relinquishment to take effect in the following water year.

1.8 Insufficient or Excessive Landowner Offers: If insufficient lands subscribe to the SID Program in the solicitation, and insufficient amounts of water are obtained to meet the total demand of the requesting Parties, which demand shall not exceed 20,000 AF or water from 7,500 acres, whichever is less in any water year, the Parties shall nevertheless be bound to purchase those amounts tendered by landowners and/or tenants from SID.

If the participating landowners and/or tenants offer amounts of water in excess of subscriptions of the Parties, the amounts tendered by each participant will be reduced by a factor representing the excess amount as a percent of the subscribed amount.

Final contracts with participants and the subscribing Parties shall be delivered to SID for approval on or before October 15.

1.9 Payment to District: The monies due to SID from the Parties shall be paid on or before October 15, and shall be obtained by SID and distributed by SID in accordance with its contractual terms with the Landowners and Tenants. Interest earned upon the payments prior to disbursement shall be credited to the Parties participating in the Program. The participating Parties shall pay to SCWA the municipal and industrial rate for the water so assigned by SID to the Parties prior to the Parties participating in the Program ordering and delivery of the water in the following water year.

1.10 No Upset Price: The provisions of the Parties' agreement with SID and the Landowner/Tenant agreement with SID will not provide for an upset price, and thus if the following water year is a plentiful water year, nevertheless the water to be transferred by SID to the Parties will be transferred on the first day of the subsequent water year and will be added to the account of the participating Parties in the Program on that day. Participating Parties should recognize that it is possible that spills of Lake Berryessa may occur after March 1, and thus it is theoretically possible to obtain water pursuant to the Program and to lose it forthwith without the ability to use it or hold it in a carryover account. Water transferred by SID to participating Parties will be treated as voluntarily added to the Party's carryover account if not utilized in the water year.

1.11 No Waiver or Transfer of Water Outside Solano Project Service Areas: As a condition of participating in the Program, no Party participating in the receipt of water from the Program shall directly or indirectly in the water year that deliveries are made under the Program (i) waive the ability to receive water from other sources available to it, or (ii) transfer directly or indirectly the amounts held by the Party in their Solano Project account or held by them pursuant to their State Water Project contracts or held as other water rights to any non-Party, or (iii) allow amounts to be received by the Party pursuant to the Solano Irrigation District Drought

Impact Reduction Program to be used for the benefit of a non-Party or for use outside the service area of the Solano Project.

1.12 Solano County Water Agency will be paid for the water transferred by SID at the municipal industrial rate by the purchaser in accordance with the schedule for payments by the Party to SCWA under the Renewal Member Unit Contract.

2.0 SIDs' Contract with Landowners/Tenants: The Program will be implemented with voluntarily participating landowners and tenants by SID determining an amount of water to be allocated by SID in the ensuing water year for each acre of participating land, and a price per acre divided by the number of AF to be allocated yielding a per AF price for water tendered by landowner and tenant to SID. Landowners will be required to allocate full measurable fields or tracts to the Program. Parcels of 20 acres or less in size will not be eligible. Water from land with permanent crops such as trees and vines will not be eligible for transfer. Participants in this relinquishment program shall not supplement their allocation with ground water at levels which exceed the historical average over the previous four (4) years. No more than 7,500 acres of SID lands will be removed from production in a water year under the Program. Specific guidelines and contract forms will be developed by SID prior to the beginning of the landowner solicitation period and that information will be provided in a notice to owners of eligible lands.

(Final 11/30/98)

APPENDIX A-5

STATE WATER PROJECT RELIABILITY - SCWA

Appendix B State Water Project Reliability

DWR Study 2029 data - SCWA Specific

Sacramento Valley Index

Value	Year Type
W	Wet
N	Below Normal
N	Above Normal
D	Dry
D	Critically Dry

Year	Sacramento Valley Index	% Full Table A	% Full Table A for Normal Year (N)	% Full Table A for Single Dry Year (D) *	% Full Table A for Multiple Dry Year (3 or more Dry years)
1922	N	0.64	0.64		
1923	N	0.61	0.61		
1924	D	0.20		0.20	0.20
1925	D	0.42			0.42
1926	D	0.52			0.52
1927	W	0.72			
1928	N	0.64	0.64		
1929	D	0.28		0.28	0.28
1930	D	0.41			0.41
1931	D	0.15			0.15
1932	D	0.39			0.39
1933	D	0.39			0.39
1934	D	0.27			0.27
1935	N	0.57	0.57		
1936	N	0.66	0.66		
1937	N	0.81	0.81		
1938	W	1.00			
1939	D	0.43		0.43	
1940	N	0.63	0.63		
1941	W	0.75			
1942	W	0.64			
1943	W	0.74			
1944	D	0.47		0.47	
1945	N	0.75	0.75		
1946	N	0.59	0.59		
1947	D	0.48		0.48	
1948	N	0.58	0.58		
1949	D	0.56		0.56	
1950	N	0.59	0.59		
1951	N	0.74	0.74		
1952	W	0.82			
1953	W	0.57			
1954	N	0.58	0.58		

1955	D	0.43		0.43	
1956	W	0.82			
1957	N	0.54	0.54		
1958	W	0.92			
1959	N	0.44	0.44		
1960	D	0.47		0.47	
1961	D	0.46			
1962	N	0.66	0.66		
1963	W	0.58			
1964	D	0.64		0.64	
1965	W	0.67			
1966	N	0.62	0.62		
1967	W	0.81			
1968	N	0.55	0.55		
1969	W	1.00			
1970	W	0.69			
1971	W	0.59			
1972	N	0.57	0.57		
1973	N	0.66	0.66		
1974	W	0.74			
1975	W	0.69			
1976	D	0.62		0.62	
1977	D	0.09			
1978	N	0.78	0.78		
1979	N	0.68	0.68		
1980	N	0.83	0.83		
1981	D	0.57		0.57	
1982	W	0.95			
1983	W	1.00			
1984	W	0.77			
1985	D	0.68		0.68	
1986	W	0.79			
1987	D	0.23		0.23	0.23
1988	D	0.30			0.30
1989	D	0.49			0.49
1990	D	0.19			0.19
1991	D	0.22			0.22
1992	D	0.18			0.18
1993	N	0.66	0.66		
1994	D	0.57		0.57	
1995	W	0.85			
1996	W	0.66			
1997	W	0.81			
1998	W	0.83			
1999	W	0.71			
2000	W	0.65			
2001	D	0.30		0.30	
2002	D	0.67			
2003	N	0.58	0.58		
	Average	0.60	0.64	0.46	0.31

*Includes first year of consecutive dry years

APPENDIX A-6

SOLANO PROJECT RELIABILITY - SCWA

Appendix C Solano Project Reliability

Ultimate level of development-of Lake Berryessa watershed @ 30,000 AF/yr - 2009 Study

Lake Berryessa Index

Value	Year Type
W	Wet
N	Below Normal
N	Above Normal
D	Dry
D	Critically Dry

Year	Index Value	% Full Alloc	% Full Alloc for Normal Year (N)	% Full Alloc for Single Dry Year (D) *	% Full Alloc for Multiple Dry Years (3 or more Dry years)
1906	W	100%			
1907	W	100%			
1908	D	100%		100%	
1909	W	100%			
1910	N	100%	100%		
1911	W	100%			
1912	D	100%		100%	
1913	D	100%			
1914	W	100%			
1915	W	100%			
1916	W	100%			
1917	N	100%	100%		
1918	D	100%		100%	
1919	N	100%	100%		
1920	D	100%		100%	
1921	N	100%	100%		
1922	N	100%	100%		
1923	N	100%	100%		
1924	D	95%		95%	
1925	N	95%	95%		
1926	N	95%	95%		
1927	W	95%			
1928	N	100%	100%		
1929	D	95%		95%	
1930	N	95%	95%		
1931	D	100%		100%	100%
1932	D	100%			100%
1933	D	45%			45%
1934	D	45%			45%
1935	N	100%	100%		
1936	N	100%	100%		
1937	N	100%	100%		
1938	W	100%			
1939	D	95%		95%	

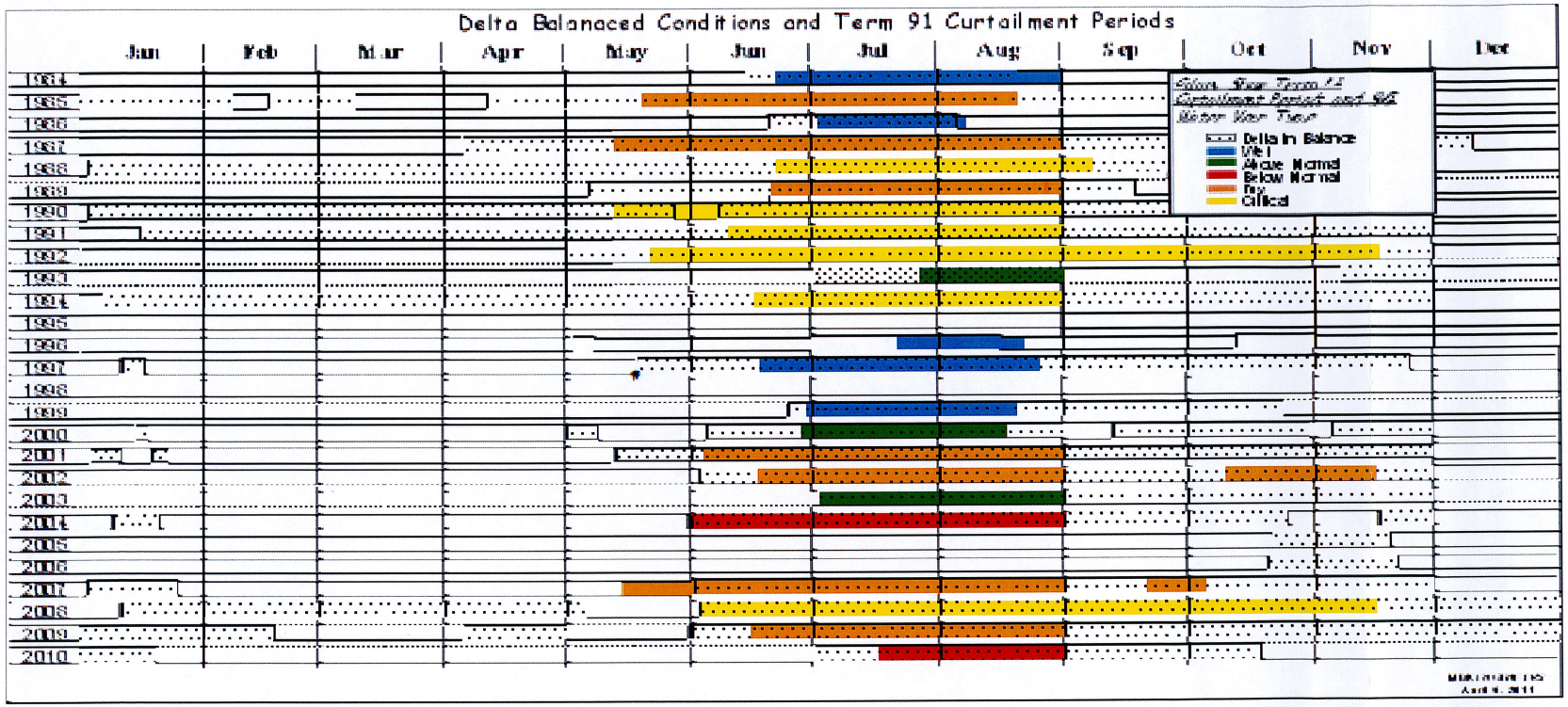
1940	W	100%			
1941	W	100%			
1942	W	100%			
1943	N	100%	100%		
1944	D	100%		100%	
1945	N	100%	100%		
1946	N	100%	100%		
1947	D	100%		100%	100%
1948	D	95%			95%
1949	D	95%			95%
1950	D	95%			95%
1951	N	95%	95%		
1952	W	100%			
1953	N	100%	100%		
1954	N	100%	100%		
1955	D	95%		95%	
1956	W	100%			
1957	D	100%		100%	
1958	W	100%			
1959	D	100%		100%	
1960	N	100%	100%		
1961	D	100%		100%	
1962	N	100%	100%		
1963	W	100%			
1964	D	100%		100%	
1965	W	100%			
1966	N	100%	100%		
1967	W	100%			
1968	N	100%	100%		
1969	W	100%			
1970	W	100%			
1971	N	100%	100%		
1972	D	100%		100%	
1973	W	100%			
1974	W	100%			
1975	N	100%	100%		
1976	D	100%		100%	
1977	D	100%			
1978	W	100%			
1979	N	100%	100%		
1980	W	100%			
1981	D	100%		100%	
1982	W	100%			
1983	W	100%			
1984	N	100%	100%		
1985	D	100%		100%	
1986	W	100%			
1987	D	100%		100%	100%
1988	D	100%			100%
1989	D	100%			100%
1990	D	95%			95%
1991	N	95%	95%		

1992	D	90%		90%	
1993	W	95%			
1994	D	95%		95%	
1995	W	100%			
1996	W	100%			
1997	W	100%			
1998	W	100%			
1999	N	100%	100%		
2000	N	100%	100%		
2001	D	100%		100%	
2002	N	100%	100%		
2003	N	100%	100%		
2003	W	100%			
2004	N	100%	100%		
2005	N	100%	100%		
2006	W	100%			
2007		100%			
	Average	98%	99%	98%	89%

*Includes first year of consecutive dry years

APPENDIX A-7

SETTLEMENT WATER


Delta Balanced Conditions and Term 91 Curtailment Periods
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Delta In Balance
Wet
Above Normal
Below Normal
Dry
Critical

SETTLEMENT WATER AVAILABILITY		
Year	Term 91 Condition Months	Settlement Water Months
1984	2.50	9.50
1985	3.00	9.00
1986	1.25	10.75
1987	3.50	8.50
1988	2.25	9.75
1989	2.50	9.50
1990	3.50	8.50
1991	2.50	9.50
1992	6.00	6.00
1993	1.25	10.75
1994	2.50	9.50
1995	0.00	12.00
1996	1.00	11.00
1997	2.00	10.00
1998	0.00	12.00
1999	1.25	10.75
2000	1.50	10.50
2001	3.00	7.00
2002	3.50	8.50
2003	2.00	10.00
2004	3.00	9.00
2005	0.00	12.00
2006	0.00	12.00
2007	4.00	8.00
2008	5.50	6.50
2009	2.50	9.50
2010	1.50	10.50
	Min.	6.00
	Avg.	8.30
	Max.	12.00

APPENDIX A-8

NBA MAXIMUM FLOW ALLOCATION SCWA

Solano County Water Agency

NBA Maximum Flow Allocation

Table 1 - Maximum Flow Allocation based upon Design Conditions

City	Reach	Max. Flow (cfs)	% of Max. Flow
Fairfield	1	21.5	14%
Vacaville	1	11.1	7%
Suisun	1	2.4	2%
Benicia	3A	31.4	20%
Vallejo	3A	41.7	27%
Napa County	3B	45.6	30%
	Total =	**154**	**100%**

Note: The FF/VV peak capacity of 20 cfs has not been included in the total allocation because the 10th pump has not yet been installed.

Table 2 - Maximum Flow Allocation based upon Actual Conditions

The NBA contains a biofilm that has decreased the flow capacity of the NBA. DWR has indicated that the current max capacity of the NBA is 130 cfs.

City	Reach	Max. Flow (cfs)	% of Max. Flow
Fairfield	1	18.2	14%
Vacaville	1	9.4	7%
Suisun	1	2.0	2%
Benicia	3A	26.6	20%
Vallejo	3A	35.3	27%
Napa County	3B	38.6	30%
	Total =	**130**	**100%**

Table 3 - Maximum Flow Allocation during Longfin Smelt Biological Opinion, Pump Curtailment

During dry and critically dry years, the BSPP is curtailed to 50 cfs from Jan-15 to Mar-31.

City	Reach	Max. Flow (cfs)	% of Max. Flow
Fairfield	1	7.0	14%
Vacaville	1	3.6	7%
Suisun	1	0.8	2%
Benicia	3A	10.2	20%
Vallejo	3A	13.6	27%
Napa County	3B	14.8	30%
	Total =	**50**	**100%**

Notes:

- While all of the tables list max allocations, SCWA, Napa County, and all of the NBA users attempt to work with each other, to maximize the use of the NBA. For example, if the Solano users are not using their full capacity of the NBA we are fine with Napa County using more capacity if they need it, and vice versa.

APPENDIX B

TECHNICAL MEMORANDUM - REGULATIONS REVIEW

TECHNICAL MEMORANDUM

DATE: December 9, 2011

TO: Scott Rovanpera
Carrie Wenslawski

FROM: David Zensius, Linda Scroggs

PROJECT: City of Benicia Water System Master Plan Update

PROJECT #: SAB046800

SUBJECT: Regulations Review

In general, the City of Benicia (City) water system performs well and complies with California Department of Public Health (CDPH) and US Environmental Protection Agency (USEPA) drinking water regulations. The system operates under CDPH Water Supply Permit No. 02-91-004, which was issued in 1991 and last amended in 2009. According to City staff, the CDPH conducted an inspection of the system in 2010 and no deficiencies were reported.

As an initial step in preparing a water system master plan update for the City, applicable current and upcoming regulations were reviewed. The goal was to identify gaps between regulatory requirements and existing facilities. After gathering available information, meeting with City staff, and visiting key facilities, the review focused upon the following specific items: 1) disinfection byproducts; 2) fluoridation; 3) chemical storage, 4) sludge lagoons, and 5) the regulatory setting for proposed projects. Findings are summarized below.

<u>Disinfection Byproducts</u>

Maximum contaminant levels (MCLs) and best available control technologies for disinfection byproducts are presented in Table 1. For total trihalomethanes (TTHMs) and regulated haloacetic acids (HAA5), the California MCLs are consistent with MCLs included in the federal Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) [1]. The federal Stage 2 DBPR, however, effectively reduces these MCLs by requiring compliance on a locational running annual average (LRAA) basis. The LRAA will be calculated at each monitoring location within a distribution system, including monitoring locations representing maximum residence time. For reference, California regulations [2] currently require public water systems to determine compliance based upon a running annual average of all results collected. Water systems serving 10,000 – 49,999 people will need to comply with LRAA requirements of the federal Stage 2 DBPR beginning in July 2014.

TABLE 1
MAXIMUM CONTAMINANT LEVELS
AND BEST AVAILABLE CONTROL TECHNOLOGIES
FOR DISINFECTION BYPRODUCTS [2]

Disinfection Byproduct	MCL, mg/L	Best Available Control Technology
TTHMs	0.080	Enhanced coagulation, enhanced softening, or granular activated carbon, with chlorine as the primary and residual disinfectant
HAA5	0.060	Enhanced coagulation, enhanced softening, or granular activated carbon, with chlorine as the primary and residual disinfectant

With careful treatment plant operation and strategic seasonal use of North Bay Aqueduct and Putah South Canal waters, the City has demonstrated the ability to comply with current and pending disinfection byproducts regulations. Adequate removal of dissolved organic carbon (DOC) within the existing water treatment plant, however, requires elevated coagulant doses and generates large quantities of sludge. The sludge lagoons are heavily loaded, and disposal of dried sludge has been expensive - approximately $30,000 annually.

City staff are considering two improvement projects to address the disinfection byproducts issues discussed above: 1) installing a magnetic ion exchange system for DOC removal upstream of existing flocculation and sedimentation units, and 2) conversion from free chlorine to chlorine dioxide for pre-oxidation. To confirm the feasibility of magnetic ion exchange, further study of waste disposal alternatives and DOC removal rates is needed. Similarly, a chlorine dioxide pre-oxidation trial should be conducted to verify performance and develop design criteria.

Another project which may significantly reduce disinfection byproduct formation is relocation of the North Bay Aqueduct intake. Moving the intake from the present Barker Slough location to a site on or nearer to the Sacramento River could reduce the magnitude of raw water DOC and turbidity variations at the City water treatment plant. This costly, legally complex, multi-agency project was discussed in the 1996 water system master plan [3], and should be further evaluated.

Fluoridation

California drinking water fluoridation regulations (California Code of Regulations, Title 22, Sections 64433, et. seq) were adopted in 1998, and require public water systems to maintain fluoride levels within a climate-specific control range. Specifically, for the average daily air temperature in Benicia, these regulations state that the optimal fluoride level is 0.9 mg/L and the control range is 0.8 to 1.4 mg/L. Hydrofluosilicic acid is injected at the City water treatment plant to achieve compliance.

On January 7, 2011, the US Department of Health and Human Services and the USEPA announced a proposal to recommend that public water systems adjust their fluoridation practices to achieve a target concentration of 0.7 mg/L instead of using the climate-specific optimal level and control range [4].

Following this announcement, the CDPH recommended that "water systems practicing fluoridation operate their fluoridation toward the lower end of their range prescribed in their permit and/or Section 644332.2, yet remain compliant with the requirements in Section 64433.3(b)" [5].

Improvements to the chemical storage area (tank farm), chemical feed systems, and controls are planned at the City water treatment plant. Possible fluoride dose reductions should be considered during design of these improvements.

Chemical Storage

Section 8003.1.3.3 of the California Fire Code [6] includes secondary containment requirements for areas in which hazardous liquids are stored, and states that outdoor storage areas shall be designed to contain the following: 1) a spill from the largest individual vessel, and 2) the volume of "a 24-hour rainfall as determined by a 25-year storm." Furthermore, incompatible materials, such as acids and alkaline caustic liquids which can react violently when mixed, shall be separated from each other in a secondary containment system.

The chemical tank farm at the City water treatment plant is equipped with a secondary containment system. However, tanks within the secondary containment system contain chemicals (e.g. sodium hydroxide and hydrofluosilicic acid) which appear to be incompatible. Adequate separation of these tanks should be provided as part of an upcoming chemical tank farm improvements project. A detailed evaluation of secondary containment system capacity and structural integrity should also be conducted.

Sludge Lagoons

California Regional Water Quality Control Board (Regional Board), San Francisco Bay Region, General Order No. R2-2009-0033 (General Permit) [7] contains waste discharge requirements for discharges from certain drinking water treatment facilities. Regional Board staff determined that specific discharges from the City's water treatment plant are eligible for coverage under the General Permit. These discharges are described in Table 2. Other discharge types are prohibited.

Signs of leakage and side slope erosion (from wave action) have been observed in the sludge lagoons at the City water treatment plant. Re-lining and slope protection should be considered as part of an improvement project to prevent possible large-volume discharges which may not be covered by the General Permit.

TABLE 2
CITY OF BENICIA WATER TREATMENT PLANT
SUMMARY OF DISCHARGE TYPES ELIGIBLE FOR GENERAL PERMIT COVERAGE

Discharge Type	General Description of Discharge Type from Section II of the General Permit
Treatment unit leakage	Some filters and other water treatment units include sub-drains to collect leaks. Collected leakage is normally diverted to backwash water settling basins and discharged with backwash water. Alternatively, a sub-drain may discharge leakage water directly to a storm drain, and through the storm drain to a State water.
Treatment unit dewatering/leakage	Occasionally, treatment units must be taken out of service for maintenance or for a seasonal facility shutdown. In this case, treatment units must be drained or dewatered. Drainage water may be diverted to a storage or settling basin before discharge, or may be discharged directly to a State water.
Discharge due to pipeline failures	These are usually non-routine, emergency discharges due to operational or instrument errors that cause one or several treatment units to overflow to a State water either directly or through a storm drain.

Regulatory Setting for Proposed Projects

Potential regulatory compliance issues associated with proposed water system improvement projects are discussed briefly below. Specifically, the regulatory setting is summarized for the following proposed projects: 1) conversion from chlorine gas to sodium hypochlorite solution; 2) installation of a magnetic ion exchange system; and 3) asbestos cement pipe repair, replacement, and connections.

Conversion to Sodium Hypochlorite Solution

Discontinuing the use of chlorine gas and converting to sodium hypochlorite solution has been planned for more than 10 years and was recommended in the last water system master plan [3]. In general, the process safety and regulatory requirements for sodium hypochlorite solution are simpler and less onerous than those that apply to chlorine gas. The following three potential issues should be addressed during conversion planning and facilities design:

- Chlorate – Chlorate is not a byproduct of disinfection with chlorine gas. However, chlorate is formed when sodium hypochlorite is used, and concentrations typically range from 0.03 mg/L to 0.20 mg/L [8]. In 2002, the CDPH established a notification level of 0.8 mg/L for chlorate based upon observed pituitary gland vacuolization and thyroid gland depletion in rats [9]. Once established, a notification level generally stays in place unless it is replaced by a MCL.

- Effects on pH - Chlorine gas and sodium hypochlorite solution have opposite effects on pH, and conversion to sodium hypochlorite solution may cause a significant pH increase. Such an increase could shift disinfection byproduct formation (less HAAs formed, more THMs formed)

within the water system [12]. Also, a review or update of the City's corrosion control strategy may be warranted.

- Secondary Containment - A secondary containment system is required for sodium hypochlorite solution storage tanks per the California Fire Code as discussed above.

Magnetic Ion Exchange

For the proposed magnetic ion exchange system at the City water treatment plant, waste handling and disposal alternatives would likely include but not be limited to the following: 1) evaporative dewatering followed by landfill disposal; 2) evaporative dewatering and mixing with alum sludge, followed by landfill disposal; 3) hauling liquid waste to a municipal or industrial wastewater treatment facility, or 4) discharging liquid waste through a pipeline to the City of Benicia wastewater treatment plant or other approved facility. Further information is needed to adequately assess the regulatory setting for each alternative. Bench and pilot-scale magnetic ion exchange studies at the City water treatment plant, if conducted, should include waste analyses.

In general, for the landfill alternatives, the applicable authority would be the Resource Conservation and Recovery Act (RCRA). Depending upon the waste characteristics, the waste would be either: a) non-hazardous, subject to RCRA Subtitle C, and suitable for disposal in municipal and industrial landfills; or b) hazardous, subject to RCRA Subtitle D, and only allowed in a hazardous waste landfill. A preliminary review of manufacturer literature suggests that the solid waste may be considered non-hazardous, particularly if mixed with alum sludge [11].

For the two liquid disposal alternatives, the applicable authority would generally be the Clean Water Act. The receiving wastewater treatment facility must comply with NPDES permit requirements (e.g. salinity limitations) while processing the magnetic ion exchange waste.

Asbestos Cement Pipe Repair, Replacement, and Connections

The City's water distribution system includes significant lengths of asbestos cement pipe that have been in service for several decades. This piping will probably be affected by upcoming improvement, replacement, and repair projects.

According to the National Emission Standard for Asbestos [12] asbestos cement pipe is a Category II, non-friable, non-regulated material when intact. When damaged by construction, demolition, removal, or disposal activity, asbestos cement pipe may become friable and subject to 40 CFR 61.150, which is the USEPA standard for waste disposal for manufacturing, fabricating, demolition, renovation, and spraying operations. Friable asbestos-containing material must be wetted and kept wet during collection and transport to an approved site or facility. If asbestos cement pipe is carefully removed using tools that do not cause significant damage, it remains non-regulated and disposal with other construction debris is acceptable.

References

[1] *Stage 2 Disinfectants and Disinfection Byproducts Rule*, Federal Register, Volume 71, Number 2, USEPA, January 4, 2006.

[2] *Disinfectant Residuals, Disinfection Byproducts, and Disinfection Byproduct Precursors*, California Code of Regulations (CCR), Title 22, Division 4, Chapter 15.5.

[3] *City of Benicia, 1996 Water System Master Plan*, prepared by Montgomery Watson, September 1996.

[4] *EPA and HHS Announce New Scientific Assessments and Actions on Fluoride / Agencies working together to maintain benefits of preventing tooth decay while preventing excessive exposure*, USEPA News Release, January 7, 2011.

[5] *Fluoridation*, CCR, Title 22, Chapter 15, Article 4.1.

[6] *Secondary containment for hazardous materials liquids and solids*, California Fire Code, CCR, Title 24, Part 9, Section 8003.1.3.3.

[7] *General Waste Discharge Requirements for Dishcarges from Surface Water Treatment Facilities for Potable Supply*, California Regional Water Quality Control Board, San Francisco Bay Region, Order No. R2-2009-0033, NPDES Permit No. CAG382001.

[8] *Reregistration Eligibility Decision (RED) for Inorganic Chlorates*, USEPA, 738-R-06-014, July 2006.

[9] *Drinking Water Notification Levels and Response Levels: An Overview*, California Department of Public Health, Drinking Water Program, December 14, 2010.

[10] *Simultaneous Compliance Manual for the Long Term 2 and Stage 2 DBP Rules*, USEPA, 815-R-07-017, March 2007.

[11] *Waste Management for the MIEX® Process*, Orica Watercare, http://www.miexresin.com.

[12] *Asbestos*, National Emission Standards for Hazardous Air Pollutants, 40 CFR Part 61 Subpart M.

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SERVICE

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