City of Escondido

2012 Water Master Plan

Prepared for:
City of Escondido

June 2012

CITY OF ESCONDIDO
2012 WATER MASTER PLAN

June 2012

Prepared for:

ESCONDIDO
City of Choice

Hale Avenue Resource Recovery Facility
1521 South Hale Avenue
Escondido, California 92029-3052

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Acronyms

AAC	All American Canal
ACP	asbestos cement pipe
AF	acre-feet
AFY	acre-feet per year
AMSL	Above Mean Sea Level
Cal Fire	California Department of Forestry and Fire Projection
CC	Coachella Canal
CIP	capital improvement program
CMLC	cement mortar lined and coated
CRA	Colorado River Aqueduct
cfs	cubic feet square
CVWD	Coachella Valley Water District
DU	dwelling units
EID	Escondido Irrigation District
EIR	Environmental Impact Report
EMWC	Escondido Mutual Water Company
ESP	Emergency Storage Project
FAR	Floor-Area Ratio
FERC	Federal Energy Regulatory Commission
FONSI	Finding of No Significant Impact
GIS	Geographical Information System
gpd	gallons per day
gpd/DU	gallons per day/dwelling unit
gpm	gallons per minute
HARRF	Hale Avenue Resource Recovery Facility
I-15	Interstate 15
IID	Imperial Irrigation District
IPR	indirect potable reuse
ISO	Insurance Services Office
LAFCO	Local Area Formation Commission
LRA	Local Responsibility Areas
MFDU	Multifamily dwelling unit
MG	million gallon

MGD	million gallons per day
MWD	Metropolitan Water District
NRP	Northern Route Pipeline
PRS	pressure reducing stations
PRV	pressure reducing valves
psi	pounds per square inch
PVC	polyvinyl chloride
QSA	Quantification Settlement Agreement
Rincon ID-A	Rincon del Diablo Municipal Water District Improvement District A
Rincon MWD	Rincon del Diablo Municipal Water District
SANDAG	San Diego Association of Governments
SCADA	supervisory control and data acquisition
SDCWA	San Diego County Water Authority
SDCWC	San Diego County Water Company
sf	square feet
SFDU	Single family dwelling unit
SOI	Sphere of Influence
SR-78	State Route 78
Study Area	General Plan Update Study Area
USDI	Secretary of Interior
UWMP	Urban Water Management Plan
Vallecitos MWD	Vallecitos Municipal Water District
Valley Center MWD	Valley Center Municipal Water District
VID	Vista Irrigation District
WTP	Water Treatment Plant

Section 1
Introduction

The Escondido Water Master Plan Update documents the existing water system facilities and demands, and identifies required improvements for build-out within the City's service area, which is anticipated to occur by 2035. The water system analyses conducted as a part of this project and documented in this report were performed to identify existing deficiencies in the system, confirm facility sizing, and recommend a future capital improvement program (CIP) based on updated water supply assessment, demand analyses and hydraulic modeling. This Master Plan provides an update to the 2000 Water Master Plan for continued reliable water service through buildout in accordance with the City's most recent amendments to the General Plan.

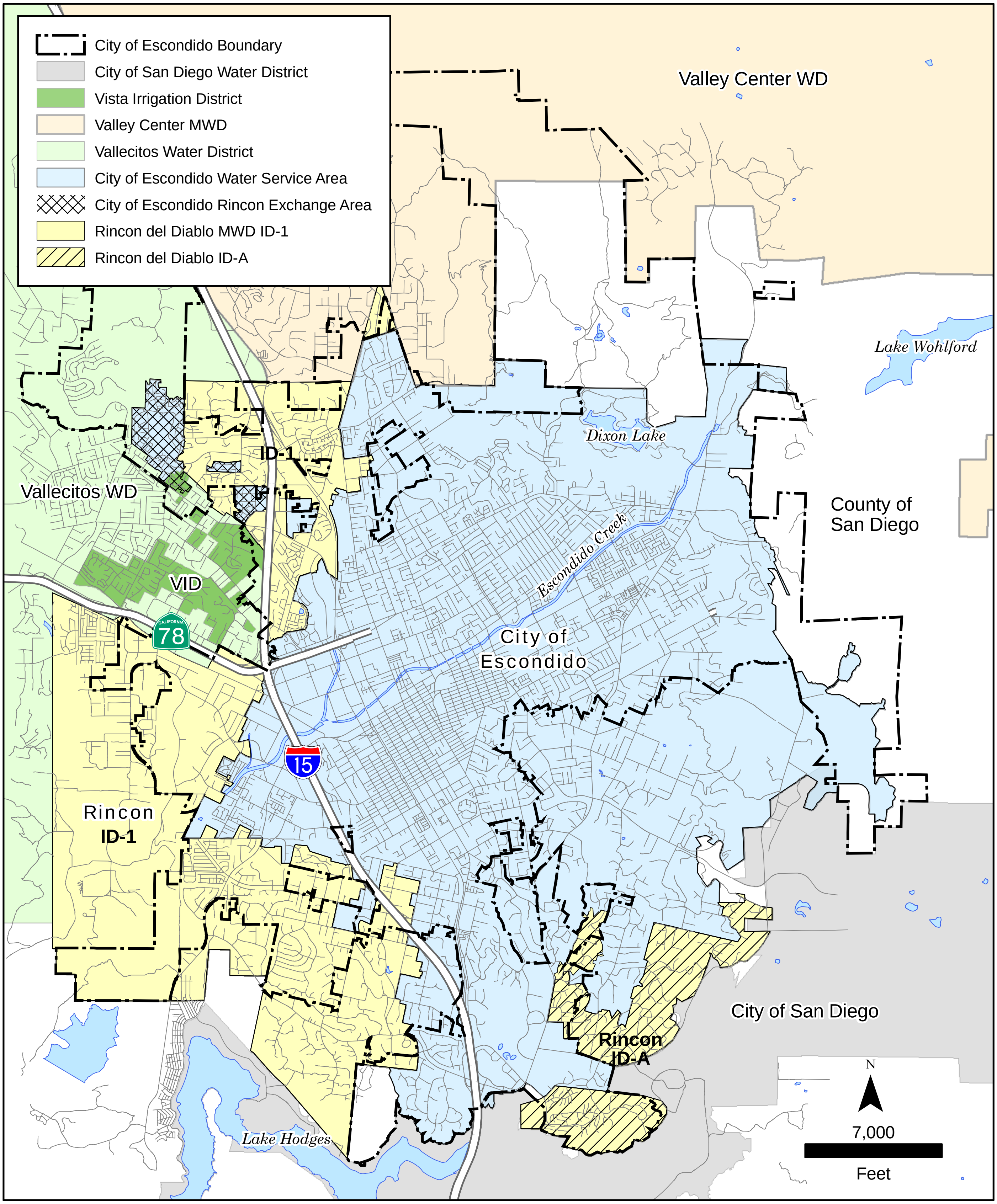
1.1 Water Service in the City of Escondido

Escondido is located approximately 25 miles northeast of downtown San Diego and 10 miles east of Oceanside and Carlsbad. The climate in Escondido consists typically of warm summers and cool wet winters and is considerably warmer than coastal cities like San Diego, Carlsbad or Oceanside. Precipitation can vary considerably from year to year and averages around 15 inches annually. More than 80 percent of all precipitation takes place from November through March. Although agricultural land use has diminished over the past decades, cultivation of avocados and citrus crops is prevalent in the northern and eastern parts of the City.

Escondido's water service area, which is not aligned with the City's incorporated boundary, is comprised of a variety of land uses including residential, commercial, industrial, agricultural, open space, and orchards. Water is supplied to the City of Escondido and its sphere of influence, as defined by the Local Area Formation Commission (LAFCO), by five water agencies: the City of Escondido Water Department, the Rincon del Diablo Municipal Water District (Rincon MWD), the Vallecitos Municipal Water District (Vallecitos MWD), the Valley Center Municipal Water District (Valley Center MWD), and the Vista Irrigation District (VID). The City of Escondido serves water to 22 square miles within the 33 square mile incorporated area, plus approximately 9 square miles outside of the incorporated area. Rincon MWD provides water service to approximately 11 square miles within the Escondido city limits. The City also maintains service exchange agreements with Vallecitos MWD, VID, and Valley Center MWD. These boundaries and the City of Escondido water service area boundary are shown on Figure 1-1.

Escondido receives its primary water supply from the San Diego County Water Authority (SDCWA) aqueducts, which deliver imported water from northern California and the Colorado River, via the Metropolitan Water District (MWD), to San Diego County. Local water also supplies the City from precipitation in the San Luis Rey River Watershed and is stored in Lake Henshaw and Lake Wohlford.

Escondido supplies potable water to approximately 26,000 residential, commercial, industrial and agricultural meters serving 146,000 customers and operates and maintains approximately 440 miles of pipe, eleven water reservoirs, five pump stations, two dams and associated lakes and the Escondido-Vista Water Treatment Plant (WTP) and clearwell. All of the water supplied to the City's service area is treated at the Escondido-Vista WTP and distributed to the customers within the service area, as well as to the VID and the parts of the Rincon MWD.



Water Service Area

Figure 1-1

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The history of water supply development in the study area dates from the nineteenth century, and the present water supply system is the result of the acquisition of the Escondido Mutual Water Company by the City of Escondido in 1970. The Escondido Mutual Water Company provided water service to areas both within the City's boundaries and unincorporated territory, and the City continues to provide water service to portions of the unincorporated areas. The City also has numerous properties that receive water service through a 1994 exchange agreement with the Rincon MWD. These properties, referred to as the "Country Club" service area, are located north of State Route 78 (SR-78) and west of Interstate 15 (I-15) and are billed by Escondido but receive water from Rincon MWD. Rincon MWD, in turn, serves some areas of the City that can receive water service most efficiently from their distribution system. The exchange agreements are designed to provide the most efficient service to all residents within the City's boundaries and sphere of influence.

1.2 Previous Master Plans

There have been four water master plans completed for the City of Escondido in the past three decades. In 1980, J.M. Montgomery Engineers prepared a master plan for the Escondido Water System. In 1987, Boyle Engineering Corp. updated that master plan, which included the development of a computer model of the Escondido water distribution system. The *1987 Escondido Water System Master Plan* also includes a detailed history of the water supply in Escondido, dating back to the late 1880s.

In 1992, Boyle Engineering Corp. prepared an update to the 1987 Master Plan, entitled, *Water Master Plan Ultimate System Update for the City of Escondido*. This update reevaluated the ultimate water system for Escondido in conformance with the 1990 General Plan and incorporated the use of reclaimed water to offset potable water demands within the service area.

In 2000, a Water Master Plan update was prepared by John Powell and Associates, Inc (now Atkins) to evaluate the existing water distribution system for the Escondido water service area and to propose improvements based on forecasted growth and optimized use of the City's water facilities. A new hydraulic model of the larger diameter pipelines and transmission system was developed based on the City's Geographical Information System (GIS) and the hydraulic computer modeling program H_2ONET. Water demand forecasts considered land use changes, conservation and reclaimed water use.

1.3 Purpose of 2012 Water Master Plan Update

It has been over 10 years since the last Water Master Plan Update, and in that time period there have been changes to the demographics of the City and to the water supply picture in California. While the population within the water service area is increasing due to residential construction in outlying areas and downtown redevelopment, agriculture continues to decline. Recent drought conditions resulted in water shortages and mandatory water use restrictions by the SDCWA. Prior master plans focused on transmission and storage needs for a growing City. The 2012 Water Master Plan takes a more detailed look at the City's aging water distribution system and remaining service, and the ability to support future growth and redevelopment.

It is important to understand the history and evolution of the City's distribution system, from its early days as a Mutual Water Company to today as one of the largest water systems in San

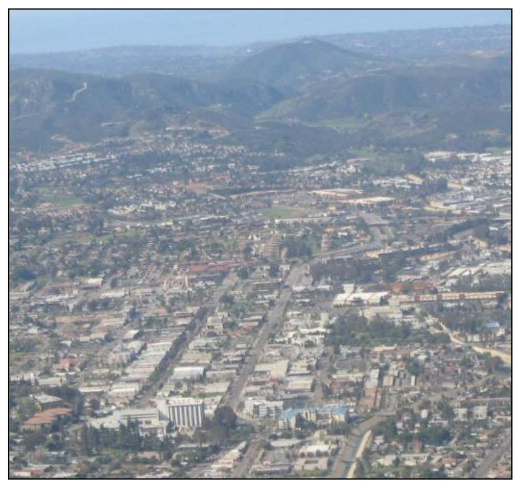
Diego County. There are still many waterlines in service today that date back to the early "Mutual" days, meaning that they may well be more than 60 to 70 years old and have reached their useful life expectancies. This Water Master Plan Update also addresses the City's new General Plan, which includes redevelopment areas with mixed use projects that may require significant upgrades to the water system in those neighborhoods. A more detailed hydraulic model with updated GIS data identifies these areas of concern and is used to analyze proposed operational changes and/or future facilities. The end result of this master plan update is a prioritized list of capital improvement projects to maintain an efficient and reliable water supply and distribution system at buildout conditions.

Section 2
Land Use and Water Demand

Water use within Escondido's water service area, which includes areas within the municipal boundaries of the City of Escondido as well as unincorporated areas of the County of San Diego, varies widely with the various land uses of the area. This section will discuss the City of Escondido's General Plan, land uses, historic water consumption information, and the development of unit water demands for different land use categories. Water peaking factors are developed and water demands are projected for buildout conditions. Finally the impacts of conservation and recycled water use on potable water demands are addressed.

2.1 Land Use and Setting

The City of Escondido is located in northern San Diego County, approximately 30 miles north of downtown San Diego and 18 miles east of the Pacific Ocean. The City is situated in a natural valley at approximately 615 feet Above Mean Sea Level (AMSL) and surrounded by rolling hills and rugged terrain ranging up to 4,200 AMSL. The City is bounded on the north by the unincorporated San Diego County communities of Valley Center and Hidden Meadows, on the west by the City of San Marcos, on the south by Lake Hodges and the City of San Diego, and on the east by unincorporated San Diego County. I-15 bisects Escondido in a north-south direction and SR-78 transitions from freeway to surface streets in an east-west direction through the City.



Aerial View of Downtown Escondido

The City of Escondido's geographic setting is characterized by hills and mountains surrounding an open valley bisected by Escondido Creek. The City includes a historic downtown and urban core area. Escondido's prominent public facilities are located downtown, providing convenient access for the community. City Hall, the performing arts and conference center, a central library, the multi-modal transit center, museums, theaters, Palomar Hospital's downtown campus, and an office, financial, and commercial employment base combine to establish the downtown area.

Escondido's urbanized core surrounds downtown within the "valley floor" of Escondido. It includes a variety of land uses including new and established single and multi-family neighborhoods and industrial and commercial developments offering a wide variety of employment opportunities. Surrounding the City's urbanized core area are many established neighborhoods with vacant or underdeveloped properties available for growth. Around Escondido's perimeter, large areas of open space, such as Daley Ranch, San Dieguito River Valley, and land around Lake Wohlford, are adjacent to the community's urbanized areas and offer recreational activities with hiking and multi-use trails. Western Escondido forms the community's primary employment area, paralleling SR-78. A system of urban and rural trails is being implemented that will provide residents with a variety of connections to city parks and large open space areas. Escondido Creek contains a paved trail system that includes plans for recreational improvements such as par courses with exercise stations, seating areas, and mini-playgrounds.

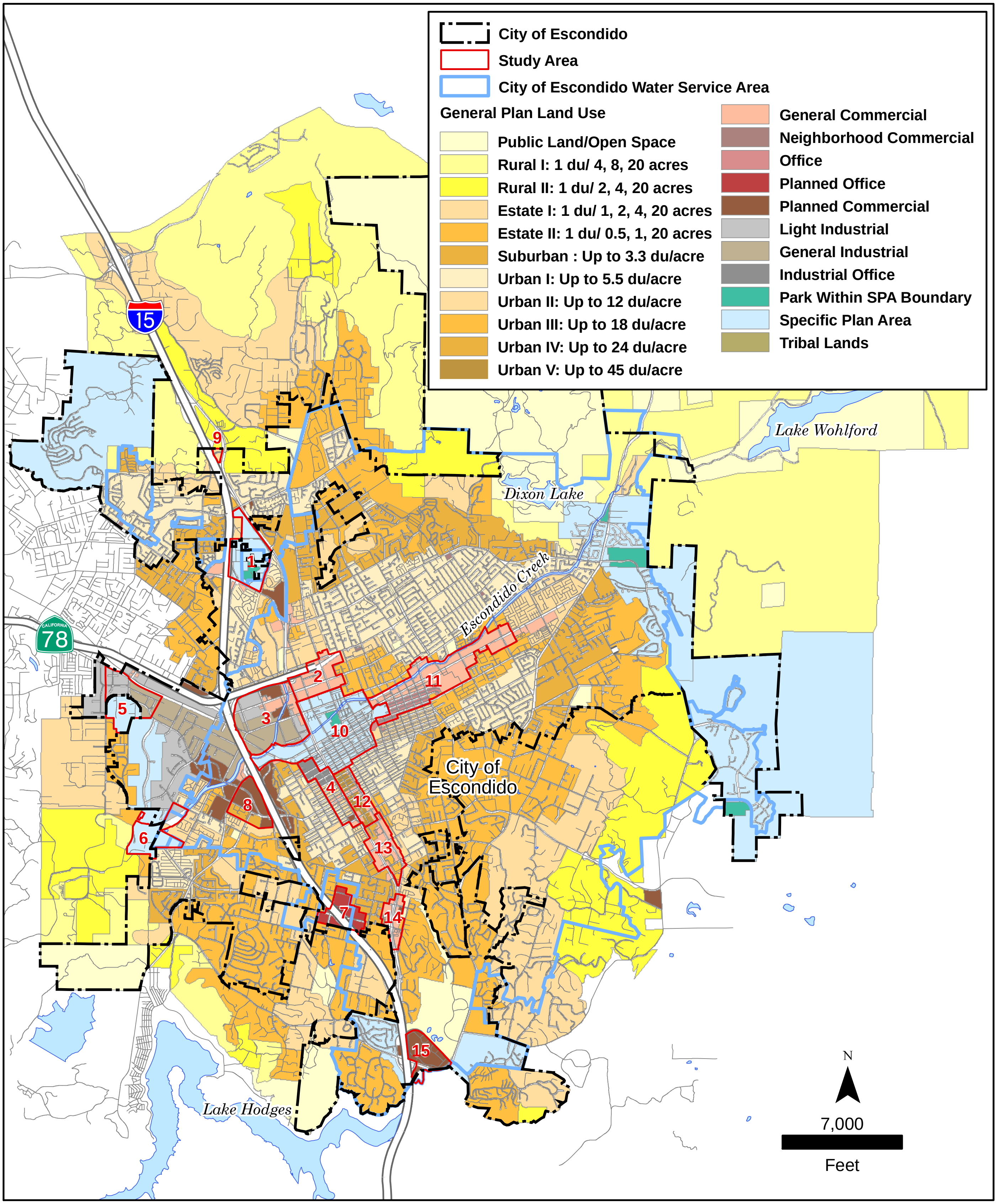
Growth over the past 125 years has transformed Escondido from a rural agricultural town to a bustling urban and suburban area offering a range of residential and employment opportunities. The growth process has brought master-planned neighborhoods and infill development; thoroughfares and freeways; major shopping centers; downtown revitalization including a new city hall, a joint police and fire headquarters; a regional medical center; employment centers; a main library; community centers; several neighborhood and community parks; a transit center with rail service; and a regional cultural and performing arts center.

2.2 2011 General Plan Update[1]

The existing City of Escondido General Plan was adopted in 1990 and an update is currently in progress. The 1990 General Plan defines land use categories and illustrates their locations within the City. The General Plan Update boundary encompasses about 80 square miles, of which 68 square miles are within the City's Sphere of Influence (SOI). Within the SOI, 37.5 square miles are within the corporate boundaries. The General Plan Update identifies 15 study areas, referred to as General Plan Update Study Areas (Study Areas) 1 though 15, which are areas proposed for land use changes as compared to the existing General Plan. The General Plan land use and 15 Study Areas are shown on Figure 2-1. Study Areas 5 and 9 are entirely within the Rincon MWD service area, and Study Areas 1, 6, and 7 extend over both the Rincon MWD and City of Escondido service areas. A decision was made by City Staff that future development within Study Area 1, which is west of North Center City Parkway, would be best served from Rincon MWD due to their stronger water distribution system and the lack of adequately sized Escondido facilities to supply non-residential demands and fire flows. A summary of the proposed land use changes and 2035 buildout scenarios within the 11 Study Areas that will be served water from the City of Escondido is provided in Table 2-1. More detailed study area descriptions are provided in Appendix A. Buildout assumptions for each study area are based on dwelling units and densities being distributed in smart growth areas and established neighborhoods, taking into account community input and visioning as well as infrastructure capabilities and quality of life standards.

The San Diego Association of Governments (SANDAG) estimates that an additional one million people will reside in the San Diego region by 2050, necessitating an additional 400,000 dwelling units. The General Plan Update considers a range of 3,350 to 5,825 new residential units that would be added to the General Plan's current build-out projection of approximately 67,900 dwelling units. Local fertility rates are anticipated to account for two-thirds of this projected growth, while one-third of new population growth is anticipated to be from residents relocating to the City.

[1] This information was obtained from the City's 2nd draft Screencheck of the General Plan EIR, October 2011.



SOURCE: City of Escondido, March 22, 2011

Study Areas and Proposed Land Use

Figure 2-1

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Table 2-1 2035 Buildout of 2011 General Plan Study Areas

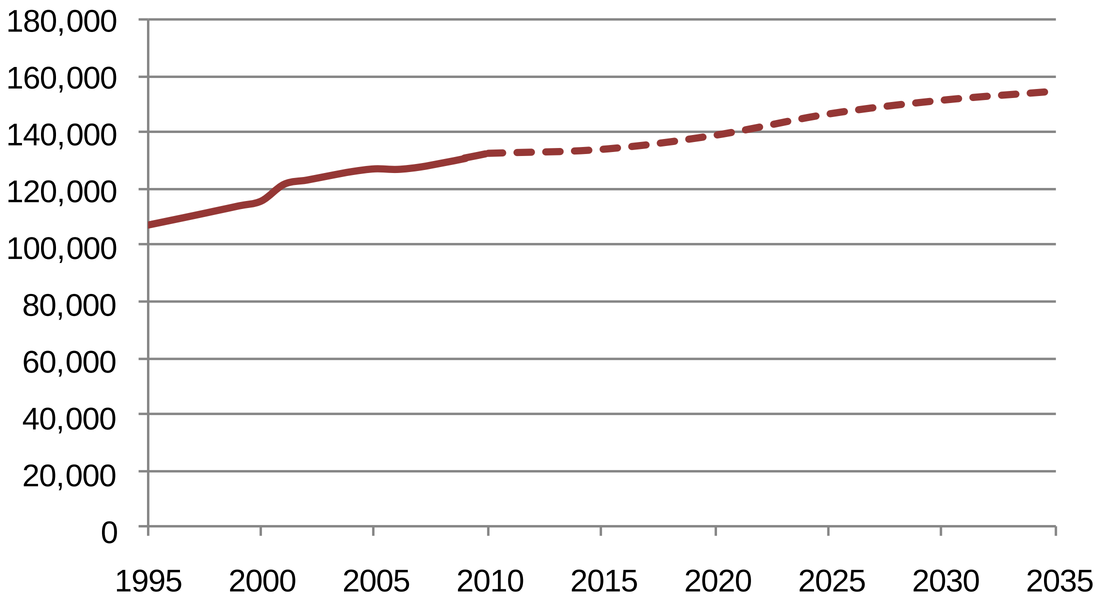
Study Areas within the City of Escondido Water Service Area	Pressure Zone	2035 Growth in Updated General Plan					Comments[3]
		Residential, DU[2]		Non-Residential, square-feet			
		SF	MF	Comm	Office	Industrial	
2. Hwy-78/Broadway	Lindley	-	-	534,000	49,000	-	FAR = 1.25
3. Transit Station	A-11/ Lindley	-	640	254,000	401,000	566,000	FAR = 1.25
4. S. Quince Street	Park Hill / Lindley	10	80	135,000	2,000	143,000	MFDU - Urban I & Urban II; FAR = 1.0
6. ERTC South SPA	A-11[1]	-	-	-	-	121,331	ex SFDUs to be replaced; includes wetlands; FAR=1.0
7. 1-15/Felicita Rd Corp. Office	A-11[1]	-	-	0	118,926	0	7.34 ac vacant; FAR 1.75
8. Promenade Retail Center	A-11	-	-	355,000	263,000	-	ex school to be replaced; MFDU =Urban IV; FAR=1.5
10. Downtown SPA	A-11/Lindley	-	3,326	1,547,000	281,000	60,000	ex park irrig w/RW, FAR=2.0
11. East Valley Parkway	Lindley	-	700	355,000	380,000	-	SFDUs to be replaced; FAR=1.25
12. S Escondido Blvd/ Centre City Pkwy	Park Hill / A-11	-	300	37,000	7,000	-	MFDU - Urban III & IV; FAR = 1.25
13. S Escondido Blvd/ Felicita Rd	Park Hill / Lindley	-	610	336,000	35,000	-	MFDU - Urban V; FAR = 1.25
14. Centre City Pkwy/ Brotherton Rd	A-11/ Lindley	-	700	407,000	206,000	-	MFDU - Urban III; FAR= 1.5
15. Westfield Shoppingtown	North County Fair	-	-	434,000	284,000	-	FAR = 1.25
Total for Study Areas:		**10**	**6,356**	**4,494,000**	**2,076,926**	**890,331**	

(1) A portion of the study area extends outside of the Escondido water service area boundary. Future development within the service area is estimated.
(2) DU = dwelling units; SF = single family; MF = multifamily;
(3) FAR = Floor-Area Ratio; SFDU = single family dwelling unit; MFDU = multifamily dwelling unit

The SANDAG 2030 forecast for the City of Escondido is 169,929 people and 53,087 dwelling units. Under existing conditions, an estimated 20,000 additional people live in the General Plan planning area, outside of the City boundaries but within the City's SOI. In 2010, approximately 147,500 residents lived within the City of Escondido's boundaries and the household median size was 3.23 persons. The majority of homes in the City of Escondido are single family residences (27,474 units) with other residences including apartments and condos (16,469 units) and mobile homes (3,736 units). The 2030 forecast shows a projected 14 percent increase in population and 10 percent increase in housing units within the City. Because population is projected to grow faster than the number of dwelling units, the average persons per household is projected to increase in 2030.

As discussed previously, the Escondido water service area is not aligned with the City's incorporated boundary. Population forecasts within the City of Escondido's water service area were also provided by SANDAG and reported in the 2010 City of Escondido Urban Water Management Plan (UWMP). Figure 2-2 illustrates the population growth since 1995 and the projected population out to 2035. The 2010 population within the water service area is approximately 132,300 and the 2030 forecast is 151,300, which is an increase of approximately 19,000 residents, or 14 percent. The population projection for 2035, which is the "buildout" year for the General Plan Study Areas is 154,600. This is nearly a 17 percent increase over the 2010 water service area population. It is noted that the Escondido water service area in the UWMP includes the County Club areas, which are supplied water from Rincon MWD and are not a part of the service area analyzed in this master plan.

Figure 2-2 Existing and Projected Water Service Area Population



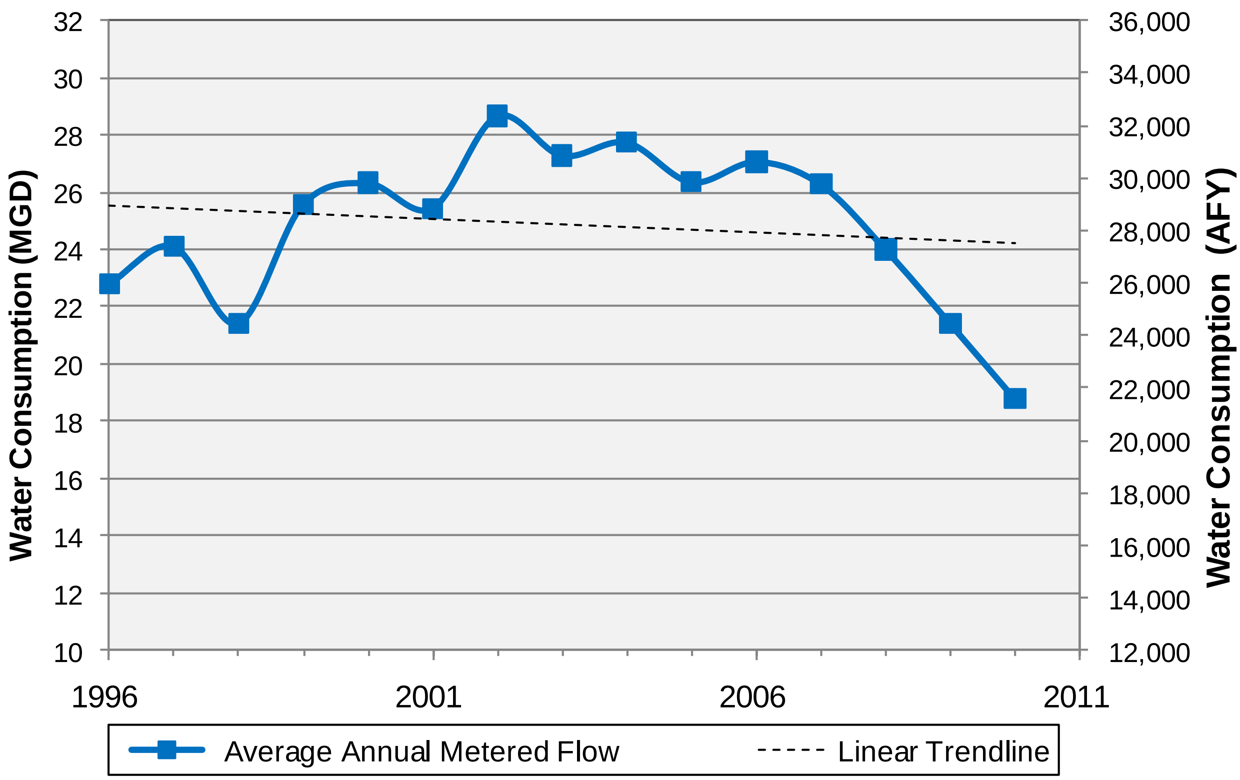
Source: 2010 City of Escondido Urban Water Management Plan

In order to accommodate the anticipated population growth proposed in the General Plan Update, future residential development will focus on smart growth principles, particularly in Study Areas 10, 11, 12, 13, 14 comprising area around downtown, East Valley Parkway, and South Escondido Boulevard. Smart growth principles enhance land use and urban design and provide a framework for developing the land use plan and General Plan policies. Smart growth principles include preserving urban centers, ensuring adequate infrastructure, establishing urban growth limits, encouraging mixed-use, developing for "human scale," encouraging high density development near transit, and protecting environmental resources. Smart growth seeks to expand transportation options to include walking, biking, public transit, and driving.

2.3 Existing Water Consumption

Approximately 65 percent of the water produced at the Escondido-Vista WTP is currently delivered to the Escondido distribution system. The Escondido distribution system begins at the WTP Clearwell, and all potable water entering the Clearwell is metered. Figure 2-3 illustrates Escondido's water consumption for the past 15 years based on WTP production reports. The water use includes demands for Rincon MWD's Improvement District A (Rincon ID-A), which is supplied from the Escondido distribution system. From the late 1990's to 2002 there was an overall increase in water demands, and the highest historical annual water usage was recorded in 2002 at 28.7 million gallons per day (MGD) (32,100 acre-feet per year (AFY)). For the next five years water use leveled off and decreased slightly, despite an annual population growth of over two percent. The overall reduction in water demands per capita during this period can be partly attributed to the reduction in agriculture demands and lasting effects of water conservation programs (low-flow toilets and shower heads, drip irrigation systems, etc.), both of which are also promoted by continually rising water costs.

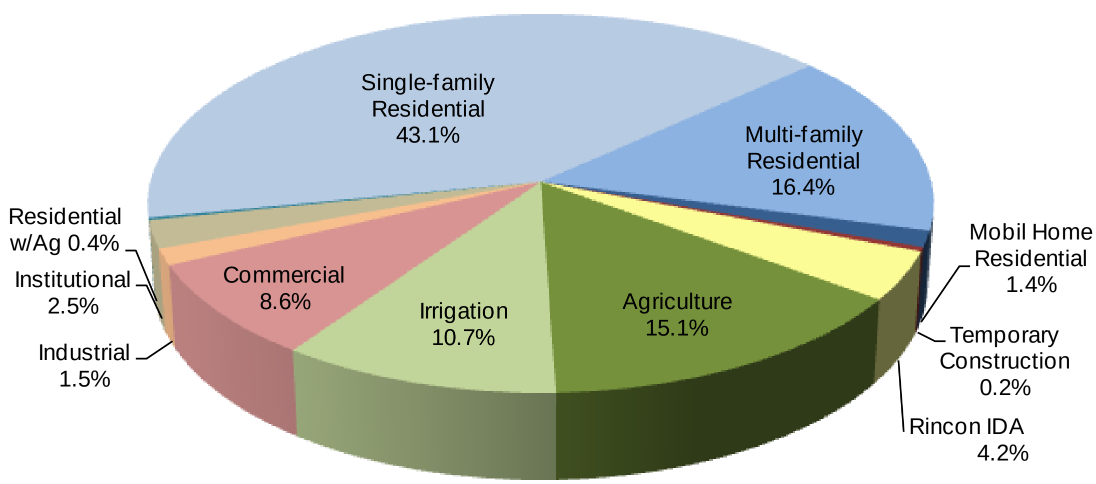
Figure 2-3 City of Escondido Historical Water Use



Since 2007, water demands have dropped off rather dramatically. This recent decline is due to a combination of factors, most notably the economic recession, rising water rates, and drought conditions. A Water Shortage Level 1-Water Watch Condition was declared in Escondido in October 2008, and a Stage 2-Water Alert Condition was declared in response to reduced water deliveries from the SDCWA in July 2009. Mandated water use restrictions include limited watering days and times plus an eight (8) percent water use reduction. Lower than average summer temperatures in both 2009 and 2010 also contributed to the reduction in demand. Based on the weather station at Lake Henshaw, temperatures were nearly four degrees below historical monthly averages from May through October in 2010.

Changes in land use and water consumption are also evidenced by a review of water billing records. Each water account is assigned one of over twenty different account categories based on water usage and billing rates. For this master plan, several billing account types were combined into more general account categories. Figure 2-4 summarizes the water usage in 2010. Residential water use, which includes single-family, multi-family and mobile home residential accounts, comprised 61 percent of the total water demand while 15 percent was for agriculture. In 1996 agricultural water use comprised 17 percent of the total demand, and the *1987 Master Plan* estimated agriculture demand as 24 percent of the total water demand.

Figure 2-4 Escondido Water Use by Billing Category



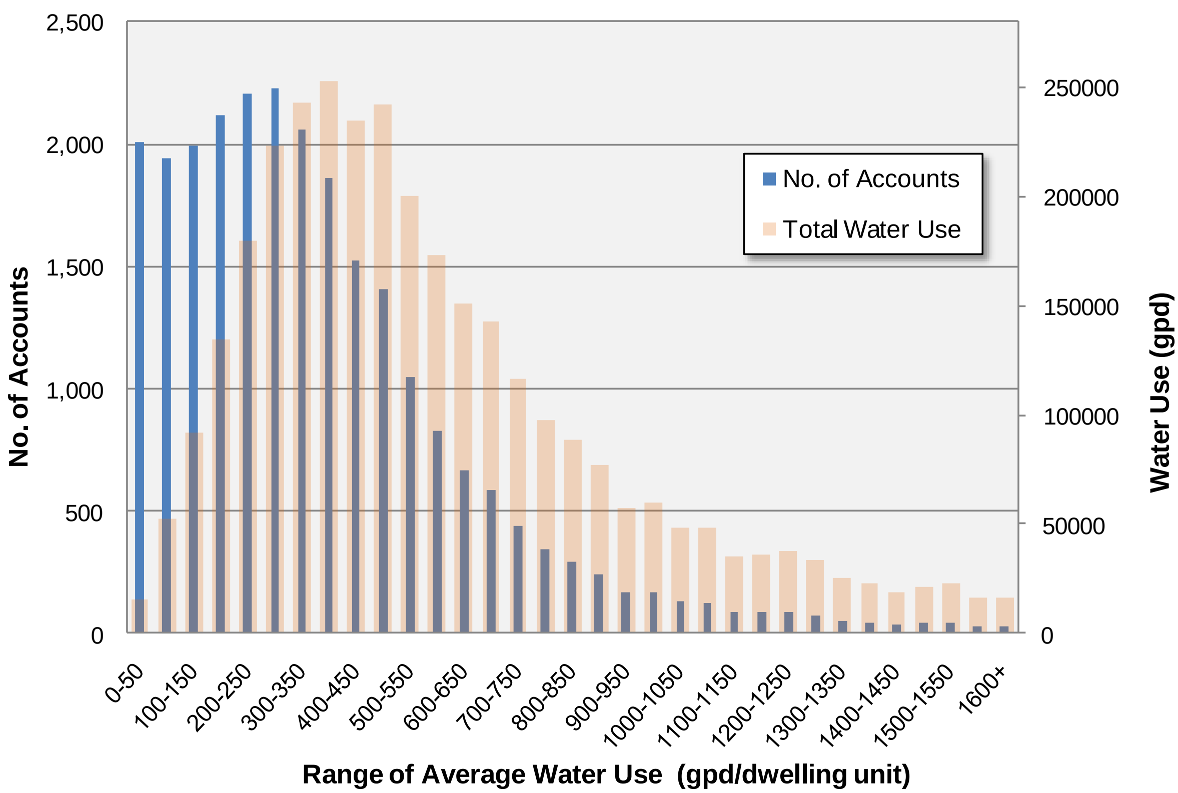
Since a portion of the recent reduction in water demands was due to mandatory water use restrictions and demands are expected to increase with improving economic conditions, a decision was made with City Staff to evaluate the existing water system with demands that are higher than the most recent year. For this master plan update, "existing" demands are the 2010 demands multiplied by a factor of 1.2, which brings demands back to approximately 2008 levels.

2.4 Unit Water Demands

Average annual unit water demands are developed for specific land use types or water billing account types to project water usage for future developments and service areas. The amount of water required by a given area of land or parcel is a function of the land use, however there can be a wide range of water use within each category. Unit demand factors developed for planning purposes are typically conservative, to ensure that facilities required to supply future demands will not be undersized.

The average water use for the approximately 25,000 single-family residential billing accounts in 2010 was 368 gallons per day/dwelling unit (gpd/DU), but the range of water use for this largest billing category is quite large. Figure 2-5 illustrates the range of water use in 2010, which is typical for this geographic area and mix of primarily suburban and estate-type residential development. Accounts with very high water use are for large lots with extensive irrigation. Accounts with very low water use are typically reflective of homes on very small lots, attached housing units that have individual water meters, or homes in planned developments in which all or a portion of private yards are maintained and irrigated by a homeowner's association. Accounts with very low water use may also include accounts that were issued or closed during the calendar year and therefore do not have a full years worth of billing data. Given the current economic conditions and higher than normal vacancy rates, the number of accounts with less than a year's worth of water use was likely higher in 2010 than in most previous years.

Figure 2-5 2010 Water Use Distribution for Single-Family Residential Accounts



Unit water demands were calculated in the *2000 Master Plan* from a review of 1996 water meter records of sample areas representing each land use type. For this master plan update sample areas of the various residential land use types were again reviewed for single-family and multi-family residential accounts, and non–residential accounts. Unit demands were updated based on current water meter records but adjusted to be somewhat conservative, and thus appropriate for master planning purposes. Demands for common area landscaping and streetscaping within residential areas were accounted for by distributing irrigation demands equally and adding to the residential water use.

Non-residential accounts have even greater variances in the range of water use than for residential accounts. For example, restaurants will have much higher water use then a retail store of the same size, and medical offices will typically use two or three times as much water as corporate office space For this master plan update, unit demands for non-residential building areas were developed based on billing data and non-residential building area estimates within the General Plan Update Study Areas provided in the December 2011 Escondido General Plan Environmental Impact Report (EIR). Water use data was then evaluated for various commercial, office, and industrial properties to refine the unit demand values for the general plan land use areas.

The updated unit water demands, which reflect the decrease in unit water consumption that has occurred over the past decade, are provided in Table 2-2. These unit demand factors are for general planning purposes, and as such they are considered to be somewhat conservative overall. Unit demands for irrigation of parks and fields were updated based on the demand analysis performed in the 2011 Escondido Recycled Water Master Plan and are appropriate for a fully irrigated parcel.

Table 2-2 Unit Water Demands

General Plan Land Use		Unit Demand[1]			
Category	**Description and Max Density**	**gpm/acre**	**gpd/acre**	**gpd/DU**	**gpd/10,000 sf**
R1	Rural I - lot size >4 acres	0.27	390	1,560	--
R2	Rural II - lot size >2 acres	0.35	500	1,500	--
E1	Estate I - lot size >40,000 sf	0.55	790	1,190	--
E2	Estate II - lot size >20,000 sf	0.85	1,220	840	--
S	Suburban - 3.3 DU/acre	1.20	1,730	630	--
U1	Urban I - 5.5 DU/acre	1.50	2,160	490	--
U2	Urban II - 12 DU/acre	2.00	2,880	330	--
U3	Urban III - 18 DU/acre	2.90	4,200	280	--
U4	Urban IV - 24 DU/acre	3.60	5,250	250	--
U5	Urban IV - 45 DU/acre	4.80	6,900	200	--
P	Public Land/Parks[2]	2.07	2,980	--	--
NC	Neighborhood Commercial - 0.35 FAR	1.15	1,650	--	--
GC	General Commercial - 0.5 FAR	1.59	2,290	--	--
PC	Planned Commercial - 1.5 FAR	3.17	4,570	--	--
MU	Mixed Use - 80 DU/acre + non-residential	6.14	8,840	--	--
I	General/Light/Office Industrial	0.80	1,150	--	--
O	General/Planned Office	1.00	1,440	--	
GP Update Study Areas	Single-Family Residential	--	--	400	--
	Multi-Family Residential	--	--	220	--
	Commercial	--	--	--	1,400
	Industrial and Office	--	--	--	800

(1) DU = dwelling units; gpd = gallons per day; gpm = gallons per minute; sf = square feet
(2) Assumes fully irrigated park

2.5 Peaking Factors

All of the water demands previously discussed in this section have been in terms of "average annual" water consumption. Actual water use, however, follows a widely varying pattern in which flows are sometimes well below or far greater than "average." Flow variations are commonly expressed in terms of "peaking factors," which are multipliers to express the magnitude of variation for a given condition. The peaking factors that are most important in the development and analysis of a water system correspond to the maximum day use and peak hour use.

Daily flow data is recorded at the Vista-Escondido WTP, including the flow entering the Clearwell. The total system peaking can therefore be determined from a review of flow records. The seasonal variation in water demands based on flow records for the past three years is illustrated in Figure 2-6. The single day with the maximum water consumption typically occurs during a dry, windy day ("Santa Ana" condition) in August or September. As previously noted, lower than average summer temperatures were recorded in 2009 and 2010, which accounts for lower maximum day demands than in 2008.

Figure 2-6 Seasonal Water Demands

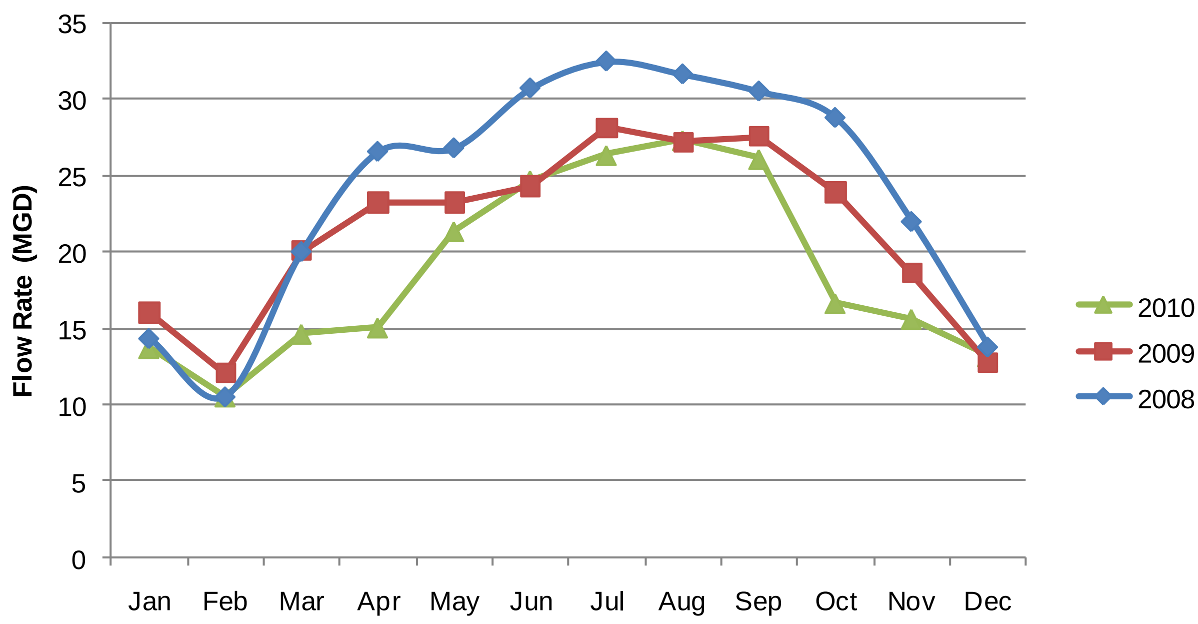


Figure 2-7 displays average annual and maximum day flows recorded at the Vista-Escondido WTP Clearwell meter for the past ten years. The maximum day peaking factors for this period ranged from 1.50 to 1.81 and averaged 1.61. In general, the peak water use factor for a distribution system will decrease as the total system demand increases. For Escondido, the recent reduction in average demand has had little effect on the maximum day peaking factor, except for the most recent year in which the peaking factor was significantly higher. This higher peaking factor is considered an anomaly in the trend, however, as the continued reduction in agriculture demand and conversion of irrigation customers to the recycled water system will likely decrease peaking factors in the future.

Figure 2-7 Historical Average and Maximum Day Flows

Table 2-3 summarizes the peaking factors for the Escondido water system that will used in the existing and future system analysis. The maximum month and maximum day factors have been reduced slightly from the previous master plan based on recent water use trends. The peak hour factor, which cannot be measured directly, has remained the same and is based on peaking factors developed by the City of San Diego for the north inland area. It is noted that the values in Table 2-3 are appropriate for the distribution system as a whole, and peaking within smaller areas, such as reduced pressure zones with almost exclusive residential water use, will be higher.

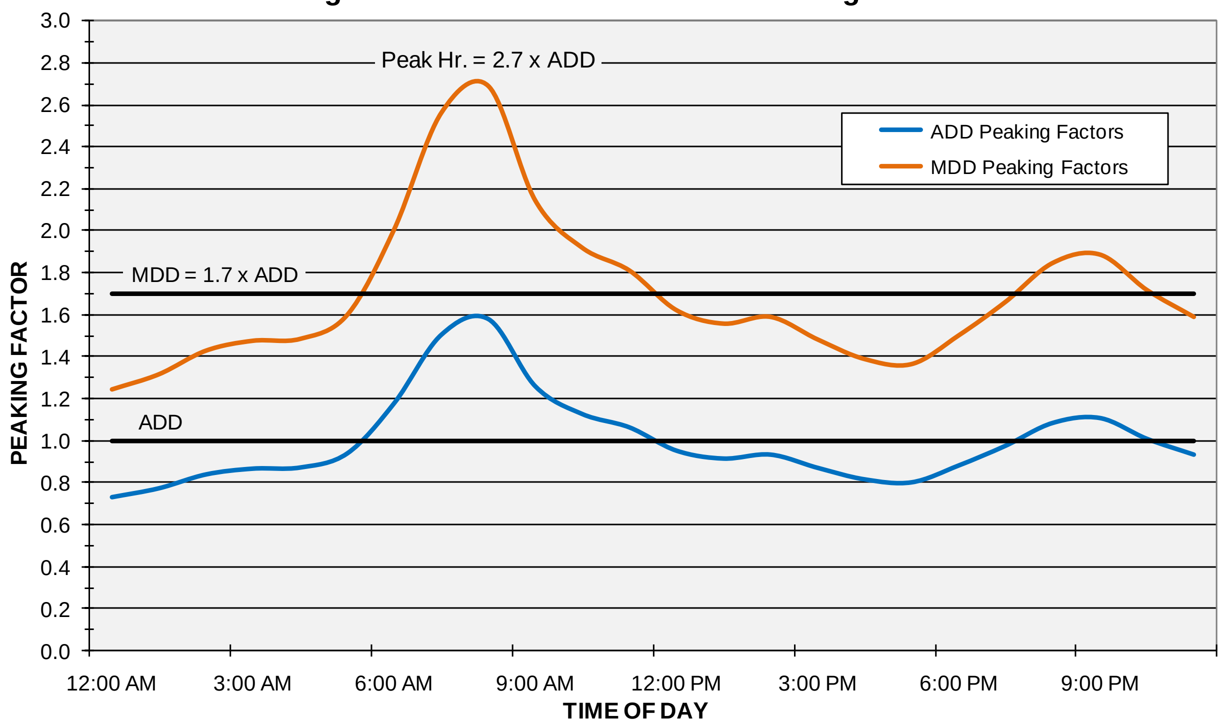
Table 2-3 Escondido Peaking Factors

Demand Condition	Factor
Average Annual Flow	1.0
Maximum Month	1.4
Maximum Day	1.7
Peak Hour	2.7

The water demand over a 24-hour period is quite variable, but generally exhibits a similar form from day to day. Hourly variations arise from typical hourly patterns of human activity, with water use higher in the daytime than in the nighttime and daytime water use peaking during the morning and early evening hours when more people are at home. The time-of-day demand curve is a series of 24 hourly demand or peaking factors that define how water usage varies over the course of a day. Each demand factor is the ratio of the hourly demand to the daily average, and the composite curve is often referred to as a diurnal demand curve because of its characteristic shape with two peaks.

Daily water demand curves for the Escondido distribution system were developed by downloading metered flows and reservoir water levels from the SCADA system for the weeklong calibration period between October 24 and October 31, 2011. The daily demand during this period ranged from 19.1 to 22.1 MGD, which was approximately the average annual demand for 2010. An average annual peaking curve was developed from this data, which was then magnified to approximate water system peaking on the maximum demand day. The average annual and maximum day demand peaking curves used for extended period hydraulic analysis in this master plan are illustrated in Figure 2-8.

Figure 2-8 Escondido 24-hour Peaking Curves



2.6 Projected 2030 Water Demands

Water demands are projected to increase within the Escondido water service area from development of vacant land, increased residential densities, redevelopment of established areas, which will be concentrated in the General Plan Update Study Areas, and an expansion of the existing water service area. The unit water demands presented in Table 2-2 are assumed valid for the future water system and are used as the basis for the demand projections. An additional land use designated as Open Space exists at several locations in the northeast section of the service area. These areas have been designated as undevelopable primarily due to the steep terrain and have no associated water demands.

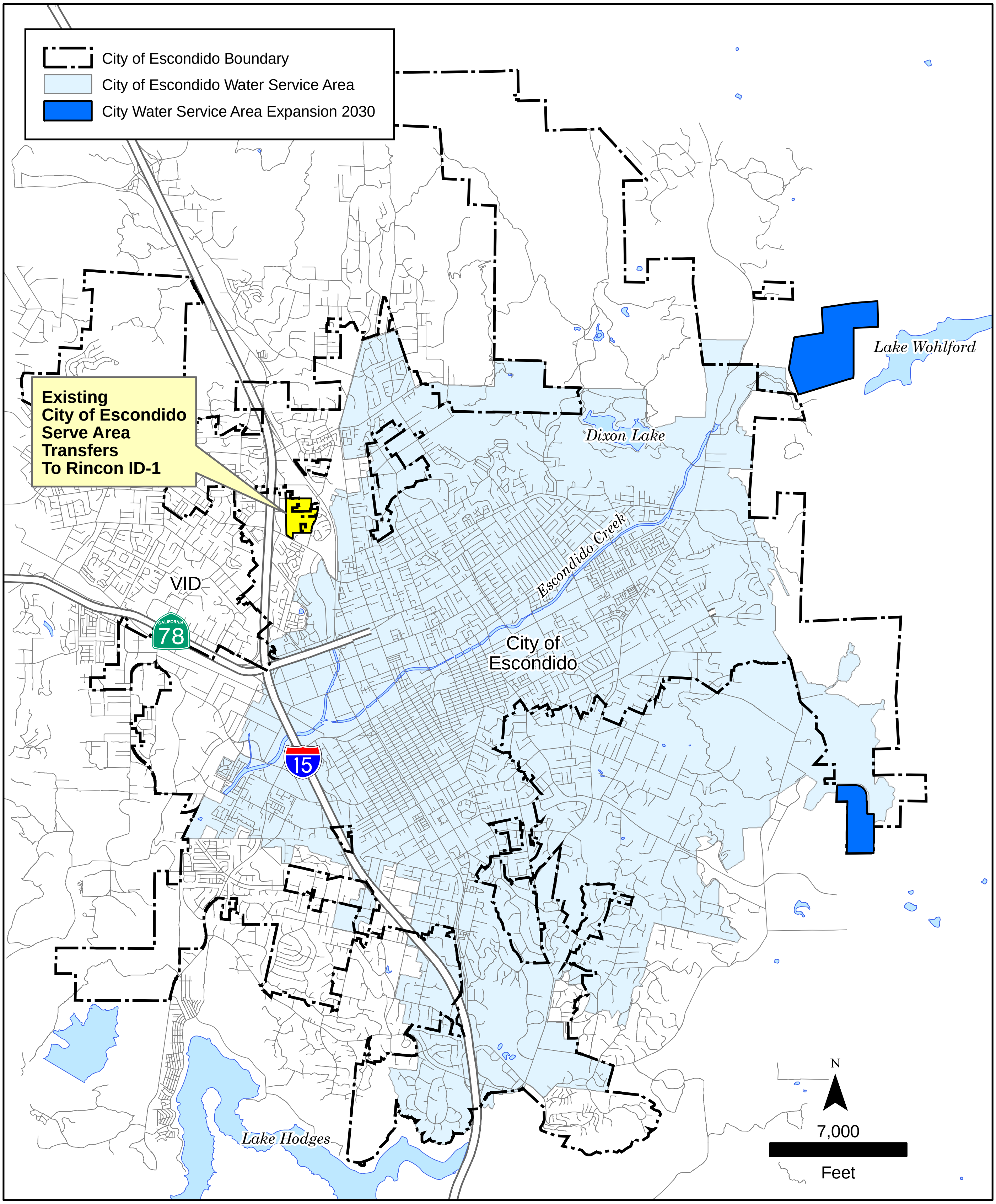
2030 Water Service Area

The existing service area of the Escondido water distribution system is calculated to be approximately 18,100 acres based on the City of Escondido GIS for the water service pressure zone areas. This area calculation includes parcels that are outside of the city boundaries but within the existing City SOI, and excludes the Country Club pressure zones that are supplied water from Rincon MWD. The service area calculation also excludes Rincon ID-A and the San Diego Zoo Safari Park, which are off-site delivery areas. There are some additional areas to the east and north outside of the current service area that that could potentially be supplied with potable water in the future. Some of these areas will require annexation into the City. Potential future service areas were discussed with City Staff and two areas were added to the existing service area to create the 2030 water service area that is evaluated in this master plan update. The 2030 service area will potentially increase by approximately 390 acres and the future annexed areas, shown on Figure 2-9, will be comprised primarily of low-density rural and residential estate land use. It is noted that the existing service area boundary with Rincon MWD is assumed to remain unchanged.

Projection Methodology and Assumptions

In this master plan update, future water demands based on a 20-year planning horizon (Horizon Year) are projected and added to existing demands to obtain the 2030 water demand used in the 2030 water system hydraulic analysis. Several different methods are used to project future demands, depending on the planning information available. For developments with approved tentative maps or other specific planning information, water demands are projected based on the number of future dwelling units as provided by the City planning department. Existing demands, primarily for agriculture, may be eliminated in some of these areas. Within the General Plan Study Areas, water demands are projected based on specific development information provided in the General Plan Update EIR for the 2035 buildout condition, shown previously in Table 2-1. For all other parcels within the service area, future flows are calculated on a parcel basis using SANDAG 2030 population projections. For parcels that currently have no or very little water use, future water use is calculated using the General Plan unit demand factors if the SANDAG 2030 population is greater than the 2010 population. For parcels with existing water use, additional future demand is calculated if the 2030 population increases by more than 20 percent. The methodology for the parcel-based demand projection and allocation is summarized in the flow chart provided in Figure 2-10.

Future demands for Rincon ID-A are assumed to be the same as the existing demand, since the area is almost completely built out. Demand projections for the San Diego Zoo Safari Park (formerly the Wild Animal Park) were increased by 20 percent over existing demands. This is considered to be conservative, since most future demands will likely be provided by recycled or other non-potable sources. Detailed tables showing the 2030 demand projections by pressure zone are provided in Section 7.

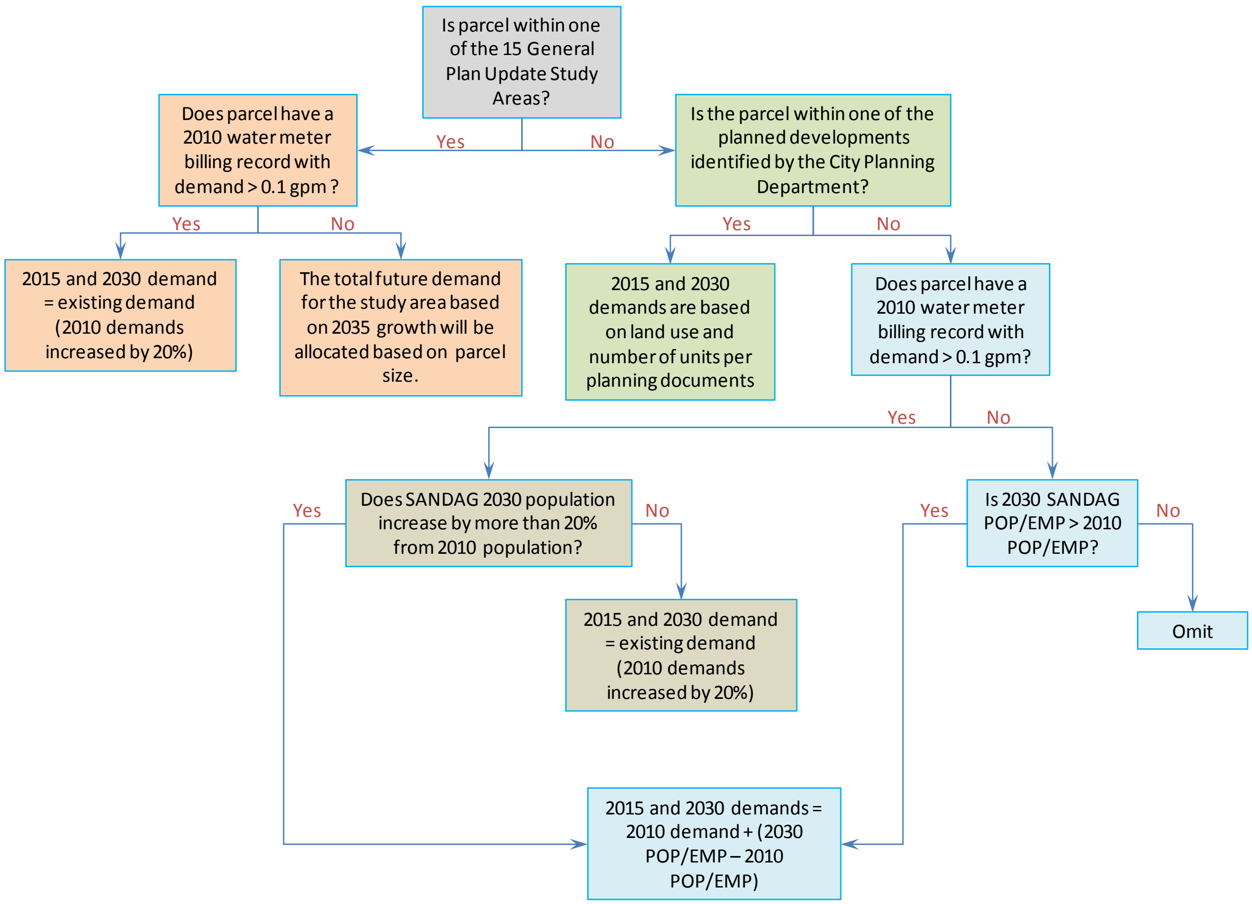


2030 Water Service Area

Figure 2-9

6/4/2012 KC-SD Z:\Projects\IS\Escondido\WaterMP\mxd\19357_Water_ServeArea_2030_Fig2-9.mxd

Figure 2-10 2030 Demand Allocation Flow Chart



Impact of Recycled Water

Approximately 0.6 MGD of recycled water is currently delivered to customers within the Escondido water service area. The 2011 Recycled Water Master Plan identifies potential future markets and proposes a phased expansion of the recycled water system to serve these customers. However, the City of Escondido is also actively studying the requirements for developing local indirect potable reuse (IPR) water supplies. It could take many years for an IPR system to be implemented in Escondido, but if results of the initial study are favorable, an aggressive expansion of the recycled water distribution system would likely not be undertaken.

Based on the uncertainty of the recycled water system expansion, it was deemed conservative to consider only potable water reduction from the customers included in the recycled water customer waiting list. The customers on the waiting list that are within the Escondido water service area (excluding the Rincon MWD water exchange areas) and their potential recycled water use are provided in Table 2-4. The average annual demand totals approximately 0.38 MGD, which will be deleted from the 2030 system demand projections and 2030 system hydraulic model.

Table 2-4 Recycled Water Customer Waiting List

Site	Irrigated Acres	Potential Use (AFY)	Potential Use (MGD)
Grace Lutheran Church & School	5.8	4	0.004
Bernardo Santa Fe[(1)]	11	14	0.013
River Village[(2)]	4.2	2	0.0002
New Tradition HOA	2.2	11	0.01
Vermont Villas	5.7	10	0.01
Weir Construction (rock crushing)	3.9	13	0.012
Escondido Elks Lodge 1687	0.9	1.5	0.001
Goal Line, LP (Ice-o-plex)	process user	365	0.326
Total		**420.5**	**0.3762**

(1) City potable water meter data used to determine potential use.
(2) River Village is physically located within the Rincon MWD boundary.

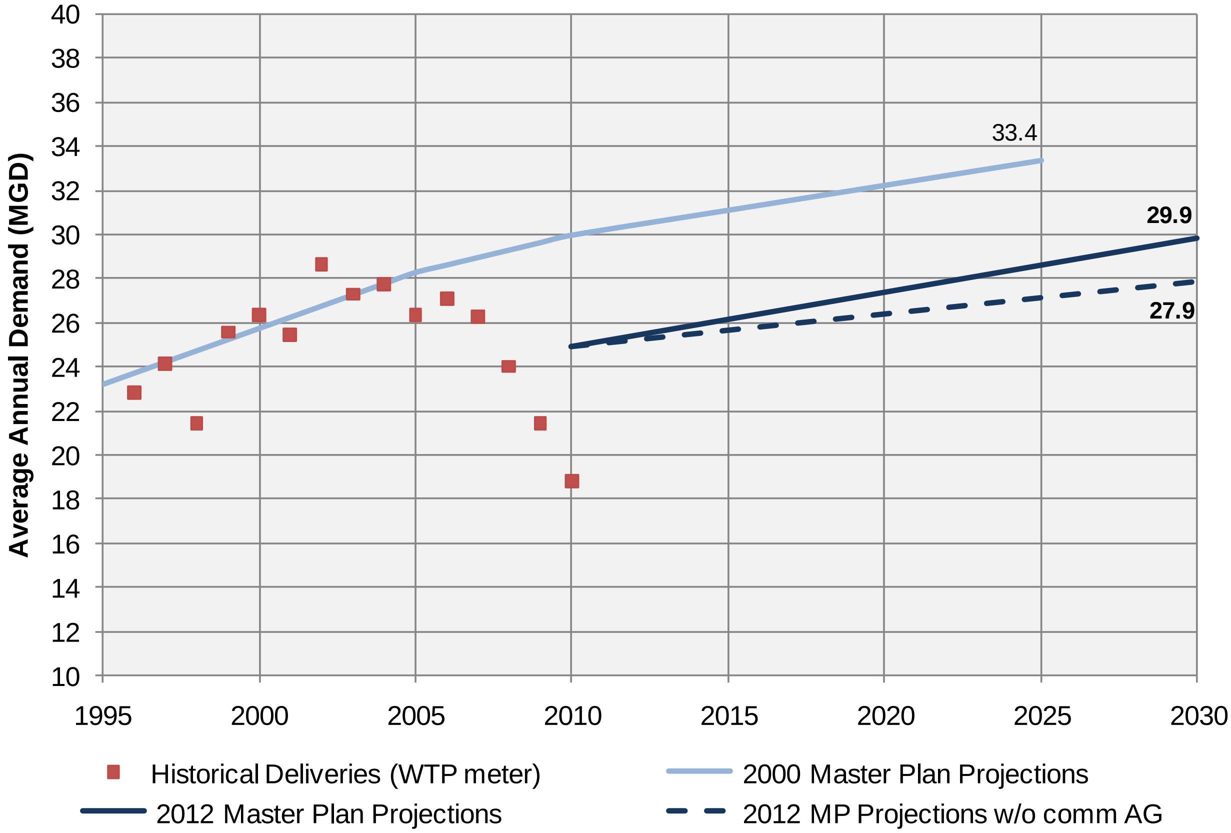
Water Demand Projections

The average annual water demand projected for the City of Escondido in 2030 is approximately 33,400 AFY (29.8 MGD). This projection is based on an increase in future demand from 2008 water consumption rates and includes off-site deliveries to Rincon ID-A and the San Diego Zoo Safari Park. As a comparison, the average annual water demand projected for 2025 in the *2000 Master Plan* was 37,400 AFY (33.4 MGD). Figure 2-11 illustrates historical water deliveries since 1995, *2000 Master Plan* water demand projections, and current water demand projections. Also shown on the figure is an additional lower demand projection of 31,200 AFY (27.9 MGD) that assumes no commercial agricultural water use by the year 2030 (existing demand from agriculture meters is removed). While it is acknowledged that the General Plan does not have an agricultural land use category and most commercial agriculture areas will be developed in the future, some amount of agriculture is likely to remain. Projected water demands associated with the General Plan Update Study Areas is provided in a table in Appendix A. The 2030 capacity analysis for this master plan is based on the higher, and therefore more conservative, demand projection.

The maximum day demand for 2030 is projected to be approximately 51.3 MGD (35,600 gpm). This projection is based on the system-wide maximum day peaking factor of 1.7 for all demands except for Rincon ID-A, which are peaked slightly higher based on historical water use.

It should be pointed out that no projection is assured of accuracy in an environment where changing economic conditions, political climates, and community values all affect growth rates and water consumption. Demand projections in this master plan assume that unit water consumption will return to 2008 levels, but this level of rebound may never fully occur. Future demand projections may also be subject to modification if the community adopts strong policies either in favor of or opposing growth in general or the role of agriculture in the community. As a final note, while a 20 year planning horizon is considered in this master plan update, SANDAG 2050 regional growth forecasts for the City of Escondido project a seven percent population increase beyond 2030.

Figure 2-11 2030 Water Demand Projections



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Section 3
Water Supply

The above-normal snowpack and precipitation totals that California experienced during the winter of 2010-2011 have allowed Escondido and other San Diego and southern California water agencies to rescind their Drought Alerts, and end the imposition of mandatory water use restrictions for their customers that were in effect the previous two years. Those restrictions were necessary to help the region manage water supply shortages that had arisen due to a combination of factors, including:

- Four consecutive years (2007-2010) of below average snowpack runoff in California, leading to drawn down storage reserves and reduced supplies available to the SWP;
- Federal Court rulings that have led to restrictions on pumping operations of the SWP in order to protect endangered species in the Sacramento – San Joaquin Delta; and
- Persistent drought on the Colorado River, leading to the elimination of any surplus deliveries that might otherwise be available. The above normal snowpack in the Colorado River basin during the winter of 2010-2011 has eased but not eliminated this situation.

In May 2011, after a sufficiently wet year, San Diego area water agencies, including the City of Escondido, lifted mandatory water use restrictions, allowing residents to begin watering their lawns more frequently and giving the City's many avocado farms a chance to revive dormant orchards. From 2009, the City's water customers were prohibited from watering their yards and trees more than three days per week or for longer than 10 minutes per watering session. Agricultural customers were forced to curtail water use by 30 percent. Under these restrictions, local water usage within the City was reduced nearly 20 percent. The restrictions were reportedly the first Escondido had placed on water use in its 122-year history.

It is against this backdrop of recent water supply shortage that Escondido is preparing its Master Plan Update. These conditions point to the importance of water supply planning and the need to evaluate possible opportunities for local supply development to help ensure the Escondido's continued ability to provide a reliable and fiscally sound water supply to its customers. This section describes Escondido's existing water supply facilities and provides an update on local water rights, including the long standing Indian Settlement Agreement. Detailed discussions regarding local hydrology and water quality characteristics from prior master plans are included in Appendix B for reference.

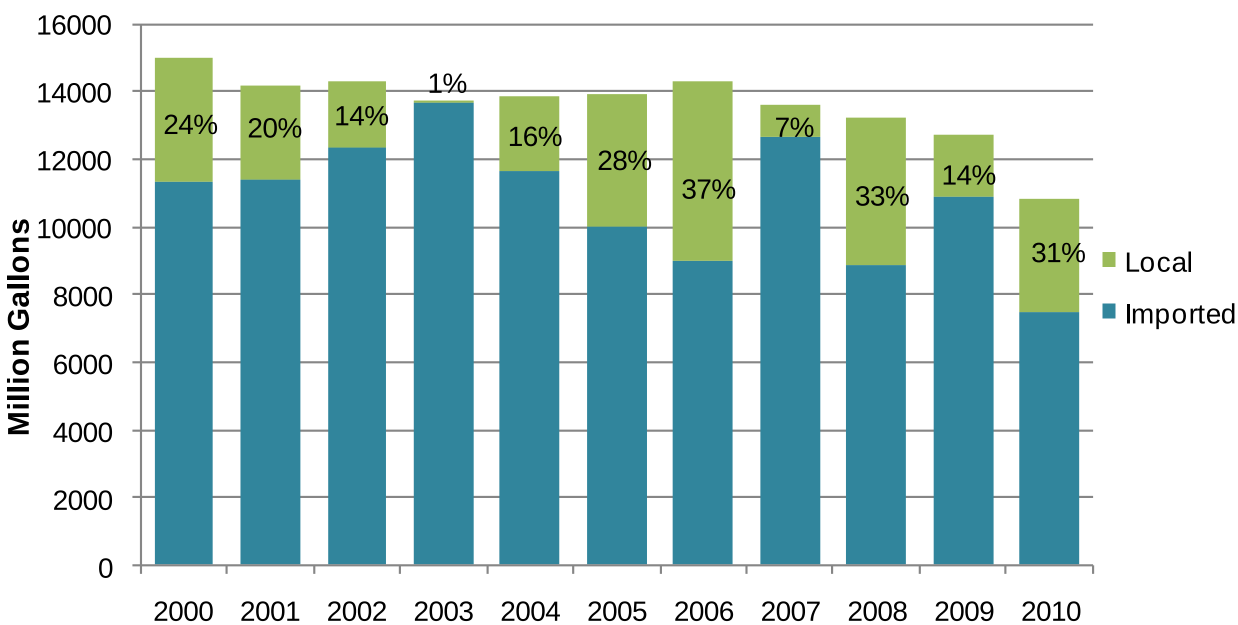
3.1 Water Supply Sources

Escondido's water supply originates from two sources: local water and imported water from SDCWA. From the San Luis Rey River watershed, local water is stored on a seasonal basis in the Lake Henshaw and Lake Wohlford reservoirs. Principal water storage and conveyance facilities include the Warner Basin aquifer, Lake Henshaw, Warner Ranch Well Field, Escondido Canal, Lake Wohlford, Dixon Lake, Bear Valley Pipeline, and Escondido-Vista WTP. A portion of the San Luis Rey River is also used for conveyance. Local water is shared with VID and provides approximately 20 percent of Escondido's average water demand. Some groundwater wells are located throughout the Escondido's service area; however, these wells are privately owned and maintained. Escondido does not participate in any groundwater storage or replenishment programs.

The remaining 80 percent of water demand within Escondido's service area is provided by imported raw water from the SDCWA 1st Aqueduct. Escondido has two operable raw water connections to the SDCWA aqueduct system (Escondido 3 and 4), and one treated water connection currently not in use (Escondido 2). The imported raw water is conveyed to the Escondido-Vista WTP through a 54-inch diameter pipe. The Escondido-Vista WTP was constructed in 1976 and has a permitted capacity of 75 MGD. After treatment, potable water is distributed from the Escondido-Vista WTP by Escondido to its service area, VID and small pockets of the Rincon MWD service area.

Figure 3-1 illustrates the mix of water supplies to the Escondido-Vista WTP over the past ten years based on the City's water production reports. The local water supply is obtained from the Lake Wohlford meter and the imported water supply is the total of readings from the Lake Dixon and SDCWA meters.

Figure 3-1 Water Supply to the Escondido-Vista WTP (2000-2010)



Escondido also owns and operates its own recycled water treatment facility, the Escondido Hale Avenue Resource Recovery Facility (HARRF). Opened in 1959 and upgraded in 1973, 1980, 1998 and 1999, HARRF is located in the southwestern area of the City and has a treatment capacity of 18 MGD. HARRF treats influent from the City of Escondido and the Rancho Bernardo community in the City of San Diego. HARRF includes conventional treatment facilities in addition to providing full Title 22 recycled water capacity. HARRF has the capacity to produce 9 MGD of tertiary treated recycled water for use as irrigation on local golf courses, parks, school grounds, green belts, roadway medians, open spaces and industrial use.

3.2 Local Water Supply Facilities

Water released from Lake Henshaw flows downstream in the San Luis Rey River channel to the intake of the Escondido Canal, which diverts water from the river. The Escondido Canal conveys water to Lake Wohlford, where it is stored and released through the Bear Valley Pipeline to the Escondido-Vista Water Treatment Plant. The City is entitled to all the water from Lake Dixon, a portion of the water of Lake Henshaw and all the water derived from runoff in Lake Wohlford. The City's water department operates Lake Dixon and Lake Wohlford, which are used for recreational purposes as well as water storage and supply. The Bear Valley power generating facility is also part of the local facilities. These facilities are described in detail in the following paragraphs. Figure 3-2 shows the location of the contributing watersheds and the storage and conveyance facilities.

Warner Basin Aquifer

The Warner Basin aquifer is a developed groundwater basin with about 150,000 acre-feet (AF) of active storage. The aquifer contains a gross pore volume of about 750,000 AF with about 530,000 AF in formations that qualify as aquifers. Only about 400,000 AF of aquifer storage is hydrologically connected to the current wells and about 250,000 AF must remain saturated to accommodate pumping drawdowns.

Long-term sustainable yield of the aquifer is about 10,000 AF annually. It is estimated that an average of about 15,000 AF annually can be extracted during a five-year drought, with any single year pumping limited to about 20,000 AF. Historically, no more than 2,300 AF has been pumped in a month. Drought condition recharge varies from 2,000 to 5,000 AF per year; wet condition recharge can be as high as 28,000 AF per year.

The performance of the aquifer is limited by extraction and recharge rates. Aquifer transmissivities limit economic pumping, and legal agreements preclude expanding the well field. Rate of recharge is limited by precipitation volume and intensity. After depletion, the aquifer generally needs from two to four years with no pumping to fully recover.

Lake Henshaw Dam and Reservoir

Lake Henshaw Dam was completed in 1922, enlarged in 1927, and modified in 1951 to comply with California State Division of Safety of Dams requirements. Lake Henshaw receives an average of about 30 inches of rain per year and has approximately 200 square miles of surrounding watershed. The dam impounds approximately 51,800 AF of water with a surface area that fluctuates from 35 to 2,220 acres. The dam and reservoir are owned and operated by VID; the City maintains storage rights. Lake Henshaw is also used for recreational purposes by the VID. The dam, a zoned hydraulic-fill embankment with an overflow weir spillway on the right abutment, can discharge up to 83,350 cfs.

Warner Ranch Well Field

VID developed this groundwater resource as a result of the droughts in the early 1950s. Sixty production wells have been drilled; 31 have been in operational condition since 1981, and 25 are currently being utilized. The well field is owned and operated by VID; four wells are jointly owned by the City and VID. The wells vary in capacity from 300 to 2,000 gallons per minute. Water is conveyed to Lake Henshaw through about 8 miles of pipeline and 12 miles of lined, open ditches.

Some wells and conveyance ditches are in need of rehabilitation to fully utilize the capacity of the Warner Basin. Needed repairs on the conveyance system have been halted pending resolution of the San Luis Rey River Water Rights Settlement and clarification of Endangered Species Act implications.

San Luis Rey River

About 9.5 miles of the natural channel of the San Luis Rey River is used to convey water from Lake Henshaw Dam to the intake of the Escondido Canal. The river is enclosed by steep canyon walls and has no maximum conveyance limitations, nor any minimum flow requirements. It is estimated that there is very little seepage from the river, although about 2,500 AF a year is used by riparian vegetation or evaporates. On the average, the river annually catches about 10,000 AF of additional runoff from adjacent watersheds.

Escondido Canal

Water is diverted to the canal through the Escondido Diversion, built in 1924. The structure is a 16 foot-high concrete gravity structure with an integral canal intake facility at the left end. There is an ungated overflow weir with a 13,000 cfs capacity. The Probable Maximum Flood for the San Luis Rey River at this location is 35,000 cfs.

The Escondido Canal was completed in 1895. Its original 28 cfs capacity was enlarged to 49 cfs in 1924. In conjunction with the construction of Lake Henshaw Dam, portions of the canal were relocated and its capacity was increased to 70 cfs. Current operational capacity is 60 cfs. The canal is owned by the City, although the VID has capacity rights. The Escondido Canal Agency, jointly supported by the City and VID, operates the facility. The canal traverses about 14 miles of rugged terrain, terminating in Escondido Creek at the north end of Lake Wohlford, and consists of 11.1 miles of shotcreted canal, 1.6 miles of pipeline, 0.7 mile of tunnel, and 0.1 mile of metal flume. In October 2003 the Paradise Fire burned 80% of the canal alignment, denuding slopes adjacent to it. The winters of 2004 and 2005 produced considerable siltation and erosion along the canal, with the result that significantly reduced local water deliveries were made despite the abundant availability of local water in 2005. The canal has been a continual maintenance problem and is inspected daily, and sections of the flume are replaced as necessary.

Lake Wohlford Dam and Reservoir

In 1895, a small dam was built to impound Escondido Creek. In 1924, the dam was completely rebuilt. The dam is a hydraulic-and-rock-fill structure with a maximum storage capacity of 6,460 AF. In 2007, the Federal Energy Regulatory Commission (FERC) began requiring that Lake Wohlford be maintained at least 20 feet below the spillway crest level for dam safety purposes, limiting the capacity to 2,800 AF. The City of Escondido has completed several studies for The Lake Wohlford Dam Replacement Project and plans to replace the existing dam structure with a new earth-core rockfill dam or RCC (roller compacted concrete) dam to be able to utilize the full storage capacity. Most of the water released from Lake Wohlford passes through the 75 cfs capacity Wohlford Penstock to the Bear Valley Hydroelectric Generation Facility, which has a capacity of 50 cfs. VID maintains a bypass line to directly divert the excess 25 cfs when necessary. Lake Wohlford is also used as a recreational facility.

The dam seeps at about 25 gpm from the spillway, the toe, and the outlet tunnel. The new parapet (constructed in 1991) is in good condition. The spillway and downstream sections are well-maintained. The dam is inspected daily when there is less than 4,000 AF in storage; 25

piezometer wells in the core are read monthly; and the dam is surveyed every three months. Inspections are made after earthquakes regardless of reservoir storage.

Bear Valley Hydroelectric Generating Facility

The Bear Valley Hydroelectric Generating Facility was originally constructed in 1922, destroyed in a landslide, and rebuilt in 1986. A penstock brings water from Lake Wohlford to the powerhouse through two 940 horsepower impulse turbines and two 700 kilowatt generators at a gross head of 495 feet.

Bear Valley Pipeline

The Bear Valley Pipeline was originally constructed as two 43-cfs pipelines, one each for the City and VID. In the early 1990s, the pipeline was rebuilt as a 54-inch diameter pipeline that terminates at a sump structure near the water treatment plant.

Lake Dixon Dam and Reservoir

Lake Dixon Dam was completed in 1970 and is a zoned earth-fill embankment with a total capacity of 2,610 AF. Two weirs discharge into a concrete channel, with capacities of 330 and 6,000 cfs. Lake Dixon is primarily used to store imported water. Lake Dixon is a part of the local water supply system only in that its water is mixed with local water prior to treatment and Lake Wohlford water balance records contain a Lake Dixon account. There is no physical delivery of local water to Lake Dixon.

Escondido-Vista Water Treatment Plant

The Escondido-Vista WTP treats all raw water from wholesale and local sources before it is delivered to customers. Water flows by gravity from Lake Dixon at a maximum instantaneous flow rate of 80 MGD and enters the WTP through a 54-inch pipeline. Water may also enter from the 42-inch SDCWA Crossover Pipeline with a fluctuating flow. Maximum inflow from Lake Wohlford is approximately 50 MGD. Local water is blended with imported water prior to treatment. The WTP was completed in 1975 and expanded in 1984. Designed for 90 MGD, the WTP is currently permitted to produce 75 MGD due to restrictions placed by the Department of Health on the plant's filtration system. Treatment includes coagulation, sedimentation, filtration and disinfection to ensure drinking water quality. Bacteriological, physical and chemical tests are performed on water samples to assure that safe water for customers is being produced and maintained in the distribution system. Treated water is delivered either to the WTP Clearwell and then to Escondido's distribution system or to the Vista Flume for delivery to VID. VID owns capacity rights for treatment of 18 MGD; Escondido owns the remainder. Escondido's water service area demand on the plant averages approximately 25 MGD, with a peak demand of approximately 40 MGD. During the summer, the instantaneous peak demand can increase to 70 MGD. The City's portion of the treated water is directed to the City's 5.4 MG Clearwell, which supplies the City's potable distribution system.

Vista Flume

While the City's portion of the treated water is conveyed to the Clearwell, VID's portion of treated water from the Escondido-Vista WTP is conveyed to VID's 20 MG Pechstein Reservoir via an 11-mile pipeline that includes both flume and siphon conveyance systems. The Vista Flume is owned, operated and maintained by VID. The flume portion of the alignment totals 6.25 miles in length and consists of 11 bench sections. The siphon system is 5 miles in length and is comprised of 6 riveted steel inverted siphons, 4 concrete inverted siphons, one buried reinforced concrete pipe section referred to as Little Tunnel (similar in construction to the flumes) and a quarter-mile long hard rock tunnel (Big Tunnel). The flumes were constructed with a very uniform vertical grade approximating 1% throughout. The horizontal bending of the flumes is often quite severe to match the terrain needed to obtain the uniform vertical grade and includes numerous compound and compound reverse curves of minimal radius. Gravity flow through the existing flumes that are lined on the floor and walls with a high density polyethylene (HDPE) sheet lining system currently conveys a maximum flow of 18 MGD. In February 2009 VID began a Pilot Project to test the viability of using an HDPE insertion liner to rehabilitate the existing VID flume and concrete siphons. Construction of the Pilot Project was completed in 2010 and was successful in inserting approximately 2,200 feet of 42-inch HDPE pipe in the section of the Vista Flume known as MW Bench.

VID is currently undertaking a water supply planning study that will evaluate the condition of the flume and siphon system and estimate the remaining useful life of the various components of the system, with specific recommendations for improvement. The study will also provide a detailed cost analysis of producing, treating and delivering water from various existing water sources over the next 20 years. Following this study, it is anticipated that the District will further investigate alternative water resources and deliverance methods, including the possibility of lining and pressurizing the Vista Flume to allow delivery of water to adjacent water agencies.

According to VID's 2005 Vista Flume Pressurized Pipe Feasibility Study, depending on the diameter of pipeline inserted and the friction factor for the selected pipe it may be possible to increase flow within the conveyance system to 23 to 24 MGD. This flow is based on the available head (approximately 60 psi) between the Clearwell at the Escondido-Vista WTP and Pechstein Reservoir. Conversion of flumes to a pressurized pipe system would also lower the risk of failure from the potential for breaching or HDPE liner displacement and in the severity of impact from water movement during an earthquake event. Currently, completing shutting down the flume in an emergency can take several hours because flow must first be terminated at the Escondido/VID Treatment Plant and water already in the flume will continue to flow towards Pechstein Reservoir. A pressurized piping system would allow the strategic placement of valves along the pipeline to quickly stop the flow of water. The 2005 estimated cost to convert the flume to a pressurized system was in the range of $10 million.

If the Vista Flume is pressurized and its capacity increased it could provide service to neighboring agencies, including Escondido. This improvement could benefit Escondido in that it could provide emergency service to the Clearwell and Lindley pressure zones from the northern end of those zones, if the transmission main from the Clearwell is out of service for any length of time. Alternatively, the Escondido could make operable its treated water connection to the San Diego Aqueduct, which would also provide an emergency connection to the Clearwell and Lindley pressure zones, bypassing the transmission main from the Clearwell, and have the added benefit of providing a completely independent source of water from the Escondido-Vista WTP. This SDCWA Emergency Connection alternative is further explored in Section 7 of this Master Plan update.

3.3 Imported Water Supply Facilities

Although the City has an active program promoting water conservation and reclamation, Escondido is unable to meet its own demand solely from local supplies. Depending on the availability of local water, Escondido obtains up to 40 percent of its potable water supply from the SDCWA. SDCWA is one of the largest of 26 member agencies of the Metropolitan Water District of Southern California (MWD), purchasing approximately 25 percent of all the water MWD delivers. The SDCWA was formed in 1944 by the California Legislature to provide a supplemental supply of water as the San Diego region's civilian and military populations expanded to meet wartime activity needs. Today, the SDCWA has 24 member agencies and supplies between 75 to 95 percent of the water needs of its service area.

SDCWA delivers treated and raw water from the State Water Project and the Colorado River into San Diego County through five large diameter pipelines, located in two principal corridors known as the First and Second San Diego Aqueducts. The system has evolved over time to serve the growing needs of the service area. The aqueduct pipelines connect to treated and raw water feeds from MWD facilities at Lake Skinner, in southern Riverside County.

The First Aqueduct, Pipelines 1 and 2, delivers filtered water to the northeastern portion of the County. Prior to 1992, Pipelines 1 and 2 provided raw water to the City of Escondido. In March 1992, SDCWA converted the northerly portion of Pipelines 1 and 2 to deliver filtered water, and connected the southern portion of Pipelines 1 and 2 to a different raw water supply: Pipeline 5, via a cross-over pipeline, described below. Currently, delivery of filtered water from Pipelines 1 and 2 ends at the delivery points to VID and Rincon MWD and the Hubbard Hill Overflow. The City of Escondido has Connection No. 2 on Pipeline 2, but facilities to deliver filtered water from this turnout have never been constructed. Pipelines 3, 4 and 5 are located west of Pipelines 1 and 2, also in a north to south alignment. Pipelines 3 and 5 deliver raw water and Pipeline 4 delivers filtered water.

The Crossover Pipeline connects Pipeline 5 to a pressure and flow control facility which serves the southern portion of Pipelines 1 and 2 with raw water. As part of the conversion, the SDCWA completed the construction of the Escondido Raw Water Pump Station, a new connection (Connection No. 4) to the Crossover Pipeline and approximately 1,500 feet of 30-inch pipeline. These facilities replaced the City's Connection No. 2 on the First Aqueduct. This raw water pump station is only necessary to supply Lake Dixon if the hydraulic grade drops so low that gravity flow cannot occur. According to the SDCWA, use of the pump station has not been necessary due to excessive flows in the Crossover Pipeline. Connection No. 4 utilizes the City's existing 30-inch raw water line to supply Lake Dixon. Connection No. 3 is located downstream of Connection No. 4 and supplies raw water directly to the Escondido-Vista WTP. Raw water delivered to Escondido via the Aqueducts is combined with local water supplies and treated at the Escondido-Vista WTP adjacent to Lake Dixon Dam. The amount of imported water needed by Escondido, as forecasted in the SDCWA 2010 Urban Water Management Plan (UWMP), is shown in Table 3-1.

Table 3-1 SDCWA Projected Demands for Escondido (in AFY)

	2005	2010	2015	2020	2025	2030	2035
City of Escondido Demand	21,446	14,388	23,734	21,337	22,913	23,931	24,601

Source: SDCWA, 2010 Urban Water Management Plan (June 2011)

The SDCWA is actively seeking additional independent supplies of water through transfer agreements with agricultural areas and through desalinization. To reduce its dependency on MWD and diversify its supplies, the SDCWA in recent years has undertaken several initiatives, including the following:

- **Imperial Irrigation District (IID) Transfer:** The SDCWA signed a Water Conservation and Transfer Agreement with IID in 1998. Through the transfer agreement, the SDCWA is purchasing water from IID at volumes that will gradually increase year-to-year, reaching 200,000 AFY in 2021. The water is physically delivered to San Diego via MWD's Colorado River Aqueduct (CRA).

- **All-American and Coachella Canal Lining Conserved Water:** In 2003, as part of the execution of the Quantification Settlement Agreement (QSA) on the Colorado River, the SDCWA was assigned rights to 77,700 AFY of conserved water from projects to line the All American Canal (AAC) and the Coachella Canal (CC). These projects are now complete and the SDCWA is receiving this water. As with the IID transfer water, the water is physically delivered to San Diego via MWD's CRA.

- **Desalination Action Plan:** To further help diversify regional supplies, the SDCWA's Board has adopted a Seawater Desalination Action Plan. This plan includes continued efforts to support the development of a seawater desalination facility at the Encina Power Station in the City of Carlsbad. It also commits the SDCWA to evaluate additional SDCWA led seawater desalination projects at other locations in the County, including a possible project at Camp Pendleton sized between 50 and 150 MGD.

- **Water Transfer and Banking Programs:** In addition to the above, the SDCWA has entered into water transfer and water banking arrangements with Central Valley area agricultural agencies and groundwater storage ventures. These projects are designed to make additional water available to the SDCWA during dry-year supply shortages from MWD.

The SDCWA's supply planning is most recently documented in its 2010 UWMP issued in June 2011. Table 3-2 summarizes the SDCWA's verifiable water supplies for future years, as documented in its 2010 UWMP.

SDCWA's goal of providing supply reliability to its member agencies has been challenged by the current drought conditions and pumping restrictions on the State Water Project in Northern California. In response to these challenges, the SDCWA is continuing to pursue efforts and programs to obtain new water supplies via water transfers and other means, and to provide financial support to retail agencies for the development of conservation programs and local water supplies, such as recycled water and brackish groundwater demineralization projects. This strategy recognizes that regional water supply reliability is dependent in part on the collective efforts of the SDCWA's member agencies to identify and implement beneficial local supply projects in their services areas where feasible.

Table 3-2 Projected Verifiable Water Supplies for SDCWA Service Area – Normal Year Conditions (in AFY)

	2015	2020	2025	2030	2035
SDCWA Supplies					
IID Water Transfer	100,000	190,000	200,000	200,000	200,000
ACC and CC Lining Projects	80,200	80,200	80,200	80,200	80,200
Proposed Regional Seawater Desalination	0	56,000	56,000	56,000	56,000
Subtotal	**180,200**	**326,200**	**336,200**	**336,200**	**336,200**
Member Agency Supplies					
Surface Water	48,206	47,940	47,878	47,542	47,289
Water Recycling	38,660	43,728	46,603	48,278	49,998
Groundwater	11,710	11,100	12,100	12,840	12,840
Groundwater Recovery	10,320	15,520	15,520	15,520	15,520
Subtotal	**108,896**	**118,288**	**122,101**	**124,180**	**125,647**
Metropolitan Water District Supplies	**358,189**	**230,601**	**259,694**	**293,239**	**323,838**
Total Projected Supplies	**647,285**	**675,089**	**717,995**	**753,619**	**785,685**
Total Demands w/ SBx 7-7 Conservation	**647,285**	**675,089**	**717,995**	**753,619**	**785,685**

Source: SDCWA, 2010 Urban Water Management Plan (June 2011)

Recognizing the potential for a large earthquake or other emergency condition to cause a sustained outage of the pipelines, the SDCWA in the early 1990s began planning for its Emergency Storage Project (ESP) to safeguard against this risk. The major objective of the ESP is to develop an adequate emergency storage and delivery system to provide 75 percent of two-month peak water demand for all water users in the SDCWA's service area. This is referred to as the "two-month" emergency event, and has formed the basis for identification and design of ESP facilities. These facilities include the now completed Olivenhain Reservoir and pipeline, and the in-construction Lake Hodges Connection, San Vicente – Miramar Pipeline, and the San Vicente Dam enlargement project, all scheduled for completion by 2012. During a two-month emergency event, the ESP facilities will deliver water stored in Olivenhain, Hodges, and San Vicente Reservoirs to the SDCWA aqueduct system for delivery to member agency connections throughout the SDCWA service area.

3.4 Local Water Rights

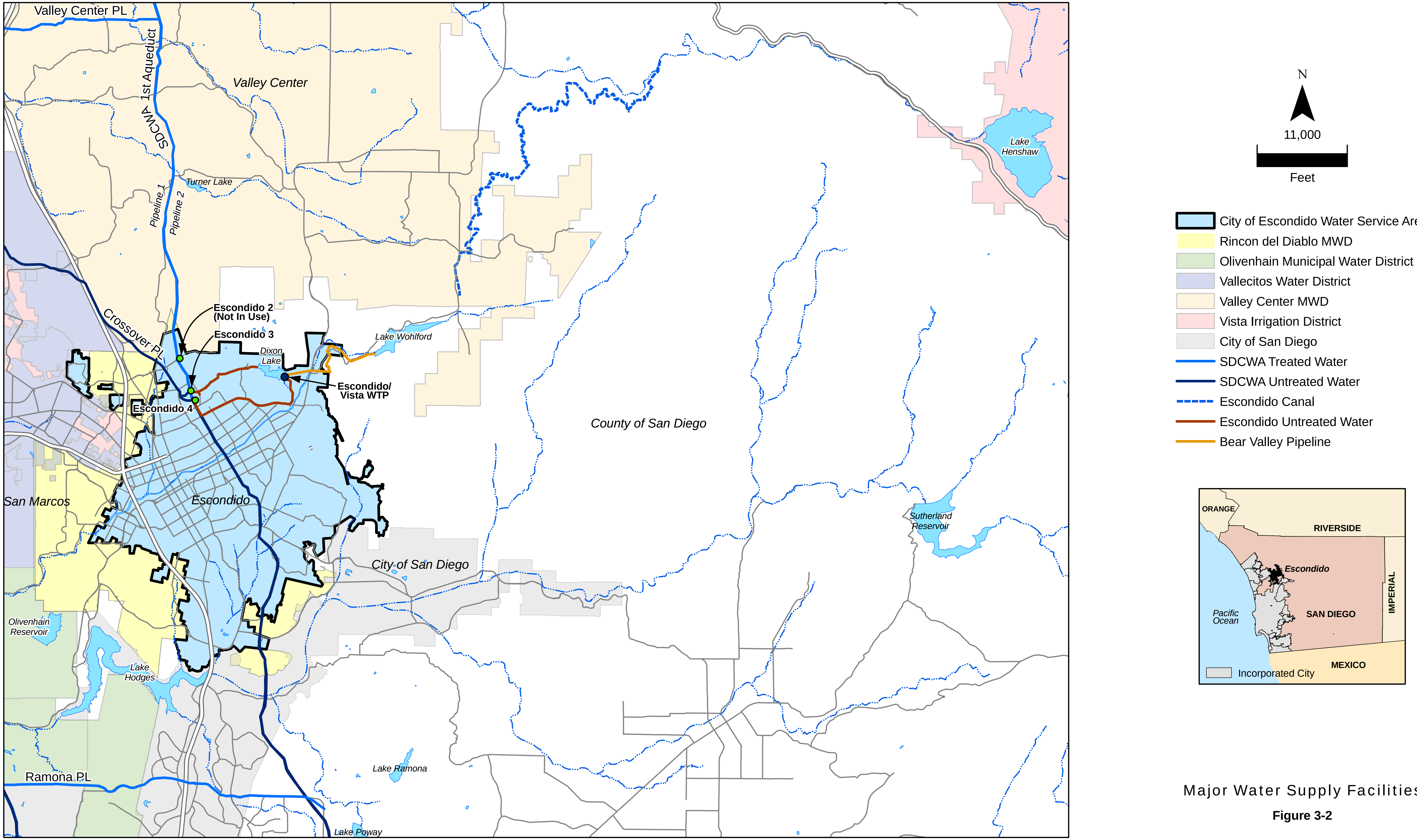
Four hydrologic subsystems comprise the local water supply: (1) the watersheds above Lake Henshaw dam, (2) the San Luis Rey River between the Lake Henshaw Dam and the intake to the Escondido Canal, (3) the Escondido Canal, and (4) Lake Wohlford. Each is located on Figure 3-2 and shown on an accompanying schematic drawing, which is Figure 3-3. Local water is defined as water that originates up the system from Lake Wohlford Dam. The City has an original right to some of this water and some is purchased from the VID. Runoff from Lake Dixon has been considered negligible over the long term.

Several agreements between the various water users have been entered into from 1894 to the present. Current water rights were previously held by entities no longer in existence; water rights now held by the City have previously been held by the Escondido Irrigation District (EID) and Escondido Mutual Water Company (EMWC); water rights now held by VID include those previously held by William Henshaw (Henshaw) and the San Diego County Water Company (SDCWC). Several Indian bands (Indians) have held rights for which the Secretary of Interior (USDI) has acted on their behalf in litigation. A history of agreements was detailed in the 2000 Master Plan and is provided in Appendix B for reference. An update on the Indian Settlement Agreement is provided in the paragraphs below.

Indian Settlement Agreement

There are nine (9) parties that are signatory to the San Luis Rey Indian Water Rights Settlement Agreement (Settlement Agreement). These parties are the United States (acting through the Secretary of the Interior (Secretary) and the Attorney General of the United States (Attorney General); the La Jolla, Rincon, San Pasqual, Pauma, and Pala Bands of Mission Indians (the Bands); the San Luis Rey River Indian SDCWA (Indian SDCWA), a permanent intertribal entity established by Congress and comprised of representatives of each of the Bands; the Vista Irrigation District (VID); and the City of Escondido (Escondido). These nine parties are referred to throughout this document as the Parties. VID and Escondido are collectively referred to as the Local Entities. The eight parties exclusive of the United States are referred to as Settlement Parties.

The purpose of the Settlement Agreement is to resolve all of the claims, controversies and issues among the Parties to the pending proceedings before the United States District Court in San Diego and the FERC. The matters at issue in these proceedings pertain chiefly to the rights of the Parties to certain waters of the San Luis Rey River watershed and rights-of-way for the operation and maintenance of water conveyance facilities and appurtenances. In resolving these matters, the Settlement Agreement relies materially upon the assets furnished by the Federal Government pursuant to the San Luis Rey Indian Water Rights Settlement Act (Settlement Act) (Pub. L. No 100-675, November 17, 1988, as amended). These assets include the provision of 16,000 AFY of water conserved from the lining of the All American Canal and Coachella Branch of the All American Canal (Supplemental Water) for the use of the Bands on their reservations or the Local Entities in their service areas. The paradigm of the Settlement Agreement is that the Bands and the Local Entities are each entitled to enjoy the benefits of both the Supplemental Water and the waters of the San Luis Rey River watershed developed by the Local Entities (Local Water). The operative provisions of the Settlement Agreement establish the rights and responsibilities of each Indian Band and Local Entity by which they may access both Supplemental and Local Water. These provisions address administrative matters as well as existing and potential future infrastructure necessary for water deliveries.



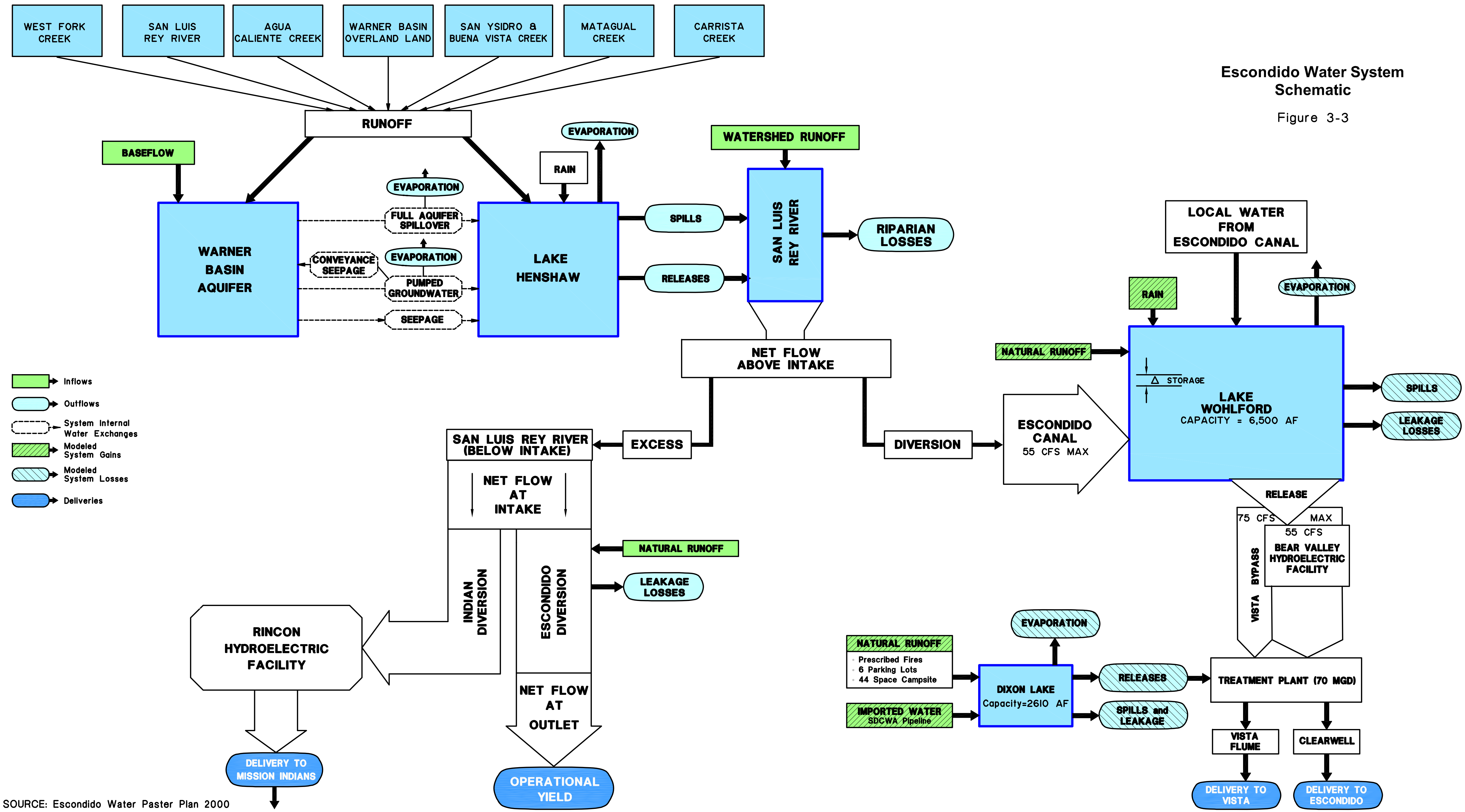
Major Water Supply Facilities

Figure 3-2

6-04-2012 KC SD Z:\Projects\IS\Escondido\WaterMP_2011\mxd\19357_MajFac_Interties_Fig3-2.mxd

Escondido Water System Schematic

Figure 3-3



SOURCE: Escondido Water Paster Plan 2000

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19357-Supply Schematic Unify.dwg June 4, 2012

Historic Operation of Water System

The water historically developed and used by the Settlement Parties consists of a combination of imported water delivered by the SDCWA and various local water supplies.

The water supply of the La Jolla, Pauma and Pala Bands for their domestic, commercial and agricultural needs has historically been derived primarily from the springs, surface water, and groundwater supplies that occur naturally on their reservations. The water supply of the Rincon Band has also been largely derived from the springs, surface water, and groundwater supplies that occur naturally on that reservation. A portion of the Local Water developed by the Local Entities has also historically been delivered to the Rincon Band by releases from the Escondido Canal. This Local Water delivery has historically been used by the Rincon Band to augment the recharge of their local groundwater supply. In addition, the Rincon Band also has an emergency connection to imported water supplies via the Yuima Municipal Water District. The water supply of the San Pasqual Reservation has also been partially derived from the springs, surface water, and groundwater supplies that occur naturally on that reservation, as well as imported water delivered through arrangements with the Valley Center Municipal Water District.

The Local Entities are member agencies of the SDCWA and receive a blend of Local Water that they develop from the San Luis Rey River watershed and imported water from the SDCWA.

History of Water Rights

In the early 1890s, the United States began setting aside certain land as reservations for the five Bands in or near the San Luis Rey River watershed. Around the same time that these Indian Reservations were being established, Escondido and its predecessors, relying upon a series of water appropriations, permits, and contracts, began diverting San Luis Rey River water for use in the Escondido community. In 1922, relying upon different water appropriations, permits and contracts, VID and its predecessors began storing flood waters in Henshaw Dam (located upstream of the Indian reservations) for subsequent release into the San Luis Rey River, from which the water was diverted for use in the Escondido and Vista communities. In 1924, the Federal Power Commission, predecessor to FERC, issued Escondido's predecessor a license for "Project 176," which authorized Escondido to use various federal lands for facilities through which San Luis Rey River flows could be diverted across portions of the La Jolla, Rincon and San Pasqual Indian reservations, to two small hydroelectric power plants, including one located on the Rincon reservation.

In 1908, the U.S. Supreme Court case *Winters v. United States* (Winters Doctrine) established that an Indian reservation may reserve water for future use in an amount necessary to fulfill the purpose of the reservation. In the 1976 *Capert v. United Stated of America* case, the U.S. Supreme Court ruled that this water right was limited to the primary purpose of the reservation and only to the minimum amount of water necessary to fulfill the purpose of the reservation. Quantifying the minimal need involves integration of several models including ecological models and surface and groundwater flow models. The variety of models available and interpretation of their results can lead to controversy in quantifying federal water rights. The Parties maintain that through the Winters Doctrine, and the Local Entities' appropriations, permits and contracts, the rights to certain waters of the San Luis Rey River watershed had been granted twice, once to the Bands and again to the Local Entities.

History of Water Litigation

In 1969-1972, the five Bands, and the United States on their behalf, sued the two Local Entities, claiming that the Local Entities' diversion of San Luis Rey River flows deprived the Indian Bands of adequate water on their reservations located downstream of the Diversion Dam. The Bands claimed that the state and federal appropriations, permits, contracts and licenses which made those diversions possible were either invalid or had been breached. At the same time, the La Jolla and Rincon Bands, and the Secretary of the Interior on their behalf, opposed the Escondido's continued operation of Project 176 under its FERC license.

After extensive hearings, FERC issued a new license for Project 176 to Escondido and VID. The Ninth Circuit reversed FERC's reissuance of the license, but the United States Supreme Court partially reversed the Ninth Circuit decision, and the matter returned to FERC for additional proceedings (*Escondido Mut. Water Co. v. La Jolla Band of Mission Indians; Escondido Mut. Water Co. v. Fed. Energy Regulatory Commission*). Following the Supreme Court's decision, the Settlement Parties and the United States entered into settlement negotiations to resolve the then fifteen-year long litigation. Their negotiations culminated in Congressional enactment of Public Law No. 100-675, the San Luis Rey Water Rights Settlement Act (Settlement Act), in 1988.

Title I of the Settlement Act recognized the inadequacy of the San Luis Rey River to supply the needs of the Indian Bands, Escondido and VID. To solve this problem, the Settlement Act directed the Secretary of the Interior to provide 16,000 AF of water annually from a source other than the San Luis Rey River (Supplemental Water) for the benefit of the Indian Bands, Escondido and VID, and created the Indian SDCWA to administer the Bands' share of the Local and Supplemental Water. The Settlement Act also appropriated $30 million to pay the Indian SDCWA for its administrative and operational expenses, to fulfill its obligations under the Settlement Agreement and to foster the economic development of the Bands' reservation lands, and their members.

Although the Settlement Act directed the Secretary of the Interior to provide 16,000 AF of Supplemental Water annually to the San Luis Rey Settlement Parties, the source of such water was not officially determined until 2000 when Congress enacted Public Law 106-377, the "Packard Amendment," which mandated that the Supplemental Water come from water conserved by the AAC and the Coachella Branch lining projects which had originally been authorized by Title II of the Settlement Act

The AAC lining project consisted of lining a 23-mile section of the canal in Imperial County by constructing a concrete-lined canal parallel to the existing AAC. Lining the canal conserved approximately 67,700 AF of water per year. Construction of this project began in June 2007 and was completed in 2010 (Kiewit 2010). The Coachella Branch lining project resulted in the lining of 33.4 miles of the Coachella Canal east of the Salton Sea and was completed in December 2006 (SDCWA 2010). It is estimated that 26,000 AF of water are conserved annually as a result of this project. The conserved water was to be delivered by the IID and MWD to meet the growing needs of California consumers, as well as to settle water rights claims brought by several Native American groups, including the Bands' dispute with the Local Entities. The lining projects were principally funded by a $200 million special appropriation of the California Legislature, with additional financing from SDCWA and MWD to ensure water delivery to their facilities, and ultimately the Bands and the Local Entities.

In October 2003, the United States and the Settlement Parties, along with IID, Coachella Valley Water District (CVWD), MWD, and SDCWA, entered into an Allocation Agreement to detail how the water conserved by the canal lining projects would be allocated. In accord with the Settlement Act, the Allocation Agreement provides that 17 percent of the water conserved by the lining project (up to a maximum of 16,000 AF annually) would be furnished for the benefit of the Settlement Parties upon a final settlement of their water rights dispute. A Water Exchange Agreement with MWD and a Water Conveyance Agreement with SDCWA allows for the use of MWD and SDCWA facilities to deliver the conserved water to the Settlement Parties.

As the canal lining projects were completed, the Settlement Parties moved forward with drafting a comprehensive Settlement Agreement that would resolve their longstanding water rights dispute and determine the distribution of the Local and Supplemental Water. On September 30, 2008, the negotiators for the Settlement Parties submitted a proposed Settlement Agreement to FERC, the components of which are described below.

Summary of Agreement

In accordance with the Settlement Act, under the Settlement Agreement the Local Entities will continue to receive, either directly or by exchange, about the same amount of water that they have historically received from the Local Water System at about the same cost. They will continue to operate and maintain their Local Water System. However, the San Luis Rey River water developed by the Local Entities (Local Water) will also be available for use on the five reservations. The Bands will be responsible for the costs of the procurement and delivery of the Supplemental Water, which they will be entitled to use on their reservations, exchange for Local Water developed by the Local Entities, or sell any surplus to Escondido and VID. There are no restrictions placed on the Bands regarding the quantity of water they may use from water that originates on their existing reservations and does not originate from the Canal, such as groundwater or local streams.

Under the Settlement Agreement, the Local Water is initially allocated to the Local Entities, with exception of the Rincon Water Entitlement, which is the historical diversion of water to the Rincon Band, as described above. The Settlement Agreement includes an entitlement of Local Water specifically for the Rincon Reservation. Under the Settlement Agreement, the Rincon Reservation is entitled to receive a quantity of Local Water, using a formula which has historically averaged 2,900 AF per year.

Local Water, including the Rincon Entitlement, would be delivered to the Rincon Band through the Rincon Penstock or its replacement. As described in Section 1.3, the penstock is currently not operational. The existing penstock will be replaced under the terms of a separate agreement between Escondido and the Rincon Band. The Settlement Agreement defines procedures for unscheduled delivery of Rincon water; however, these procedures do not differ from existing operations and would not result in any new physical environmental impacts. The instances that would require unscheduled delivery of water to the Rincon reservation include: 1) special releases from Henshaw Dam and the Canal; 2) runoff exceeding the capacity of the Escondido Canal, and 3) runoff below Henshaw Dam not being divertible.

The 16,000 AF of Supplemental Water would be initially allocated to the Bands. The Supplemental Water may be used directly by the Bands or exchanged with the Local Entities for Local Water. The Local Entities would be obligated to exchange Local Water for Supplemental Water on an acre-foot per acre-foot basis. Over time, the Local Entities would be expected to use less Local Water as the Bands use more and provide Supplemental Water to the Local

Entities in exchange. Any Supplemental Water that is not used or exchanged for Local Water annually by the Bands would be conveyed to the Local Entities as Surplus Supplemental Water. The Local Entities will be obliged to reimburse the Bands for the delivery of any Surplus Supplemental Water at the same rate that they would otherwise pay the SDCWA for the same quantity of imported water.

The priorities for the use of Local Water would be to prevent structural damage to the Canal, preserve the recreational uses and water quality needs of Lake Wohlford, and satisfy the Rincon Water Entitlement, and are still being negotiated. Presumably, during a dry year, all available Local Water would be split evenly between the Local Entities and the Bands to satisfy these priorities. The Local Entities are required to use their share of this Local Water entitlement to meet the priorities to protect the Canal and Lake Wohlford before they may use the water for other purposes. The Local Entities have the right to use the Bands' dry year allocation if needed to meet these priorities, including the Rincon Water Entitlement, provided that the water is not required to meet the existing and immediate water needs of the Bands.

The Settlement Agreement also details water rights to maintain existing and provide for future uses at Lake Henshaw. The Settlement Agreement commits the Local Entities to use their best efforts to utilize their share of Local Water to provide for a carryover storage pool of no less than 2,500 AF in Lake Henshaw. If such efforts are inadequate, VID may call for all Settlement Parties to confer to secure an opportunity to maintain the carryover storage pool. The pool is desirable to maintain recreational, environmental, and water quality objectives in Lake Henshaw. In the event that VID needs additional water for use on the Warner Ranch (the 43,000 acres of land owned by VID surrounding Lake Henshaw), either to maintain storage in Lake Henshaw or for future economically significant purposes, the additional water that would be supplied to VID would be based on a tiered system. First, VID would have the right to use up to 1,250 AF of its share of Local Water for this use, provided that this use of water would not affect the Rincon Water Entitlement. This water is referred to as Tier 1 water. If VID needs more water for use on the Warner Ranch than is available through its Tier 1 water entitlement, VID may also use Local Water obtained by exchange with the Bands or Escondido, provided that the use of water would not result in a detrimental effect to the Bands, the Escondido, or dry year entitlements. This water is referred to as Tier 2 water. VID is obligated to maximize the amount of water available from the Escondido before exercising its right to use the Bands' water as Tier 2 water.

VID would also continue to the have the right to use water on the Warner Ranch from Lake Henshaw in the same quantity and for the same uses historically enjoyed, including recreational use, domestic use, and use to fight wildfires.

In order to delay the need to use local exchange water on Warner Ranch, the Bands are obligated under the Settlement Agreement to pay for facilities designed and constructed in consultation with the Local Entities and Valley Center Municipal Water District to deliver water from the Valley Center Municipal Water District to Lake Wohlford, reducing the amount of water that would be required to be released from Lake Henshaw.

As previously described, the Local Entities are currently applying to FERC for an Administrative Surrender of License and FERC Conduit Exemption License for various FERC Project 176 facilities. Historically, under the Escondido Project 176 license and also under the proposed FERC Conduit Exemption License, the Bear Valley Powerhouse operates such that the Local Water simply passes through the power generating facilities into an existing water supply conduit system, generating power with water as it is passes through the facility. No new construction is needed or proposed as part of the FERC applications.

The Settlement Agreement determines which entities have the rights to both the Local and Supplemental water, but does not specify exactly how the water is to be delivered. It is anticipated that full implementation of the Settlement Agreement would require several new improvements to distribute the water. These projects have the potential to result in a physical environmental effect and are discussed in greater detail below:

- Construction of a Northern Route Pipeline to provide the Supplemental Water to the Pala, Pauma/Yuima, Rincon and San Pasqual Indian Reservations;
- Undergrounding a section of the Escondido Canal located within portions of the San Pasqual Indian Reservation and across certain private land;
- Possible construction of facilities to deliver imported water from the infrastructure of Valley Center Municipal Water District to Lake Wohlford;
- Construction of a new pipeline to replace the existing Rincon Penstock (currently not in service) in the same location; and
- Construction of other pipelines and infrastructure as required.

The Northern Route Pipeline (NRP) project is not part of the proposed action. The NRP project and the EIR/EA prepared for the project were approved and certified by Yuima Municipal Water District in October 2008 but the pipeline has not yet been constructed. The BIA subsequently issued a Finding of No Significant Impact (FONSI) for the project in January 2009. The project is the construction of an 11.7-mile potable water transmission pipeline and would include related support facilities. The pipeline would deliver Supplemental Water to four Indian Reservations. Specifically, the NRP would serve the Pala reservation and Pauma and Yuima reservation by crossing the proposed alignment directly across reservation lands. The proposed action would also serve the Rincon Reservation by transporting or delivering water from the proposed NRP alignment through existing infrastructure. The NRP project would serve the San Pasqual Reservation by transporting water from the proposed pipeline alignment though existing Yuima and Valley Center Municipal Water Districts facilities.

The remaining projects that are required to implement the Settlement Agreement are described below.

Escondido Canal Undergrounding

This proposed action under the Settlement Agreement would remove, relocate, and replace about two and a half miles of the Escondido Canal that crosses the San Pasqual Indian Reservation. Appurtenant structures, facilities, and rights-of-way would also be removed and/or relocated. The preferred alignment would be approximately 8,200 linear feet, 56-inches in diameter, and have a design flow of 55 cfs. The preferred alignment would travel down an existing roadway north of N. Canal Road, then cross Canal Road and travel directly south. The alignment would continue west to the north of a chicken ranch, and then south within N. Lake Wohlford Road. The connection to the existing Escondido Canal would be south of Paradise Mountain Road. No pumping would be required to convey flows through the proposed underground pipeline. The portion of the existing Escondido Canal that would be replaced by the underground pipeline would be removed as part of the proposed action. Demolition and debris removal would be required. Following removal of this portion of the Escondido Canal, the disturbed land would be reclaimed through grading and reestablishment of drainage. This project component is anticipated to take no more than six years to complete, including both construction of the underground pipeline and the removal of a portion of the existing canal.

Rincon Penstock Replacement

Due to corrosion and structural deterioration of the existing non-operational Rincon penstock, the existing penstock would be replaced in order to the deliver the Rincon Entitlement to the Rincon reservation. The existing Rincon penstock is 2,130 foot (approximately 0.4 mile) long pipeline would be replaced with a 20-inch diameter pipeline. The old penstock would be removed and the new penstock pipeline would be installed in the same alignment and existing 50-foot right-of-way. The penstock would be located below-grade and constructed of welded-steel pipe with a maximum capacity of 12 cfs. The project also includes the replacement of an intake structure, a new “Y”-shaped stub and blind flange at the lower portion of the penstock, and use of solar power for the Canal control gates instead of a below-grade conduit. The existing intake structure would be replaced with a new intake structure that can accommodate 12 cfs of water; however, only 6 cfs of water would continue to be diverted from the Escondido Canal. The new intake would include an isolation valve and an enlarged air vent, which are required for surge control.

The new penstock will run parallel to the existing hydroelectric facility. It will terminate nine feet beyond the north end of the building with a blind flange. The flange would facilitate a potential future connection and use on the reservation. The stub in the penstock will be installed and capped for a potential future connection to a rebuilt hydroelectric facility, which will replace the recently abandoned Rincon hydroelectric facility. Two feet from the blind flange connection would be a pressure reducing valve and parshall flume. This connection will allow by-passing of the hydroelectric facility and preserve the ability to release 6 cfs of water to Paradise Creek per the existing agreement with the Rincon Band.

Speculative Projects

As discussed above, if needed in order to delay the need for VID to use Tier 2 water on Warner Ranch, facilities to deliver water from the Valley Center Municipal Water District to Lake Wohlford may need to be constructed. These facilities could tie into the Escondido Canal to provide water to Lake Wohlford to avoid, to the extent possible, the use of the Bands’ share of Local Water to maintain the water level in Lake Wohlford that is required to protect its recreational uses and water quality. The need for, design and alignment of these facilities has not been determined.

Future projects required to implement the Settlement Agreement could also include direct connections to the Escondido Canal and other infrastructure to provide water for use by the Bands; however, the size, type, and location of facilities are speculative. It is also possible that some water would be used to recharge underground reservoirs that supply water to the reservations, but no such projects have been designed or proposed.

3.5 Water Supply Reliability

Table 3-3 summarizes the types of water shortage events that could affect Escondido, the assets currently available to address the shortage event and the consequences of each event with existing assets. This type of analysis provides an understanding of the risk associated with planned and unplanned events that affect the City’s water supply sources. Sections 7 and 8 address proposed improvements to increase water supply reliability both to the City's service area, and within the City's distribution system.

Table 3-3 Summary of Water Shortage Events and Consequences

Event	Frequency	Duration	Existing Response Assets	Consequence
1) Outage of Escondido Vista WTP, Clearwell or Transmission main from Clearwell	Low	Unknown	• One day of Emergency storage within City's distribution system • Limited supply from Rincon MWD	**Significant**
2) Drought (or other prolonged reduction in imported water supplies)	Unknown (Imported delivery reliability is dependent on State, MWD and SDCWA actions)	1 year and longer	• Escondido drought response ordinance and rate structure • State, MWD, and SDCWA response capabilities • Water Shortage Contingency Plan	**Moderate** (Cutbacks to customers at same level as SDCWA cutbacks to City)
3) Emergency Event (Earthquake-induced or other failure of the San Diego Aqueduct pipelines)	Rare (on the order of one event per 100 years)	2 months (per SDCWA Emergency Storage Project design criteria, based on aqueduct repair time estimates)	• Escondido Local Water from Lake Henshaw • Escondido interties w/ Rincon, VWD, and Valley Center • Water Shortage Contingency Plan	**Moderate to Significant** (No SDCWA deliveries for 5-7 days; thereafter deliveries at minimum 75% level of service)
4) Raw Water Shutdown of First Aqueduct (planned event)	Low – Assume one per five years	10 days (Dec. – Mar. window)	• Escondido Local Water from Lake Henshaw • Escondido interties w/ Rincon, VWD, and Valley Center • Water Shortage Contingency Plan	**Minor to Moderate** (Possible drawdown of Escondido Local Water below preferred levels)

The greatest risk to the City is the loss of the Escondido-Vista WTP or the Clearwell Transmission main curtailing treated water supply to the City. Increasing the reliability and ability to provide a secondary service is a high priority for the City given its large service area of 100,000 people.

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Section 4
Design Criteria

Design of potable water facilities in Escondido is based upon design criteria established by the City. Design criteria include standards for fire flows, pipelines, storage reservoirs, and pumping facilities. These criteria are the basis for evaluating water system performance and improvement needs, and for determining what facilities are required to serve future development. The existing design criteria established in the 2000 Master Plan for the planning and evaluation of water facilities are summarized below. A comparison of the criteria with other agencies is presented and proposed changes to the criteria developed with input from City Staff during the course of this master plan are presented at the end of this section.

4.1 Existing Design Criteria

The existing potable water design criteria applicable to the planning and evaluation of water facilities were established in the 2000 Master Plan. The criteria for system pressures, pipeline pump station and storage design, and fire flows are discussed in detail in the following sections.

System Pressures

The range of water pressures experienced at any location is a function of the hydraulic grade and the service elevation. Within a specific pressure zone the hydraulic grade is affected by the reservoir water level and pressure reducing valve setting or pump station discharge head, and the head loss in the distribution system. The maximum desired pressure is 110 psi and the absolute maximum pressure should be no greater than 150 psi. The criteria for minimum pressures are 40 psi under peak hour flow conditions and 20 psi at a fire flow location during a fire occurring under maximum day flow conditions.

Under certain circumstances the City will approve the installation of private pumps for areas which receive less than the minimum 40 psi operating pressure. The minimum pressure in the distribution system for these areas must be 20 psi based on Health Department guidelines and the ability to provide adequate pressures for fire flows. It is also noted that are several areas of the distribution system with static pressures exceeding 150 psi. In a few cases, on-site water systems for new developments have been designed to accommodate these high pressures.

Pipelines

Criteria for pipeline sizing are based on keeping velocities low to minimize wear on valves and scouring of interior coatings, and limit head loss in the distribution system. Water distribution mains are to supply peak flows at velocities below 7 feet per second and head loss within pipelines should not exceed 10 feet per 1000 feet. These criteria may be exceeded during fire flow situations or in areas where there is a large safety factor in meeting pressure criteria. Generally transmission mains are designed based on peak flows and reservoir filling conditions, while distribution piping is sized for fire flows.

Looping is highly desirable in a distribution system and long, dead-ended pipelines should be avoided where possible due to reliability and water quality concerns. Although there are no specific requirements for minimum pipe size, pipelines supplying a fire hydrant must be a minimum of 6-inches in diameter to provide the minimum required fire flow rate. New pipelines serving a hydrant should be a minimum of 8-inches in diameter.

Hydraulic water system models use the Hazen-Williams equation to determine head loss in a pipeline for a given flow rate. The Hazen-Williams coefficient, or “C factor,” in the equation is a function of the diameter, material and age of the conduit. For the design of new pipelines the recommended Hazen-Williams C factors are as follows: C=140 for pipelines larger than 24-inches in diameter, C=130 for pipelines from 14-inches to 20-inches in diameter, and C=120 for pipelines 12-inches in diameter and smaller. These values take into account minor losses at fittings and valves and are considered somewhat conservative. C factors for existing pipelines may be modified in the hydraulic model based on results from previous analyses and hydrant flow tests.

Water Storage

Within the Escondido water system, storage of potable water is provided by tanks or covered reservoirs that serve specific pressure zones by gravity. Water storage is used to supply peak hourly demand fluctuations (operational storage), provide fire flows, and supply the service area in the event of a planned facility shutdown or emergency situation. Providing operational storage allows pumping facilities and/or associated transmission mains for each pressure zone to be sized for maximum day rather than peak hour flows. Storage reservoirs should be provided separately in each service area or zone when possible, or if necessary, in a higher pressure zone.

The 2000 Master Plan re-evaluated the previous storage criteria and recommended changes based on a review of system peaking data, water quality concerns, and risk assessment. The operational component of storage is based on providing 15 percent of the maximum day demand within each pressure zone. In addition to operational storage, fire storage should be provided based on two hours of flow at the highest fire flow rate in the zone and emergency storage capacity should be equal to one day of average day use. To reduce capital expenditures for reservoirs and minimize potential water quality problems it was decided to combine the fire flow and emergency storage components. Reservoir sizing criteria was therefore based on the sum of: 1) operational storage and 2) fire flow or emergency storage, whichever is greater.

While the operational and fire flow storage components need to be located within each pressure zone, emergency storage can be located in a higher pressure zone, provided that the stored water can be delivered by gravity.

Pump Stations

Pump stations boost the water pressure so that service may be provided to users at a higher elevation. Pump stations may supply water to an “open system” or to a “closed system.” An open system is a service area with its own storage reservoir. A closed system is an area without a storage reservoir. Pump stations supplying a closed system must regulate pressures utilizing multiple pumps, variable speed drives, and/or a hydropneumatic tank.

Design criteria for pump stations supplying an open system require the pumps to provide capacity equal to the maximum day demands plus an amount adequate to replenish fire storage in a reasonable period, usually 3 days. This replenishment is called recharge.

Design criteria for pump stations supplying water to a closed system require the pumps to provide capacity for either peak hour demands or maximum day demands plus fire flows, whichever is greater.

For both open and closed systems, a standby pump equal to the size of the largest pump within the facility is also required. Closed system pump stations should have an on-site generator to provided backup power, while an open system pump station should have either an on-site generator or a socket which will allow connection to a portable generator.

Fire Flows

Water must be available not only for domestic and agricultural use, but also for emergency fire fighting situations. This type of water use is called a fire flow, and the fire flow must be sustainable for a specific duration at a minimum pressure of 20 pounds per square inch (psi). General standards establishing the amount of water for fire protection purposes are set by the Insurance Services Office (ISO), and these general standards are applied by local jurisdictions such as the City of Escondido and its Fire Department. The standards are specific to a given particular building and based on a number of considerations such as type of occupancy, type of construction and construction materials, distance from other structures, and other factors.

The Escondido Fire Department requires a minimum fire flow of 1,500 gpm and the City of Escondido has established a local policy for fire flows that limits fire flow requirements to 2,500 gpm. Buildings with a greater fire flow requirement, as determine by the ISO and the City of Escondido's building permit, must incorporate mitigating features such as fire sprinklers and low-combustible landscaping and building materials, to lower their requirement to 2,500 gpm.

To perform a fire flow analysis at the master planning level, the required fire flows are assigned to the hydraulic model based on general categories. Table 4-1 lists the design values for fire flows which have been established with the Escondido Fire Department for water planning purposes based on the general plan land use. It is noted that when evaluating the ability of a water system to provide fire flows, the required flow rate must be provided from the pipeline fronting a property. The required fire flow is not the flow available from an individual fire hydrant, since a 2,500 gpm fire flow may be supplied from two or more fire hydrants, one or more of which may be supplied from on-site pipelines or fire lines.

Table 4-1 Updated Fire Flow Design Criteria

Land Use/ Density	General Plan Land Use Category	Required Fire Flow	Minimum Duration
Low Residential	Rural, Estate & Suburban	1,500 gpm	2 hours
Medium Residential(1)	Urban I & II	2,000 gpm	2 hours
High Residential(1)	Urban III, IV & V	2,500 gpm	2 hours
Residential in high or very high fire hazard areas(1)	All Residential categories	2,500 gpm	2 hours
Agriculture	Rural	1,500 gpm	2 hours
Commercial(1)	Commercial & Office	2,500 gpm	2 hours
Industrial(1)	Industrial	2,500 gpm	2 hours
Parks & Recreation Facilities(1)	Public Lands/Parks	2,500 gpm	2 hours

(1) Automated fire sprinklers required for new construction

4.2 Design Criteria Updates

For this master plan update, design criteria for several other agencies in the San Diego area were reviewed and evaluated for comparison with Escondido. A summary of the criteria for other agencies is provided in Appendix C. Based on this comparison and a review of the existing design criteria, the following design criteria updates are presented below.

Fire Hazard Severity Zones

The California Department of Forestry and Fire Protection (Cal Fire) has mapped areas of very high fire hazard within Local Responsibility Areas (LRA). Mapping of the areas is based on relevant factors such as fuels, terrain, and weather. In 2005, the California Building Commission adopted the Wildland-Urban Interface codes to determine appropriate construction materials for new buildings and compliance measure for property owners in the Wildland-Urban Interface. Fire severity codes are within the City of Escondido water service area are designated as moderate, high or very high, as shown on Figure 4-1.

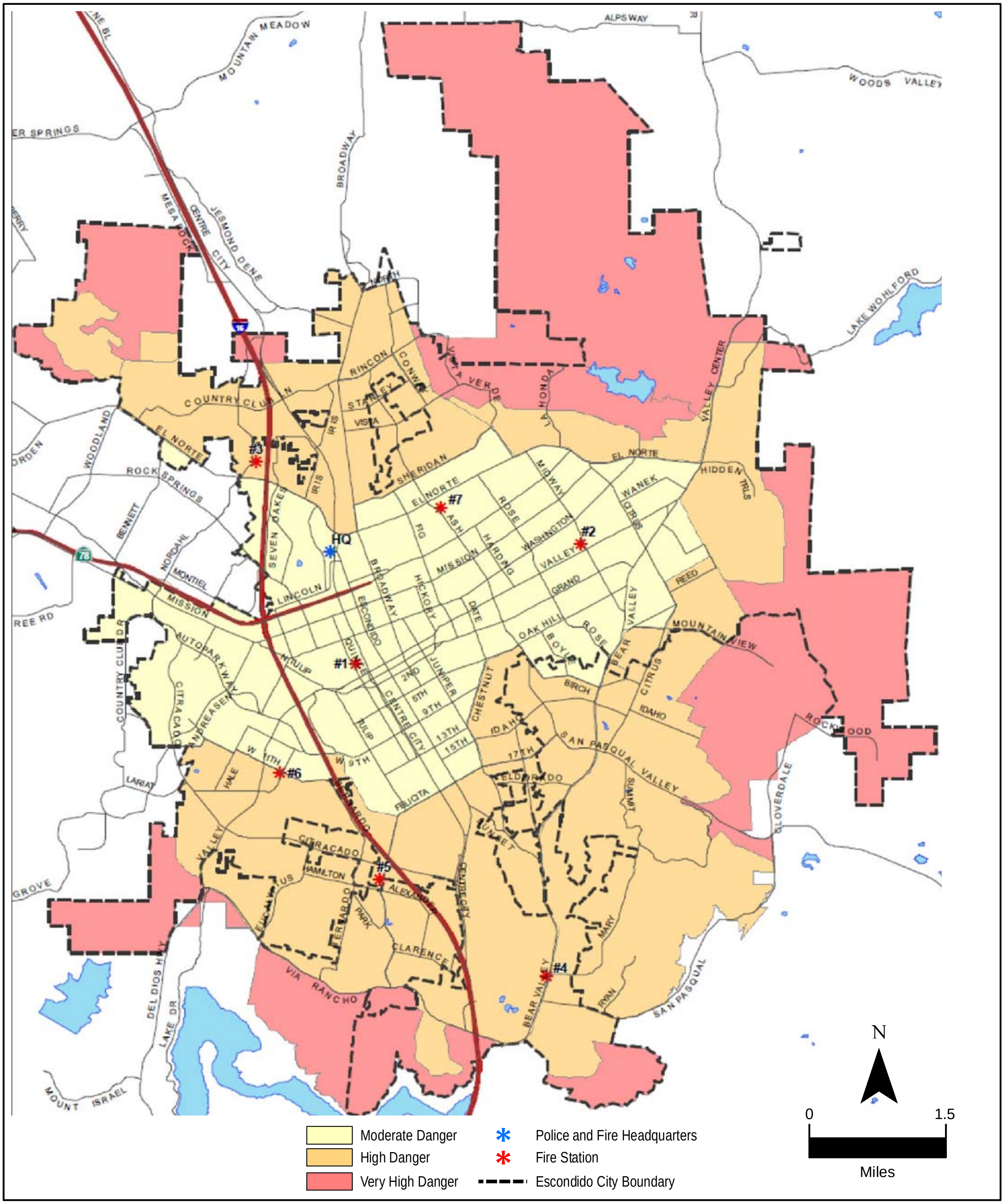
The City of Escondido recently adopted a new ordinance (Ordinance No 2011-03) which modifies the City of Escondido Municipal Code to reflect the 2010 California Fire Code and proposed local amendments that increase consistency with the San Diego County Fire Code. This ordinance requires automatic sprinkler systems for buildings and structures where the required fire flow exceeds 1,500 gpm. In addition, a minimum 2,500 gpm capacity is established for watermains for new subdivisions located in hazardous fire areas (high or very high fire hazard area). As a result, the fire flow for single family developments in hazardous areas is 1,000 gpm greater than the 2000 Master Plan criteria.

The City of Escondido's local policy is still based on the implementation of mitigating measures so that the required fire flow does not exceed 2,500 gpm. As an example, plans for the new Palomar Hospital have been approved with a 2,500 gpm fire flow requirement. Furthermore, the Escondido Fire Department does not anticipate any future construction requiring a fire flow higher than 2,500 gpm, even for mid-rise commercial and mixed-use buildings.

Hydraulic analyses will be performed with this master plan to identify areas within the hazardous fire area that cannot deliver the required 2,500 gpm fire flow. However, specific improvement projects will not be included in the CIP, since the ordinance applies to new subdivisions only.

Emergency Storage

Water quality regulations are becoming more stringent, and system operators are finding it more difficult to maintain the water quality in reservoirs, especially in those that do not have good turnover rates. Per the design criteria, operational and fire storage should be located within each pressure zone, but emergency storage can be located in a higher zone if the stored water can be delivered back down by gravity. In this master plan update, the emergency storage criteria was re-evaluated on a zone-by-zone basis to take into consideration any alternative ways to supply a zone in the event of a loss of water supply or failure of a key delivery facility. Specifically, in special circumstances the City may elect to reduce or eliminate the emergency storage component for a specific zone if there are multiple supply sources, delivery locations and a well-looped transmission system within the zone. This option was added to the storage criteria in this master plan update to address water quality concerns and the lack of suitable storage sites, and to allow for alternative improvements to bring in new sources of water in lieu of constructing additional storage.



SOURCE: City of Escondido, 2011

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Fire Severity Zones

Figure 4-1

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4.3 Revised Design Criteria Summary

The revised design criteria for this master plan update are summarized in Table 4-2.

Table 4-2 City of Escondido Potable Water Design Criteria

Category	Design/Evaluation Criteria
Pressure	110 psi -maximum desired pressure 150 psi - maximum allowable pressure 40 psi - minimum pressure at peak flow 20 psi - minimum pressure with maximum day demands plus fire flow 20 psi - minimum pressure at peak flow for private pumps
Pipelines	7 fps - maximum allowable velocity at peak flow 10 ft / 1000 ft - maximum allowable head loss at peak flow
Storage Reservoirs	Capacity equal to: • 15% of maximum day demand (for operations) plus • 1 average day (emergency use)[(1)] or 2 hours of maximum fire flow, whichever is greater • Separate inlet and outlet pipelines
Pump Stations	Open System (with storage): • Minimum capacity of maximum day demands plus fire flow recharge over 3 days Closed System (no storage): • Peak hour capacity or maximum day demands plus fire flow, whichever is greater • Standby power • Variable speed drives or hydropneumatic tank (for low flows)
Fire Flows[(2)]	Fire flows to be provided at a minimum of 20 psi for a 2 hour duration based on land use: 1,500 gpm - Low density residential in the moderate fire severity zone - agricultural areas 2,000 gpm - Medium density residential in the moderate fire severity zone 2,500 gpm - All development in the high and very high fire severity zones - high density residential - commercial, industrial and all other non-residential development

(1) Emergency storage can be reduced for specific zones if there are multiple supply sources and delivery locations.

(2) Fire flows for individual buildings shall be based on the ISO standards. Buildings with a greater fire flow requirement must incorporate mitigating features to lower their requirement to 2,500 gpm.

Section 5
Existing Distribution System

This section presents a physical and operational summary of Escondido's existing water distribution system. The first section provides an overview of the distribution system and detailed inventory of the major facilities. Water system operations are then summarized on a zone-by-zone basis. Several facilities that are currently in design or construction are considered part of the existing distribution system.

5.1 Major Facilities

Escondido currently operates its water distribution system with ten major pressure zones that include one or more storage facilities. There are also six smaller reduced pressure zones and one pumped zone that do not have in-zone storage. The Clearwell at the Escondido-Vista WTP supplies the Clearwell Zone, which is the backbone of the distribution system. The other nine major pressure zones are supplied from either pressure reducing stations (Reed, A-11/Lindley, A-3, Park Hill, and Royal Crest Zones) or pump stations (Vista Verde, Hogback, Dixon and East Grove Zones). Figure 5-1 provides a water system schematic of Escondido's distribution system and the pressure zones and major facilities are shown on Figure 5-2.

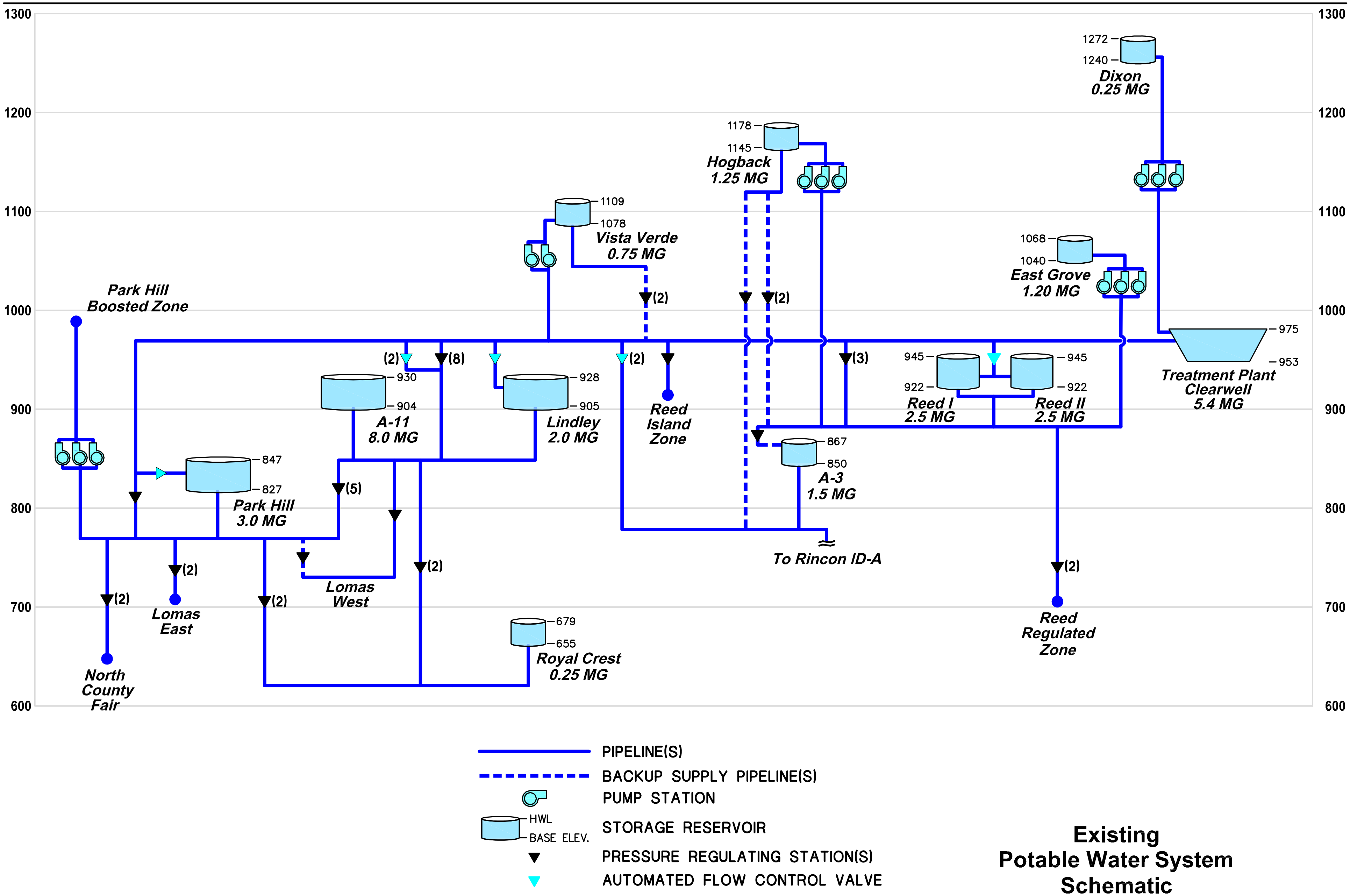
Reservoirs

Storage for the water distribution system is contained in the 5.4 million gallon (MG) Clearwell and eleven additional reservoirs ranging in size from 0.25 to 8.0 MG. Summary information on each of the reservoirs obtained from construction drawings and previous system documentation is provided in Table 5-1. Included in the summary table are the water level alarm settings, which establish the normal operating levels of each reservoir (between the low and high settings). The level settings, which may be changed seasonally, reflect the settings as of April 2011.

The 2.0 MG East Grove Reservoir and the two-2.5 MG Reed Reservoir tanks have been constructed since the last master plan. The new Reed tanks, which have identical dimensions, were constructed at the site of the original 2.75 MG Reed Reservoir and were first put into operation in February 2012. The SCADA water level settings in Table 5-1 therefore reflect the operational settings of the original Reed Reservoir. With the new storage facilities, the City of Escondido water distribution system has a total treated water storage capacity of 28.6 MG.

Pressure Reducing Stations

The majority of the distribution system is supplied either directly or indirectly from the Clearwell Zone via pressure reducing valves. Each of the five major reduced pressure zones is supplied from four to eleven separate pressure reducing stations (PRSs). In addition, each of the six smaller reduced pressure zones that do not have in-zone storage are supplied from one or two PRSs. The existing PRSs in the Escondido water system are summarized in Table 5-2 and organized according to the zone being supplied. Each PRS contains from one to three pressure reducing valves (PRVs), almost all of which are globe-type valves manufactured by the Clayton Valve Company (commonly referred to as "Clay Valves"). The individual valves have either manual or automated controls.



Existing Potable Water System Schematic

Figure 5-1

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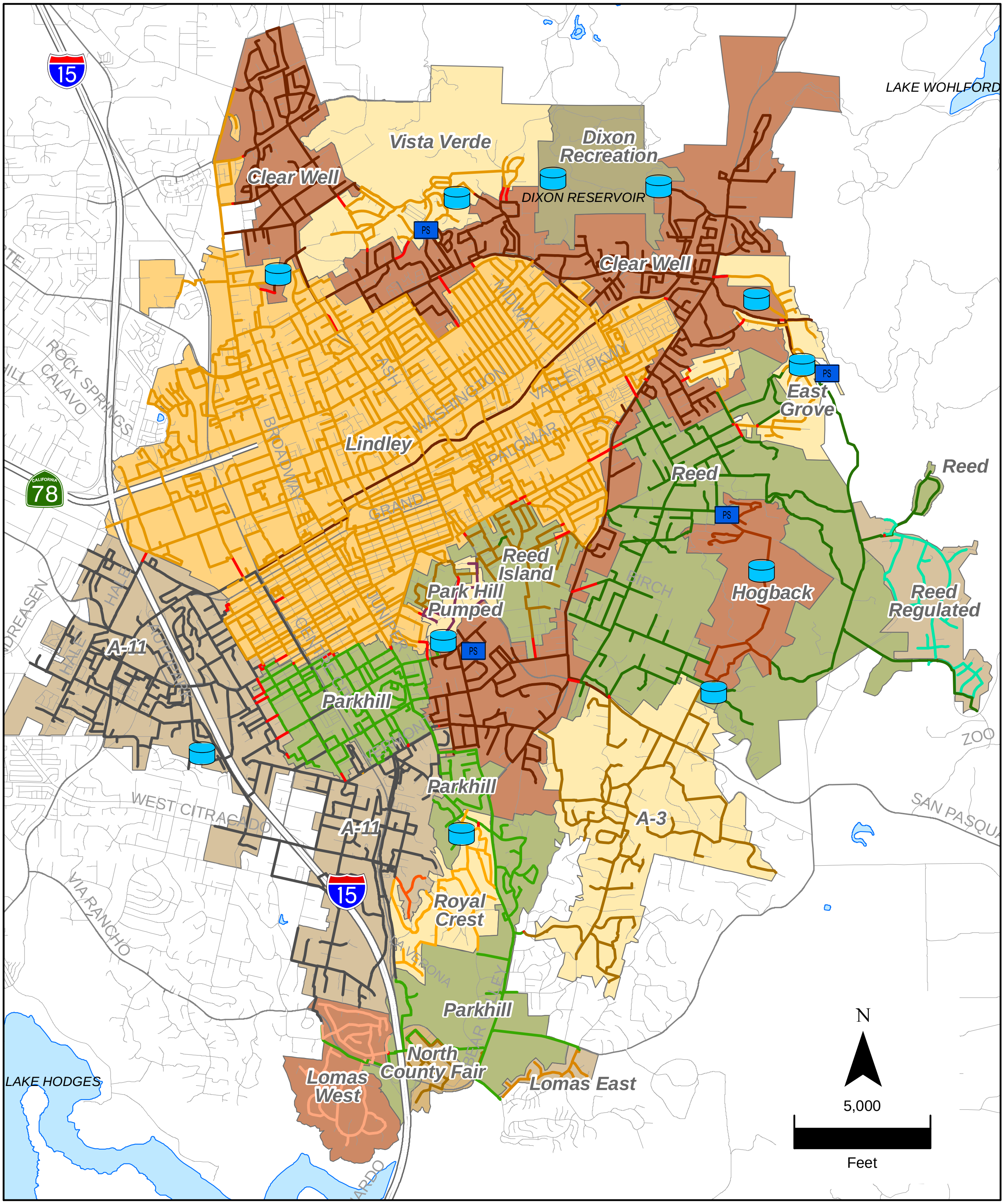

Water Pressure Zones and Major Facilities

Figure 5-2

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Table 5-1 Storage Facility Summary

Reservoir Name	Reservoir Type	Year Constructed	Capacity (MG)	Bottom Elevation (feet)	HWL Elevation (feet)	Interior Dimensions (feet)	Level Settings			
							L-L (feet)	Low (feet)	High (feet)	H-H (feet)
Clearwell	rectangular concrete, hopper bottom	1973	5.4	953	975	266 x 134			20	
Reed 1 & 2	circular prestressed concrete, partially buried	2011	2.5 each	922	945	138 foot diameter	6.0	8.0	18.0	21.0
Lindley	circular steel	1950	2.0	905	928	120 foot diameter	6.0	8.0	18.0	20.5
A-11	rectangular concrete, hopper bottom, east & west basins	1984	8.0	904	930	170 x 147 single bay	6.5	8.5	19.5	23.5
A-3	circular concrete	1940	1.5	850	867	121 foot diameter	5.0	6.5	15.0	16.8
Parkhill	5-sided concrete, partially buried, basins 1 & 2	2001	3.0	827	847	74 x 134 single bay		4.0	17.0	18.0
Royal Crest	welded steel tank	1958	0.25	655	679	42 foot diameter	6.3	8.3	19.0	22.5
Vista Verde	welded steel tank	1979	0.75	1078	1109	63 foot diameter	8.0	10.5	37.0	29.3
Hogback	circular concrete	1991	1.25	1145	1178	80 foot diameter	2.3	5.4	28.8	32.5
East Grove	welded steel tank	2002	1.20	1040	1068	85 foot diameter	2.0	5.8	29.0	31.0
Dixon	welded steel tank	1978	0.25	1240	1270	40 foot diameter	8.0	10.5	27.6	30.0

Table 5-2 Pressure Regulating Station Summary

Sta No.	Location	Atlas Page	Zone Connections	Valve Size/Type	Control Type	Normal Valve Position		Normal Pressures		Comments
						Summer	Winter	Up-Stream	Down-Stream	
47	Sheridan Ave/ Vista Verde Wy	4020	Vista Verde => Clearwell		manual	closed	closed			Emergency or high demands
48	2025 Skyview	4020	Vista Verde => Clearwell		manual	closed	closed			Emergency or high demands
1	Washington/Citrus	4222	Clearwell => A-11 Lindley	8" globe	manual	open	open only to fill tank	105	95	always runs
2	Lindley Reservoir	4118	Clearwell => A-11 Lindley	12" globe	SCADA % open	5-35%	open to fill tank	25-27	25	Fills Lindley Res.; Upstream press recorded & affected by V.V. pumps, must be kept >12psi
3	Midway/Channel	4321	Clearwell => A-11 Lindley	12" globe	manual	closed	closed	120	75	Emergency or high demands
4	Rose/Channel	4421	Clearwell => A-11 Lindley	12" globe	manual	closed	closed	120	70	Emergency or high demands
5	Ash/Channel	4420	Clearwell => A-11 Lindley	12" globe	SCADA % open	35%	5-15%	120	110	Fills A-11 Res; upstream press recorded; Both valves usually operated in tandem
6	City Hall, Valley Pkwy/Valley Blvd.	4619	Clearwell => A-11 Lindley	12" globe	manual	closed	closed	130	95	Emergency or high demands
7	Valley Pkwy/ Broadway	4618	Clearwell => A-11 Lindley	12" globe	manual	closed	closed	135	85	Emergency or high demands
8	Valley Pkwy/Esc. Blvd.	4618	Clearwell => A-11 Lindley	12" globe	manual	closed	closed	135	105	Emergency or high demands
9	Valley Pkwy/Orange	4618	Clearwell => A-11 Lindley	12" globe	SCADA % open	30-75%	15-30%	135	110-120	Primary fill to A-11 Res.; 12" valve on 36" pipe, valve too small;
10	Bear Valley/Midway	4522	Clearwell => A-11 Lindley	8" globe	manual	10%	closed	105	90	Primarily back-up, may be slightly open during summer peaks.
11	Eldorado/Juniper	4920	Clearwell => A-11 Lindley	12" globe	manual	closed	closed	122	95	Normally closed;
28a	Cranston/Las Palmas	5219	A-11 Lindley => A-11 regulated	4" globe	manual	active	active	140	75-78	Supplies isolated area of reduced press

Table 5-2 continued

Sta No.	Location	Atlas Page	Zone Connections	Valve Size/Type	Control Type	Normal Valve Position		Normal Pressures		Comments
						Summer	Winter	Up-Stream	Down-Stream	
13	Bear Valley/Boyle (Heinrich)	4622	Clearwell => Reed Island	12" globe	manual	active	active	110	90	Supplies an insulated portion of the Reed Zone (Reed Island); inactive on SCADA
14	Bear Valley/Idaho	4722	Clearwell => Reed	10" globe	manual	closed	closed	120-128	93-110	Emergency back-up
43	Bear Valley/Citrus	4422	Clearwell => Reed	16"	manual			100-110	95	
44	Bear Valley/ Glenridge	4522	Clearwell => Reed	16"	manual			100-110	90	
15	East Grove Pump Station/ Reed Res	4324	Clearwell => Reed	24" B'fly	SCADA % open	active	10-30%			Fills Reed Res.; Wild Animal Park demands affect positioning
45	Idaho/Oro Verde	4823	Hogback => Reed	12"	manual	closed	closed	155	45	emergency back-up
46	Via Casabel/ Cloveridge	4824	Hogback => Reed	8"	manual	closed	closed	150	40	emergency back-up
16	San Pasqual/Citrus	4922	Clearwell => A-3	12" globe	SCADA % open	active	closed	150	104	Fills A-3 Res.; Can be wide open in summer; upstream press on SCADA
17	Bear Valley/Eldorado (Perry Lane)	4921	Clearwell => A-3	8" globe	SCADA % open	closed	closed	165	103-110	Currently not in use; Upstream press on SCADA
42	2036 Oro Verde Dr.	4923	Hogback => A-3	4	manual	closed	closed	135	3-8	Backup/Emergency supply
				8	manual	closed	closed	135	3-8	
19	A-3 Reservoir	4923	Reed => A-3	6" globe	Auto	closed	closed/ active	35-37	5-8	Backup/Emergency Supply
21	Encino	5021	Clearwell => Park Hill	8" globe	manual	active	active	140	85	
22	Park Hill Reservoir	4820	Clearwell => Park Hill	8" globe	SCADA % open	active	5-20%	50	5-20	Fills Park Hill; Usually open in summer; Upstream press on SCADA
23	Esc./Vermont	5019	A-11 Lindley => Park Hill	10" globe	manual	closed	closed	118	80	
24	Tulip/9th	4918	A-11 Lindley => Park Hill	10" globe	manual	closed	closed	110-120	75	
25	Frontage Rd./El Ku	5420	A-11 Lindley => Park Hill	10" globe	manual	active	active	200-205	155-165	Runs all the time
26	Major Market Felicita/ Centre City Pkwy	5019	A-11 Lindley => Park Hill	10" globe	manual	closed	closed	82	72	
40	Via Rancho/Quiet Hills	5519	A-11 Lindley => Park Hill	12" globe	manual	closed	closed	190-210	130	

Table 5-2 continued

Sta No.	Location	Atlas Page	Zone Connections	Valve Size/Type	Control Type	Normal Valve Position		Normal Pressures		Comments
						Summer	Winter	Up-Stream	Down-Stream	
28b	Cranston/Las Palmas	5219	A-11 Lindley => Royal Crest	4" globe	manual	active	active	140	42	Backup/Emergency supply
29	La Verona/Esc. Blvd.	5420	A-11 Lindley => Royal Crest	10" globe	auto	active/ off	active/ off	185-205	85	Backup supply; Turned off periodically by operations staff to cycle tank
30	Old Spanish Trail	5221	Park Hill => Royal Crest	6" globe	manual	active	active	165-170	94	Primary Supply
31	K.C.Park/Humane Society	5421	Park Hill => Royal Crest	8" globe	manual	active/ off	active/ off	183-189	115	Turns off when valve #28 comes on; Turned off periodically by operations staff
32	N.C. Fair #1/Bear Valley	5520	Park Hill => N County Fair	8" globe 12" globe	manual manual			200 200	100 90	Backup supply
33	N.C. Fair #2/ Nordstroms	5520	Park Hill => N County Fair	3" globe 12" globe	manual			225 225	130 120	Primary supply
34	N.C.Fair and I-15	5520	Park Hill => Caltrans	4"	manual			200	100	
35	Rockwood/Old Ranch Rd South	4826	Reed => Reed Regulated	1.5" globe 4" globe 8" globe	manual manual manual			200-240 200-240 200-240	140 120 110	Back-up Supply
36	Old Ranch Rd. North (Cloverdale North)	4625	Reed => Reed Regulated	1.5" globe 4" globe 8" globe	manual manual manual			200-240 200-240 200-240	125 110 105	Primary Supply
37	San Pasqual/ Sierra Linda	5522	Park Hill => Lomas E.	2" globe 8" globe	manual manual	active active/ closed	active active/ closed	180 180	125 120	Primary supply to Lomas E.
38	Beethoven/Calle Montera	5621	Park Hill => Lomas E.	2" globe 8" globe	manual manual	closed closed	closed closed	235 235	150-160 130-140	Backup Supply
39	Via Rancho/Lomas Serenas	5620	Park Hill => Lomas W.	2" globe 6" globe	manual manual	closed closed	closed closed	170-180 170-180	150-160 150-160	Backup Supply
41	Via Rancho/Quiet Hills	5519	A-11 Lindley => Lomas W.	2" globe 6" globe	manual manual	active active/ closed	active active/ closed	190-210 190-210	145 140	Primary supply to Lomas W.

Manual valves are hydraulically actuated and maintain a constant downstream pressure based on a control setpoint. Pressure gages are located on the downstream and upstream sides of the valve. When the valve is modulating (active) the pressure control setting can be read from the downstream gage. The settings on many of the manual valves are adjusted seasonally or even more frequently in the field by system operators.

Automated valves have electronic actuators that are controlled at the Escondido-Vista WTP through the supervisory control and data acquisition (SCADA) system. These valves are controlled by specifying the percent open position of the valve disk, and the resulting headloss through the valve reduces the downstream pressure. The valves are thus operated essentially as flow control valves, although the flow rate through the valves is not measured. Automated valves are adjusted based on the water levels of downstream reservoirs.

Pump Stations

The City currently operates and maintains five separate pump stations in the water distribution system. The Vista Verde, East Grove and Hogback pump stations supply main pressure zones that have storage tanks. The Park Hill Boosted Pump Station supplies a small, closed water system and has a hydropneumatic tank to regulate pressures. The Dixon Pump Station supplies the small Dixon Zone directly from the WTP Clearwell. The pump stations are summarized in Table 5-3.

Table 5-3 Pump Station Summary

			Zone and Piping		Pump Information			
Name	**Location**	**Year Built**	**Suction**	**Discharge**	**No.**	**Motor Size**	**Operating Point**	**Comments**
Vista Verde	Vista Verde Way/Timber Glen	1989	Clearwell Z 12 inch diameter	Vista Verde 12 inch diameter	2	75 Hp	800 gpm @ 243 feet	Press & flow on SCADA; space for 2 additional pumps; connection for generator
Hogback	Mountain View Drive/ Canyon Crest	1991	Reed Zone 14 inch diameter	Hogback 14 inch diameter	3	100 Hp	950 gpm @ 305 feet	backup generator; pressure on SCADA
Park Hill Boosted	Park Hill Lane/ Idaho Avenue (Park Hill Reservoir site)	2001	Park Hill Z. 12 inch diameter	PH Boosted 12 inch diameter	2	10 Hp	120 gpm @ 165 feet	hydropneumatic tank; emergency supply from Clearwell Zone; press & flow on SCADA
					1	100 Hp	1600 gpm @ 120 feet	
East Grove	199 Hidden Trails Road	2002	Reed Zone 30 inch diameter	East Grove 16 inch diameter	3	50 Hp	950 gpm @140 feet	backup generator; pressure on SCADA
Dixon	In Dixon Campground		Clearwell	Dixon Z.	3			Supplied directly from Clearwell

Hp = horsepower
gpm = gallons per minute

Rincon Interties

There are over thirty interties with the adjacent water agency, Rincon MWD. The intertie locations are summarized in Table 5-4. Many of these connections are normally open and district water exchanges (Escondido to Rincon or Rincon to Escondido) are either metered at the intertie or tracked through individual customer water bills. The remainder of the interties are normally closed valves which are opened manually only during emergencies. Two of the interties are at Rincon SDCWA treated water connections, which can be used to supply the Clearwell Zone directly from the SDCWA Aqueduct during a loss of supply from the Escondido-Vista WTP. The large number of interties greatly increases the reliability of Escondido's water system, since Rincon MWD can directly the supply the Clearwell, A-11, Lindley and Park Hill Zones from multiple connection sites during emergencies.

Table 5-4 Escondido-Rincon Interties

Location	Escondido System Zone & Pipe Size		Connecting Valve Size	Water Meter	Rincon System Zone & Pipe Size		Operations/Comments
Canyon/Bear Valley (A-1)	850 Park Hill	10"		Yes	829 ID-A	8"&10"	limited capacity
Mary Lane/ Summit (A-2)	867 A-3	14"	14" B-fly flow controlled	Yes	829 ID-A	16"	main supply, continuous use; manually controlled by Rincon
Beethoven/ Huckelberry (A-3)	850 Park Hill	16"	10" PRV	Yes	829 ID-A	10"	emergency use only
Mary Lane/Foothill	850 Park Hill	12"	12" GV w/plate	No	829 ID-A	10"	closed
Bear Valley/Alamo	850 Park Hill	14"	8" PV w/plate	No	829 ID-A	8"	closed
Bear Valley/Cody Lane	850 Park Hill	14"	8" PV w/plate	No	829 ID-A	8"	closed
El Norte Pkwy/ Nutmeg	928 Lindley	12"	12" GV w/plate	No	958 ID-1	12"	closed
Morning View/ Borden	928 Lindley	12"	12" GV	No	958 ID-1	12"	valve off & valve can filled w/rock
Vista/Ash	975 Clearwell	25"	14" plug	Yes	CWA PL#1	24"	CWA Rin 3 Conn. at 1060 ft. grade - emergency supply to Clearwell
Ash/Sheridan	975 Clearwell	25"	12"	Yes	CWA PL#1	36"	meter is currently not operational
N Broadway/Vista	928 Lindley	8"	8" gate valve	Yes	958 ID-1	24"	emergency use only
Simpson Way/ Andreasen	930 A-11	10"	10" gate valve	Yes	958 ID-1	18"	emergency use only
Andreason Dr/ Industrial Ave	930 A-11	8"	8" gate valve	No	958 ID-1	18"	normally closed
Auto Park Way North	930 A-11	12"	12" gate valve	No	958 ID-1	12"	normally closed
Auto Park Way South	930 A-11	12"	12" gate valve	No	958 ID-1	12"	normally closed
Auto Park Way S./ Howard	930 A-11	10"	10" gate valve	No	958 ID-1	12"	normally closed

Table 5-4 continued

Location	Escondido System Zone & Pipe Size		Connecting Valve Size	Water Meter	Rincon System Zone & Pipe Size		Operations/Comments
Brotherton Rd/ Miller Ave	930 A-11	8"		No	958 ID-1	6"	existing connection? fire hose hi-line?
Quiet Hills/Via Rancho Pkwy	850 Park Hill	12"	6" gate valve	No	958 ID-1	6"	normally closed
Gary Lane/ Fuerte Ln	Country Club	8"	8"	Yes	958 ID-1	8"	normally open; Country Club area, Escondido pipes, Rincon water
Country Club Drive	Country Club	12"	10"	Yes	958 ID-1	12"	normally open; Country Club area, Escondido pipes, Rincon water
Cortez/Esc. Golf Course	Country Club	10"	10"	Yes	958 ID-1	10"	normally open; Country Club area, Escondido pipes, Rincon water
Pinehurst/ Firestone	Country Club	8"	8" plug	No	958 ID-1	8"	normally open; Country Club area, Escondido pipes, Rincon water
Pinehurst Ave/ Cottonwood Pl	Country Club		gate valve	No	958 ID-1		normally open; Country Club area, Escondido pipes, Rincon water
Nutmeg/ Yuma Glen	subdivision	8"	6"	Yes	958 ID-1	10"	normally open; Escondido pipes, Rincon water
Nordahl Rd/ Rhea Glen	subdivision	8"	6"	Yes	958 ID-1	10"	normally open; Escondido pipes, Rincon water
Nutmeg/Sunset Heights Rd	subdivision	10"	6"	Yes	958 ID-1	10"	normally open; Escondido pipes, Rincon water
Canyon Creek Road	850 Park Hill	8"	2-8" gate valves	No	958 ID-1	8"	
Candlelight Ave/ Scenic Dr	930 A-11	8"	8" gate valve	No	subdivision	8"	normally closed; Tract 547R Rincon pipes, Escondido water
A-11 Reservoir	930 A-11	30"	10" plug valve	No	subdivision	10"	normally closed; Tract 547R Rincon pipes
Eucalyptus Ave	930 A-11	10"	10" plug valve	No	958 ID-1	10"	normally closed; Tract 547R Rincon pipes
Clarence Ln/ Calle de Malibu	930 A-11	4"	8" gate valve	No	subdivision	6"	normally closed; Rincon pipes, Escondido water
Howard Ave/ Moonglow MHP	930 A-11	8"	6" gate valve	No	subdivision	6"	normally open; Rincon pipes, Escondido water
Howard Ave/ Privada Glen	930 A-11	8"	gate valve	No	subdivision		normally open; Rincon pipes, Escondido water
Summit Crest	subdivision	8"	2-8" gate valves	No	829 ID-A	8"	normally closed; Escondido pipes, Rincon water

5.2 Pressure Zone Operations

The existing pressure zone boundaries are illustrated on the existing water system map provided previously in Figure 5-2. Many of the boundaries have been retained from the merging of several water purveyors decades ago. Other boundaries have been created to increase pressures in some local critical areas or reduce pressures in older pipelines. Field operators adjust some of the pressure boundaries seasonally to improve water circulation; therefore the boundaries shown on Figure 5-2 can fluctuate.

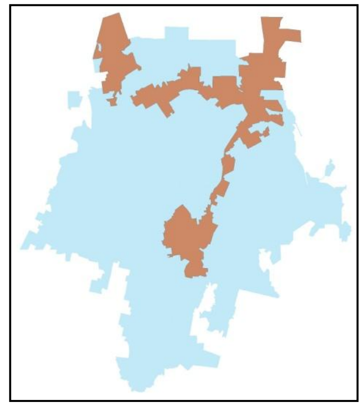
A hydraulic summary of each pressure zone is shown in Table 5-5. The range of design service elevations listed for each zone is approximate and based on providing the minimum and maximum design pressures as defined by the design criteria in Section 4. Major features and operations of each of the main pressure zones are described in detail below. The information is based on previous master plans and studies, site visits, and numerous discussions with field and WTP operators.

Table 5-5 Pressure Zone Hydraulic Summary

Pressure Zone	Hydraulic Grade(1) (feet)	Design Service Elevations(2) (feet)
Dixon	1,272	930 – 1,130
Hogback	1,178	830 – 1,040
Vista Verde	1,109	760 – 970
East Grove	1,068	720 – 930
Parkhill Pumped	995	650 – 860
Clearwell	975	630 – 840
Reed	945	600 – 810
Reed Island	935	590 – 800
A-11/Lindley	930/928	580 – 790
A-3	867	520 – 730
Parkhill	847	500 – 710
Lomas West	815	470 – 680
Lomas East	715	370 – 580
Reed Regulated	705	360 – 570
Royal Crest	679	330 – 540
No. County Fair	645	300 – 510

(1) Based on the reservoir high water level, highest PRV setting, or maximum head pumping condition.

(2) Based on minimum and maximum static pressures of 60 pounds per square inch and 150 pounds per square inch, respectively.



Clearwell Zone

Clearwell Zone (975)

The Clearwell Zone (also referred to as the Filtration Plant Zone) directly or indirectly supplies all the other pressure zones in the distribution system. The Clearwell Zone originates at the Escondido-Vista WTP 5.4 MG Clearwell, which provides the only storage for the zone and also provides storage for treatment plant operations. Two parallel 42-inch diameter transmission mains extend from the Clearwell to supply the Clearwell Zone's major delivery mains, which radiate out to the west, southwest, south, east and north. The Clearwell Zone is supplied by gravity, and the flow rate entering the distribution system is affected by the water level in the Clearwell, downstream zone demands, pump station operations, and supply rates to other zones through automated valves, which are controlled by water system operators.

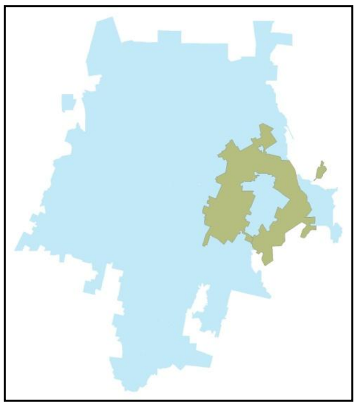
The Clearwell Zone is characterized by long transmission supply mains devoid of pipeline looping. The transmission main to the west follows portions of El Norte Parkway and eventually terminates along Ash Street near the Lindley Reservoir. Most of the original 25-inch diameter pipeline installed in the 1950s was replaced between 2002 and 2006 with 36-inch and 30-inch diameter cement mortar lined and coated (CMLC) steel pipe. This transmission main supplies the Vista Verde Pump Station and Lindley Reservoir, as well as distribution pipelines primarily to the north of the distribution main. North of Lindley Reservoir a 24-inch diameter CMLC transmission main supplies a looped distribution system in the vicinity of Ash Street and Conway Drive.

Elevations along the western main are highest around the Lindley Reservoir and at the northern end of the distribution system. An area within the Clearwell Zone around Hubbard Hill is too high to be served directly, and several customers in the vicinity operate private pumps. To maintain adequate pressures in this area, treatment plant operators monitor the pressure upstream of the Lindley Reservoir PRV and ensure that it remains above 12 psi. With the recent transmission main capacity improvements, pressures are generally above 20 psi during normal operations.

Another primary transmission main in the Clearwell Zone consists of a 36-inch CMLC pipeline, installed in the late 1970s, which parallels the flood control channel toward the southwest. This main is unique in that it does not serve any customers in the Clearwell Zone but supplies only the A-11 Lindley Zone through seven PRSs. Two of the PRSs are automated valves controlled at the Escondido-Vista WTP and provide the primary supply to the A-11 Lindley Zone and the A-11 Reservoir. The remaining PRSs are set manually to open only during emergencies or high demand periods.

The Clearwell Zone's longest transmission main (over three miles) extends to the southern portion of the City in Bear Valley Parkway. The Bear Valley Pipeline, commonly referred to as the B-line, was originally constructed in the 1930s. Most of the pipeline has been replaced since 1990 with 36-inch diameter CMLC pipe; however, there are some remaining portions of 27-inch diameter cement lined-in-place steel pipe constructed in the 1940s and 1950s. The B-line supplies water to the A-3 Zone and Reservoir, the Park Hill Reservoir, and portions of the Reed, A-11, Lindley and Royal Crest Zones through automated and manual pressure reducing valves. The B-line also supplies the Reed Island Zone through a single PRV, and directly serves an area of the Clearwell Zone southeast of Citrus Avenue and east of the Parkhill Reservoir.

There is a relatively short Clearwell Zone transmission main branch which extends to the east and supplies the Reed Reservoir. A 30-inch diameter CMLC steel pipe in Old Guejito Grade Road constructed in the 1970s supplies a newer section of 36-inch diameter wrapped steel pipe that terminates at the Reed Reservoir flow control valve, which is operated from the treatment plant. In addition, there is a 26-inch diameter Clearwell Zone transmission main that extends north in East Valley Parkway to supply a small portion of the Clearwell Zone located north and east of the Escondido-Vista WTP.



Reed Zone

Reed Zone (945)

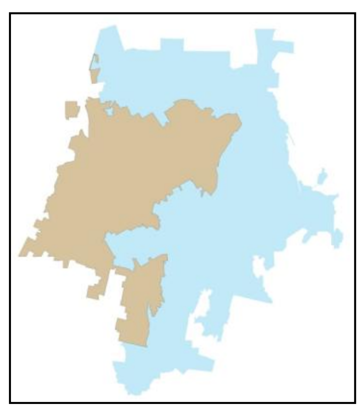
The Reed Zone is centered around the Mountain View Drive area to the east of Bear Valley Parkway. A significant portion of the existing demand within the Reed Zone is associated with agricultural usage, which has been steadily decreasing over the past three decades. The service area also includes newer development in the Reed Regulated Zone (also referred to as the San Pasqual reduced pressure zone) east of Cloverdale Road. The largest single user in the Reed Zone is the San Diego Zoo Safari Park (formerly the Wild Animal Park), which comprises approximately 20 percent of the total zone demand. The Reed Zone also supplies the East Grove and Hogback Pump Stations and provides a backup supply to the A-3 Reservoir.

The Reed Zone is supplied from the Clearwell Zone at four separate locations. The primary supply is a 24-inch valve located near the two Reed Zone Reservoirs, which is controlled from the Escondido-Vista WTP. Three additional PRVs are located on the Clearwell Zone B-Line. Two PRVs can supply the Reed Zone from the pumped Hogback Zone in an emergency. Many distribution pipelines in the Reed Zone are from the Escondido Mutual Water Company and are reported to be in poor condition. Pipeline improvements are currently in design for the eastern portion of the zone. The “cemetery pipeline” project will replace aging pipelines with larger diameter pipes and increase pipeline looping.

There is an isolated section of the distribution system west of Bear Valley Parkway that operates at Reed Zone pressure but is supplied through a PRV from the Clearwell Zone. This area is called the Reed Island Zone, but it is not supplied or connected to the Reed Zone.

A-11 (930)/Lindley Zone (928)

The A-11/Lindley Zone is by far the City’s largest and approximately half of the total Escondido water demand is supplied from this zone. The service area includes the central downtown area from Interstate 15 east to Citrus Avenue and from Sheridan Avenue south to where Interstate 15 and Centre City Parkway intersect. The land use is primarily commercial and medium to high density residential, with no sizable agricultural areas. The Lomas West reduced pressure zone is supplied primarily from the A-11/Lindley Zone.



A-11/Lindley Zone

The A-11/Lindley Zone contains two separate storage facilities: the Lindley Reservoir (HWL=928 feet, 2.0 MG) to the north and the A-11 Reservoir (HWL=930 feet, 8.0 MG partitioned into 2-4.0 MG bays) at the far southwest edge of the zone. Water supply is entirely from the Clearwell Zone through eleven PRSs, three of which are automated stations controlled at the Escondido-Vista WTP. In addition to supplying the service area, the A-11/Lindley Zone supplies the southern area of the Park Hill Zone from the PRS at Frontage Road/El Ku, a portion of the Royal Crest Zone from two separate PRSs, and a small reduced pressure area directly north of the Royal Crest Zone that is supplied from a single PRV at Cranston Drive and Las Palmas Avenue. There are also four additional PRSs which can provide flow to the Park Hill Zone under emergency conditions.

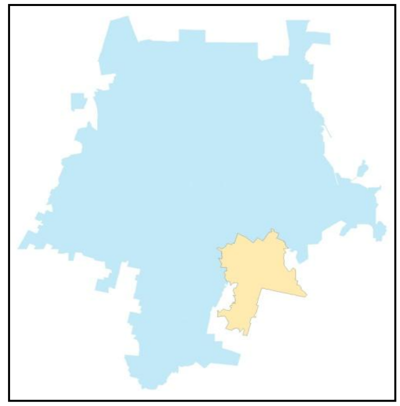
Most of the A-11/Lindley Zone distribution system is laid out in an extensive grid pattern with substantial pipeline looping, although there are many smaller 4-inch and 6-inch diameter pipelines. Elevations within the service area vary gradually and the only low pressure areas are in the vicinity of the reservoirs and along a ridgeline south of Valley Parkway and east of I-15. The primary operational problem with this zone is the inability to effectively utilize the A-11 Reservoir.

The A-11 Reservoir is supplied primarily through the Clearwell Zone Channel Line from an automated 12-inch diameter PRS at Valley Parkway and Orange Avenue, and then through 24-inch and 18-inch diameter transmission pipelines within the A-11/Lindley Zone. This contrasts with the Lindley Reservoir, which is supplied from a PRS on-site (no A-11/Lindley Zone transmission main losses), yet has a high water level 2 feet lower than the A-11 Reservoir. Because of system pressure losses in the supply valve and pipeline, the WTP operators cannot fill the A-11 Reservoir during peak demand periods even with the Clearwell Zone supply valve set wide open and the bypass open on the reservoir altitude valve. Circulation in and out of the reservoir is further restricted by a quarter mile long single inlet/outlet pipeline, and lack of separate inlet and outlet piping at the reservoir. To maintain adequate water quality, only one bay of the reservoir is currently being used and the water level in this bay is typically kept around half full. Pipeline improvements have recently been made in the southern A-11/Lindley Zone with the construction of the Alexander area waterline replacement projects, which increased transmission capacity to the A-11 Reservoir.

System operators have closed valves within the A-11/Lindley Zone to operate the system as two separate zones, and thereby have more control over water levels in the A-11 Reservoir. With these valve closures the A-11 Zone service area is generally south of Mission Avenue and west of Tulip Street, and the A-11 Zone and reservoir also supply the Lomas West reduced zone. It is noted that the A-11 and Lindley Zones may not operate as completely separate zones, since the locations of all the closed valves have not been documented and it appears that some smaller pipelines may still be open between the two service areas. The A-11 and Lindley Zones are analyzed separately in this master plan for both the existing and 2030 water systems.

A-3 Zone (867)

The A-3 Zone supplies water to the southeast portion of the City and provides the sole supply to the Rincon ID-A. Storage for the zone is contained in the 1.5 MG A-3 Reservoir, located at the northern zone boundary. The primary supply to the zone and reservoir is from the Clearwell Zone B-Line, through an automated PRS. The A-3 Reservoir can also be supplied from the Reed Zone via a 6-inch PRV located in a vault at the reservoir site. The vault also contains a pump which can discharge water from the reservoir back to the Reed Zone. The pump was run periodically to circulate water in the reservoir back when a Reed Zone gravity pipeline supplied a constant flow to the A-3 Reservoir. With recent improvements to the Hogback Zone and elimination of the gravity pipeline, the pump is no longer used.



A-3 Zone

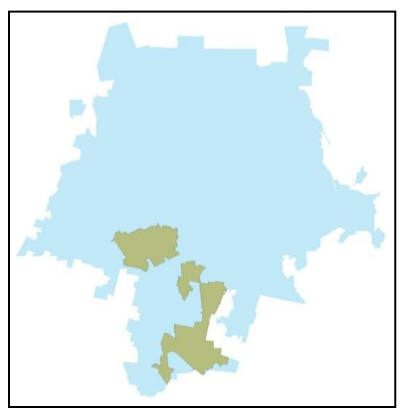
Land use within the A-3 Zone boundary is primarily rural residential and residential estate, with a sizable component of water use for agriculture. Over the past decade many land owners have discontinued irrigating their groves and water demands for this zone have decreased. This trend in water use is expected to reverse itself, however, as new subdivisions are built on former groves.

The A-3 service area covers an area of varying topography. Included within the A-3 service area are higher elevations around Summit Avenue and Mary Lane which cannot be served without pumping. Many customers operate private pumps and their water systems are sensitive to any reduction in pressure.

The City of Escondido supplies up to the maximum day demand for Rincon ID-A. Presently this demand is approximately 50 percent of the total zone demand. Flow is supplied through a 14-inch diameter flow control valve which supplies Rincon MWD's three ID-A Reservoirs and distribution system. The flow rate is controlled by Rincon and can be adjusted at any time. There can be significant changes in flow rates as Rincon attempts to cycle its reservoirs. Escondido's water system operators are not informed when flow changes occur and must make valve position changes at the automated PRV based on resulting level changes in the A-3 Reservoir.

Most of the major A-3 Zone transmission mains (12, 14, 16, and 18-inch diameter) are tar coated and cement lined-in-place welded steel pipelines. These pipelines are very old and should be replaced in the near future, as there have been numerous recent pipeline breaks. The A-3 Reservoir, the oldest reservoir that the City still operates, is in poor condition and significant water leaks are located approximately nine to ten feet above the ground. System operators keep the water level low to minimize leakage.

Park Hill Zone (847)



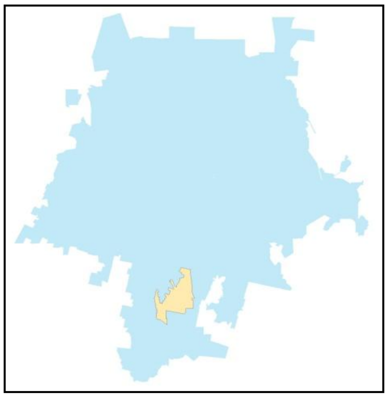
Park Hill Zone

The Park Hill Zone consists of the southerly downtown area, centered around Centre City Parkway and 15th Avenue, and the extreme south area of the City adjacent to and including the North County Fair Shopping Center. As the zone extends south from the downtown area the topography gradually decreases in elevation. The Park Hill Zone also supplies the Lomas East and North County Fair reduced pressure zones, and the small Park Hill Boosted Zone. Storage capacity for these zones is included in the storage calculation for the Park Hill Reservoir. In addition, the zone is the primary supply to the Royal Crest Zone, and provides a backup supply to the Lomas West Zone. Water storage in the Park Hill Zone is provided by the 3.0 MG Park Hill II Reservoir (HWL = 847 feet), which is partitioned into two basins and was constructed in 2001. The reservoir serves as a forebay for the Park Hill Boosted Pump Station.

The Park Hill Zone can be supplied from the Clearwell Zone (2 PRSs) and the A-11 Zone (5 PRSs). All the PRSs are manual with the exception of the automated valve at the reservoir, which is the primary supply to the zone. The Frontage Road/El Ku PRS also supplies a constant flow from the A-11 Zone to reduce pressure swings and improve circulation in the very long transmission main serving the southern portion of the zone.

The Park Hill Boosted Zone service area includes residences situated in the high elevation areas north of the reservoir. The pump station supplies domestic and fire flows and incorporates a hydropneumatic tank to stabilize pressures and provide low flows.

The Park Hill Zone also has two metered connections to the Rincon ID-A (HGL = 829) which are used only in emergencies. The minimal hydraulic gradient between the zones limits the available supply rate.



Royal Crest Zone

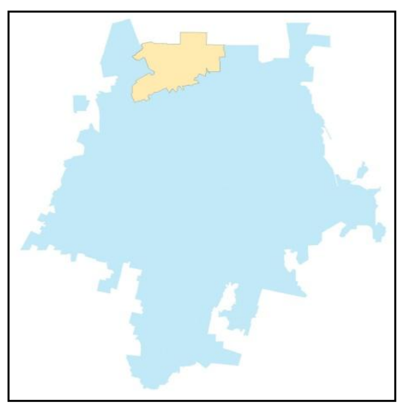
Royal Crest Zone (679)

The Royal Crest Zone is the smallest of the major reduced zones and serves a residential area north of Kit Carson Park. Four pressure reducing stations supply the zone and the 0.25 MG Royal Crest Reservoir from the A-11 and Park Hill Zones.

The Royal Crest Zone is unique in that all of the PRSs are manual. Distribution pipelines within the Royal Crest service area are generally old and small (4-, 6-, and 8-inch diameter) and there are essentially no transmission mains. The multiple PRSs around the perimeter of the zone are required to deliver fire flows, since the reservoir can provide the required fire flows only to the immediate surrounding area. With all the PRSs in operation, reservoir water levels will fluctuate very little and periodic manual adjustments are required to turnover water in the reservoir. A 2-inch diameter valve controlled by a timer was recently added between the Park Hill and Royal Crest Zones to fill the reservoir. The valve is now opened for several hours during the day to fill the tank, and the PRVs are set to open only when the tank reaches a low level or in response to an emergency condition, such as a fire flow. This system improvement has eliminated the need for manual changes to PRS settings.

Vista Verde Zone (1109)

The Vista Verde Zone serves the high elevation areas north of El Norte Parkway along Vista Verde Way. The pressure zone includes the 0.75 MG Vista Verde Reservoir which is supplied from the Vista Verde Pump Station. Suction pressure to the pumps is from the Clearwell Zone. The distribution system serves primarily newer planned developments and the service area will continue to expand as existing large parcels are subdivided and new housing projects constructed. The Vista Verde Zone will also expand in the future to serve low pressure areas that are now within the Clearwell Zone service area.



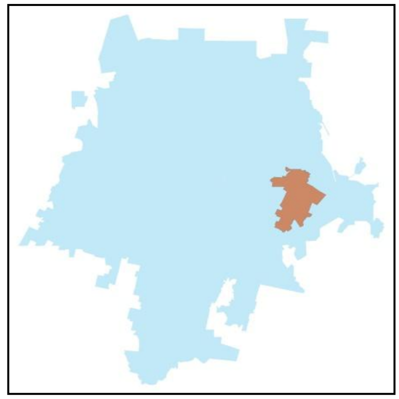
Vista Verde Zone

The existing pump station, constructed in 1989 to replace the smaller original pump station, will accommodate much larger ultimate demands. Two 75 horsepower pumps are currently installed, although only one pump runs at a time and cycles on and off to supply existing demands. Suction and discharge piping is in place to accommodate two additional future pumps. The design capacity of a single pump is 800 gpm; however, the discharge rate is currently about 975 gpm due to low head loss in the delivery mains. With all four pumps installed the Vista Verde Pump Station could supply over three times the existing demand of the service area.

Distribution pipelines within the service area are mostly looped, with the exception of a long dead-end pipeline serving the La Honda area. Existing operational problems center around the high elevations immediately west of the reservoir. There are several customers operating private pumps that are supplied from an 8-inch pipeline paralleling the reservoir supply pipeline. The pumps are located at elevations that do not receive adequate pressures during peak demand periods when the reservoir water level is low.

Hogback Zone (1178)

The Hogback Zone, the City's highest pressure zone, was constructed in 1991 with initial pipelines in Mountain Vista, Carrol Lane and Royal Oak Drive. An expansion of the zone service area occurred in the early 2000s, with the elimination of the "gravity line" and transfer of customers from the Reed Zone. Nearly 80 percent of the demand in the service area is for agriculture, and the remainder is residential. The zone is supplied from the Hogback Pump Station, which takes suction from the Reed Zone, and storage is provided in the 1.25 MG Hogback Reservoir. Three 100 horsepower pumps rated at 950 gpm are installed at the pump station; however, existing demands require that only one pump operates at a time. Pumps controls are based on water levels in the reservoir. Since the reservoir is oversized based current demands, control settings keep the reservoir at approximately 20 to 35 percent full.

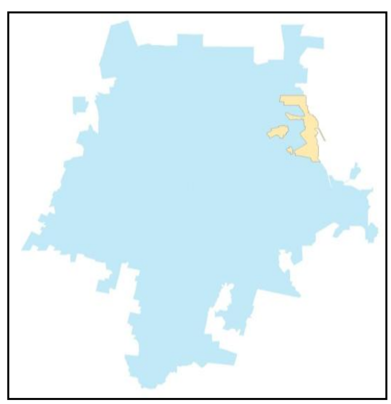


Hogback Zone

The Hogback service area will be expanded in the future to serve new development. Based on design criteria the existing Hogback Pump Station could supply an ultimate average annual demand of approximately 600 gpm, which is about four times the demand of the existing system.

East Grove Zone (1068)

The East Grove Zone is the City's newest pressure zone and serves areas that were previously supplied from the Clearwell and Reed Zones. The East Grove Pump Station and 1.2 MG East Grove Reservoir were both constructed in 2002 to serve new residential development near the Reed Reservoir. Development in the service area consists primarily of single family estate-type homes; however, there are several large agricultural parcels served from the zone as well. Transmission mains and distribution pipelines were all constructed in the 2000s, except for a few distribution pipelines from the late 1980s that were incorporated into the zone. The East Grove Pump Station takes suction from the Reed Reservoir and consists of



East Grove Zone

three 50 horsepower pumps rated at 950 gpm. Existing demands require that only one pump operates at a time. Pumps controls are based on water levels in the reservoir.

5.3 Facility Condition Assessments

A desktop condition assessment of the existing water facilities was conducted based on the City's GIS data and past facility inspection reports. This information is provided below.

Distribution and Transmission Pipelines

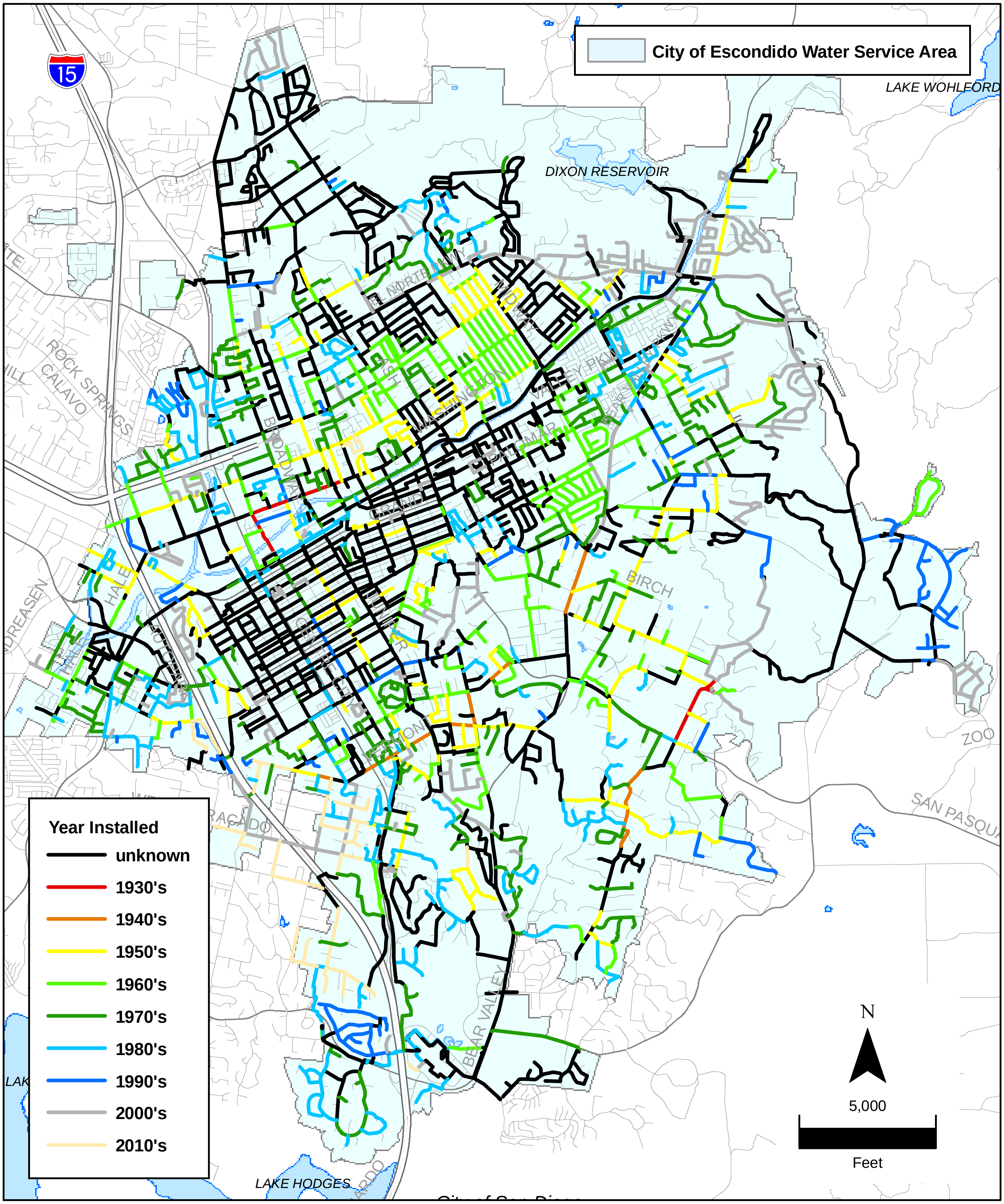
The City of Escondido maintains approximately 370 miles of active water mains ranging in size from 4-inch to 42-inch in diameter. The pipelines are predominantly asbestos cement pipe (ACP), which was extensively used in the 1950s through the 1980s, and polyvinyl chloride (PVC) pipe, which is currently in widespread use. Large diameter transmission mains are primarily CMLC steel pipe. There are also numerous welded steel, carbon steel and small diameter CMLC pipelines in older portions of the distribution system, primarily in areas that were previously part of the Escondido Mutual Water Company. To estimate the general condition of a distribution system, data pertaining to the material type and the approximate date of installation for a large percentage of its system is important. Based on this information, the remaining life of the facilities can be approximated. Additional factors that should be considered for determining the expected remaining life of pipe include:

- metal pipes with corrosion problems
- facility maintenance efforts
- quantity and location of pipeline breaks
- overall condition of the facilities
- current age of the pipe
- potential impact of pipe failure
- cathodic protection

Figure 5-3 shows the age of existing pipes based on information in the City's water system GIS. The oldest pipelines in the system date back to the 1930s, and there are still significant areas of the system with pipelines installed in the 1950s and 1960s. The information in the GIS is not complete, however, and as can be seen from Figure 5-3, approximately half of the pipelines do not have a year assigned. Most of the pipelines without a year assigned are in the older downtown areas, but sizable portions are in some of the newer, outlying areas. Pipeline material information is likewise missing from a large portion of pipelines in the GIS. A meaningful statistical assessment of pipeline service life will not be practical until an effort is made to fill in this missing information.

Reservoirs

All reservoirs in the distribution system were last inspected in 2009 or 2010. The inspections were performed by Aquatic Inspections, Inc. and included a visual assessment of the exterior walls, roof, exposed piping and appurtenances, and wet inspections of the interior using divers. An inspection report was prepared for each reservoir, and a summary of the findings for each reservoir is provided in Table 5-6. It is noted that a summary for Reed Reservoir is not included in the table, since the two new tanks replacing the original reservoir are now in operation and the original reservoir has been demolished.



Age of Existing Pipes

Figure 5-3

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ATKINS

Escondido Water Master Plan
June 2012

The oldest reservoirs in the Escondido distribution systems are over 50 years old, and are in need of significant repairs or replacement. The A-3 Reservoir, which was constructed in 1940, is in poor condition. The concrete reservoir is leaking, primarily along the seams, and to minimize water loss the reservoir is typically operated at a water level below 10 feet. This master plan will assess the need for the A-3 Reservoir and pressure zone, and evaluate options with the hydraulic model to eliminate the reservoir altogether. The Lindley Reservoir, which was constructed in 1950, is scheduled for replacement within the next few years. The City has identified a site near the existing reservoir which it appears can accommodate two 1.5 MG tanks to replace the existing 2.0 MG tank.

The A-11 Reservoir was constructed in 1984 as a dual-bay reservoir. Due to water quality concerns and operational limitations, however, only a single bay is currently in operation, and the second bay has remained empty for many years. As summarized in Table 5-6, the majority of the exterior and the bulk of the interior of the reservoir appear to be in good condition, with only hairline cracks and minor areas of spalling or cracked caulking. However, there is some tie wire and rebar corrosion on the interior of the reservoir and extensive coating failure on the common inlet/outlet, overflow and drain lines that has lead to significant corrosion of these pipelines. It is noted that only the operational bay of the A-11 Reservoir was inspected. The dry side of the A-11 Reservoir is reported to be unusable in its current condition and will require extensive cleaning and some repairs to be put back in service.

The Parkhill Reservoir was constructed in 2001 to replace an older reservoir at the same site. The partially buried concrete reservoir is comprised of hydraulically equivalent bays with equal volumes. Water is supplied to the reservoir through a single regulating valve and pipeline, which splits into two separate inlets. Each bay has a separate outlet with pipelines that join together before supplying downstream distribution pipelines or the Parkhill Booster Pump Station. Water level data recorded by the SCADA system indicates that water levels in each bay are often separated by two to five or more feet, and only one bay appears to be hydraulically active at a time. The inlet pipes to each bay were designed with a flapper-type swing check valve, and it was reported that these valves would stick, resulting in the difference in water levels. However, the 2010 Parkhill Reservoir Inspection Report states that "Flapper valves are no longer attached to the ends of the lines. At the request of water department personnel the divers removed the flapper valves during the last inspection [seven years ago]".

Table 5-6 2009-10 Reservoir Inspection Reports Summary

	Exterior				Interior					Appurtenances					Sanitation			
Facility	Roof	Tank Walls	Ringwall	Caulking	Tank Walls/Shell	Roof	Caulking	Support Columns	Tank Floor	Ladders/ Handrail	Hatches/ Manways	Drain Lines	Overflow	Inlet/ Outlet Lines	Interior	Roof Vents	Security Fence	Comments/Other
Clearwell	hairline cracks; 2 spall spots	exposed rebar at 1 location	--	cracked & delaminated	hairline cracks; delaminated patches; corrosion & 2 spall spots	good; couple of small spalled areas	cracked & delaminated	few slight hairline cracks	hairline cracks	light surface corrosion	cracked & delaminating coating	coating failure & corrosion	minor cracks in weir box	outlet-coating failure & corrosion	scattered sediment & sand	small holes in mesh screens	--	
Lindley	paint-fair/poor	paint-fair/ poor; surface corrosion	asphalt - good	N/A	coating- good-very poor; delaminated areas w/corrosion	epoxy coating - poor; corrosion w/ small holes	N/A	good to very poor	N/A	fair/very poor; corroded areas	fair-poor; gasket is cracking	poor - coating failure	fair; areas of light corrosion	common I/O - fair/ good	1/8" of sediment; coating & steel debris	screen-good	--	cathodic protection system - fair; dense corrosion on a few anodes; sampling line poor
A-11 Bay #1	good; hairline cracks & 2 spalled areas	good; crack at joint	N/A	fair	good-fair; hairline cracks, patched sections & tie wire/rebar corrosion	good; couple of small spalled areas	good to fair	fair; significant corrosion	good; rebar corrosion near toe of slope	ladder-good; hardware is heavily corroded	good	very poor; mod to dense corrosion	very poor; mod to dense corrosion	common I/O-very poor; mod to dense corrosion	1/8"-1/4" of sediment	screen-good	good; one cut hole	Bay #2 is dry and was not inspected
A-3	wood roof-good; some dry rot spots	fair-poor; many cracks & leakage	N/A	--	fair to extremely poor; concrete patches - very poor	good;	N/A	good	good	paint-poor; light to dense corrosion	good	very poor; dense corrosion	good	line -good; valves-very poor	sediment and larger debris	screens-tears & holes; very poor	N/A	bats are living in the wood roof rafters
Parkhill	gravel covered	paint - good; small spots of spalled concrete	N/A	--	good; repair patches - good; corrosion from exposed rebar in 2 areas & tie wire corrosion	good; some tie wire corrosion	good	good; tie wire corrosion	good; patches-fair	very good/ excellent	excellent	epoxy coated; good	good	epoxy coated; inlet-good outlet-good	1/8"-1/4" of sediment	paint - good; screens-excellent	excellent	~2 gpm water leak at hole in caulked joint in Bay #2; sacrificial anodes on pipes are completely spent
Royal Crest	paint-poor; few areas of dense corrosion & metal loss	paint - fair; delaminated areas w/ corrosion	good	N/A	epoxy coating good to very poor; cracked & delaminated areas w/ mod to dense corrosion	epoxy coating-poor; delaminated areas w/dense corrosion & metal loss	N/A	center pole - good to fair	epoxy coating - good	paint-fair; epoxy coating-good; no ladder safety cage	paint - fair; epoxy coating on hatch - very poor	mod-severe interior corrosion on exterior		common I/O - fair/good	1/8"-1/4" of sediment; coating & steel debris	screen - good	--	poor water clarity from 2" fill line turbulence; former outlet line is abandoned due to coating failure; cathodic protection system-good
Vista Verde	paint-good to poor; cracked on plate weld seams w/light corrosion	paint - good	good	N/A	epoxy coating good to very poor; cracked & delaminated areas w/ light to dense corrosion	very poor; light-dense corrosion throughout; metal loss & failure of rafters, tie rods & rafter tails	N/A	center pole - good to very poor above water	good	paint-good; epoxy coating - poor; dense corrosion on dry rungs	paint-good; epoxy coating -poor w/corroded areas	good to poor; corrosion above water line	epoxy coating good-poor; corrosion above water	common I/O - good	1/8"-1/4" of sediment; steel & tie rod debris	few holes in fine mesh screen	--	sight level gage was not functional; cathodic projection system in good condition
Hogback	paint- good; delimitation along edge	paint- good	good	N/A	epoxy coating-good; some ruptured blisters w/light-mod corrosion	epoxy coating fair-good; mod-dense corrosion in few areas on roof plates	N/A	center pole - good	epoxy coating - good	good-poor; few areas of dense corrosion	good; dense corrosion on 1 hinge	good	fair; few areas of dense corrosion	separate lines - good	1/16" of sediment	fair-poor; dense corrosion on frames	--	cathodic protection system in good condition; corrosion on anode hatches
East Grove	paint- good	paint- good	good	N/A	epoxy coating - good some epoxy patches & blisters	epoxy coating - good; cracked coating on rafter tails	N/A	center pole - good	epoxy coating - good	good	aluminum - good	good		separate lines - good	sediment & leaves	good	--	some graffiti; cathodic protection system is in good condition
Dixon	paint- fair/ poor	paint- fair/ poor	good	N/A	coating-fair/good; pinhole & light-mod corrosion spots	coating - poor, cracked; light-mod corrosion	N/A	center pole - good	coating-fair/poor	fair-poor	coating - poor; light-mod corrosion	good	coating - good; some corrosion	common I/O - good	1/8" of sediment	excellent	--	cathodic protection system is in good condition

Section 6
Existing Distribution System Analysis

This section first describes the water system computer model and hydraulic analyses which were used to identify system deficiencies. Extended period maximum day demand simulations of the existing water system were performed using the GIS-based H_2OMAP network computer program, and additional analyses were made with fire flows and an emergency supply scenario assuming a new/upgraded SDCWA treated water turnout. Water system deficiencies are described and system improvements are recommended to satisfy the water system criteria outlined in Section 4.

6.1 Hydraulic Model Development

For this master plan update, a new computer model of Escondido's water distribution system was developed based on the City's existing H_2ONET model and GIS pipeline data. The existing H_2ONET model developed as part of the 2000 Master Plan included only major transmission and distribution mains and select distribution pipelines, generally 8-inches in diameter and larger. For this update, the CAD-based H_2ONET model was first converted to the GIS-based H_2OMAP software. Smaller distribution pipelines and facilities constructed since the last master plan were added to the model based on the City's GIS. The small diameter pipelines included all the pipelines serving fire hydrants. For recently constructed facilities not yet included in the City's GIS, facility data was obtained from design or as-built drawings. New facilities input from construction drawings include:

- Park Hill Reservoir and Park Hill Pump Station
- Alexander Area Water Replacement Project
- Leslie Lane Improvements
- East Grove Reservoir, pump station and supply and distribution pipelines
- Hogback Zone improvements, including two new PRSs

Data input to the model for new pipelines includes the pipeline length, diameter, material and construction year. The pipeline roughness coefficient (Hazen Williams "C" factor), which determines friction loss (pressure drop) in the pipelines, was estimated from the material and construction year. Node elevations throughout the model were updated based on the City's 2-foot topographic data. For areas in the distribution system that are outside of the City boundaries, elevation data was input from Rincon MWD or USGS topographic data, or from construction drawings. Settings for pressure reducing valves and locations of closed valves separating pressure zones were provided by the City operations department. Exact locations of all the closed valves separating the Lindley and A-11 Zones are unknown, and closed valves were modeled based on assumed locations that were reviewed by City staff.

The H_2OMAP model includes all pump stations and reservoirs, including the WTP Clearwell. Pump station data, pump curves, and reservoir dimensional data were input from design drawings and construction specifications. Pump station controls were added to the model based on current SCADA reservoir level control settings. A 2-inch diameter valve with time controls was added to the model to simulate fill rates to the Royal Crest Reservoir from the Park Hill Zone based on information provided by City operations staff. The pipelines and major facilities in the H_2OMAP model were shown previously on Figure 5-2.

After the physical data was input to the new hydraulic model, demands were input at nodes from 2010 water billing data. The City's water billing database was initially reviewed to remove accounts that do not receive potable water from the Escondido-Vista WTP. These accounts include recycled water accounts, agricultural accounts receiving raw water, the "Country Club" exchange areas that are supplied from Rincon MWD, and a mobile home resort near Lake Wohlford that receives raw water.

Billing accounts were assigned XY coordinates in the GIS utilizing the "Premise Location" or "Parcel Number" field in the City's water billing database. Approximately 97 percent of accounts were located using this method. Accounts that could not be located due to missing or incomplete data were sorted by demand. Accounts with high water use were either located by City Staff or located manually using aerial photos and internet searches. The total demand from the remaining unlocated accounts, which was less than two percent of the total demand, was distributed evenly in the model.

The H_2OMAP model was then setup to perform extended period simulations incorporating pump station controls and control valve positioning data. Automated valves, which are controlled through SCADA and throttled at the treatment plant based on percent open positioning, were modeled by adjusting the minor loss coefficient ("K" factor) based on valve positioning data provided by the valve manufacturer.

6.2 Hydraulic Model Verification

An accurate and reliable hydraulic model is necessary to properly analyze the water distribution system. A properly calibrated model provides the confidence needed to make significant capital planning decisions and provides a planning tool to guide operational decisions. The existing system H_2OMAP model was verified and calibrated using both "macro" and "micro" level calibration procedures. "Macro" level calibration procedures utilize continuous pressure monitoring to obtain data points to simulate system operations over an extended period of time. The data is used to establish boundary conditions for steady state calibration and provide information for extended period calibration. "Micro" calibration procedures involve stressing the water system through a series of flow tests. A flow test can be described as flowing one (or more) hydrant(s) while measuring the pressure at other nearby fire hydrants.

Calibration data was collected from existing pressure loggers, a series of fire hydrant flow tests performed on October 25, 2011, and system operations data collected over a one-week period from October 25 to 31, 2011.

Pressure Logger Data

The water operations department monitors pressures throughout the distribution system using portable electronic data loggers. Historical pressure data was provided for thirteen locations where loggers had been in place for at least the past two years. The data consisted of printed graphs from data downloaded in mid-April 2011 showing approximately two weeks of pressures recorded in 30-second intervals. Additional graphs from previous years during the same time of year were also provided for most sites. Water demands in April are typically close to average annual demands, and the pressure data was used to determine average pressure ranges and daily pressure swings, and adjust PRV settings in the model. A comparison of recorded pressures in April 2011 with model pressures from a steady state simulation with average demands is provided in Table 6-1. Model pressures at all data logger locations were within the recorded pressure range. It is noted that reservoir water levels are set at approximate mid-points in the model, and therefore may not be representative of actual water levels during the pressure monitoring period.

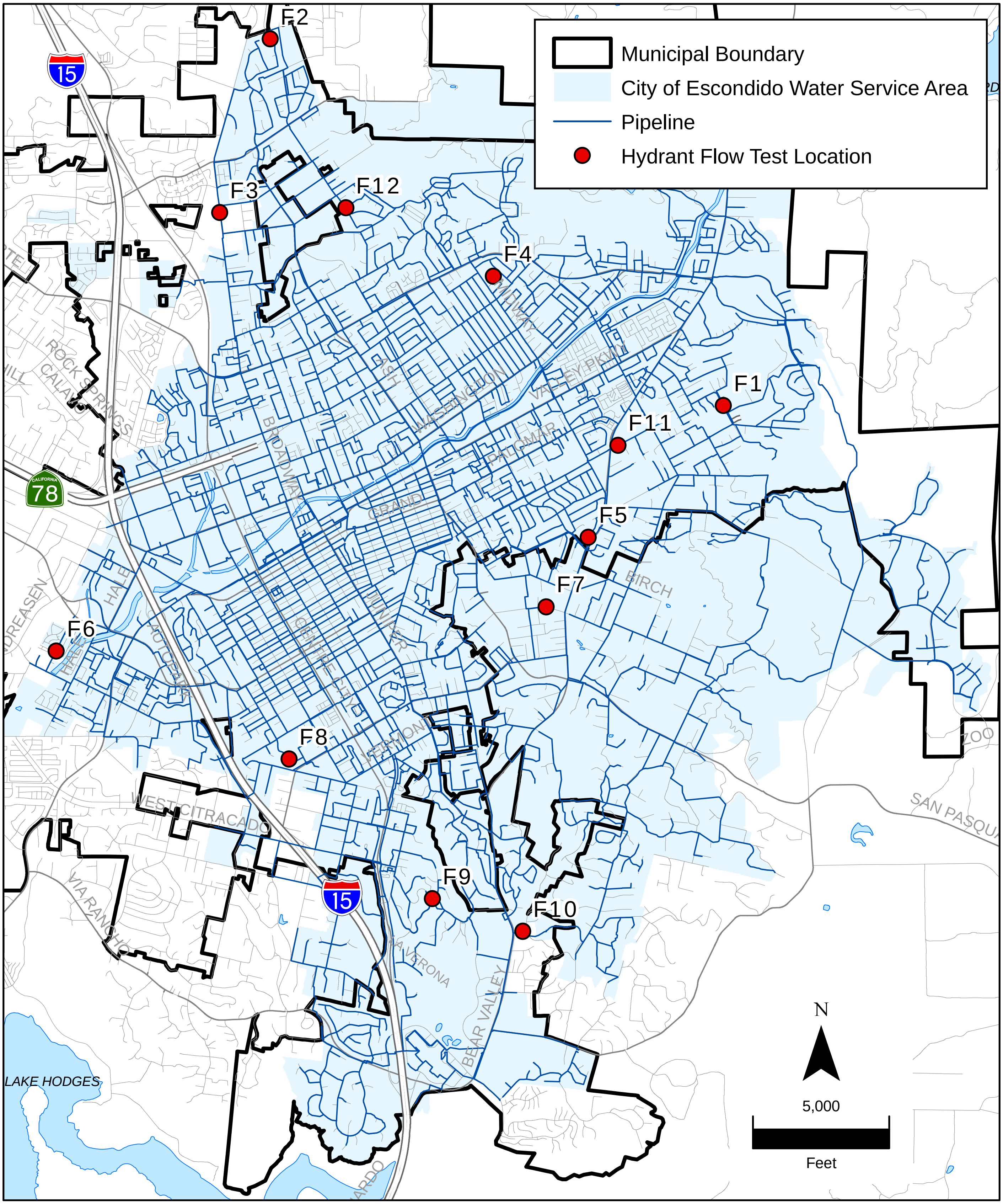
Table 6-1 April 2011 Pressure Logger Data

Pressure Logger No.	Location	Zone	Model Junction Node	Elev. (feet)	Recorded Pressure range (psi)	Daily Variance (psi)	Model pressure (psi)
1	Honeysuckle Way	Clearwell	J-0602	816	65 - 73	5	65
2	629 Hubbard Hill	Clearwell	J-0741	876	37 - 46	8	39
3	3198 Ridgeline Pl.	East Grove	J-0786	912	40 - 80	25	60
4	1414 Boyle Ave	Reed Island	J-0218	806	55 - 70	11	56
5	15305 Rockwood Rd	Reed	J-2670	410	215 - 235	15	228
6	2289 Old Ranch Rd	Reed Regulated	J-2671	526	67 - 82	12	67
7	3680 Sierra Linda	Lomas East	j-2672	558	62 - 76	10	68
8	3300 Bear Valley Pkwy	Parkhill	J-2531	416	170 - 182	10	181
9	210 E. Via Rancho Pkwy	N County Fair	J-2673	362	112 - 123	10	123
10	3538 Lomas Serenas Dr.	Lomas West	J-1861	542	100 - 109	20	108
11	257 Silvercreek Glen	A-11/Lindley	J-1832	572	141 - 153	10	147
12	1311 Park Hill Lane	Parkhill Pumped	J-1310	895	40 - 45	5	40
13	1091 Park Hill Terrace	Reed Island	J-1321	82	53 - 60	5	58

Hydrant Flow Tests

Twelve hydrants were opened and flowed by water operations staff on October 25, 2011 for the model calibration effort. The hydrants are in major pressure zones and are generally located near the edge of the zone/distribution system and away from the water source, where the resulting pressure loss in transmission mains will be greatest. The locations of the hydrant flow tests are shown on Figure 6-1. For each flow test, water levels in reservoirs and automated control valve positions were recorded at the WTP and the flow rate through the hydrant and residual pressure at two nearby hydrants were recorded in the field. Flow entering the Clearwell was also recorded, and system demands were calculated from the flow entering the distribution system and change in reservoir water levels. The data gathered during these flow tests was used to perform a steady-state or micro calibration of the hydraulic model. The primary goal for this analysis is to closely approximate the pressure drop in the model at each hydrant flow location.

Table 6-2 summarizes the test results and provides a comparison between field data and model results. For the field data, static pressures are recorded just prior to the flow test and residual pressures are recorded once flow through the open hydrant has stabilized. In the model results, the residual pressure is obtained from a steady state simulation with a demand equal to the measured hydrant flow input at the location of the flowed hydrant. At most residual hydrants, the difference between field and modeled pressures is within 10 percent, which is considered a good correlation for this type of test.



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Hydrant Flow Test Locations

Figure 6-1

ATKINS

Escondido Water Master Plan
June 2012

Table 6-2 Hydrant Flow Test Summary

Hydrant	Zone	Field Data: Static Read 1 (psi)	Field Data: Static Read 2 (psi)	Field Data: Residual (flowing) Read (psi)	Field Data: Residual (flowing) Drop fr/ static (psi)	Field Data: Hydrant Flow (gpm)	Model Results: Model ID	Model Results: Static Pressure (psi)	Model Results: Static Difference Field-Model (psi)	Model Results: Residual Pressure (psi)	Model Results: Residual Difference Field-Model (psi)	Model Results: Residual Difference Field-Model (%)
F1	Clearwell	--	--	--	--	1,240	J-2704	97	--	--	--	--
F1-R1		106	106	103	3	--	J-2716	104	-2	99	-4	4%
F1-R2		97	96	75	22	--	J-2705	99	2	66	-9	12%
F2	Clearwell	--	--	--	--	1,250	J-2695	87	--	--	--	--
F2-R1		83	83	72	11	--	J-2687	84	1	71	-1	1%
F2-R2		90	90	80	10	--	J-0600	92	2	81	1	-1%
F3	Lindley	--	--	--	--	1,300	J-2706	89	--	--	--	--
F3-R1		86	86	70	16	--	J-2717	82	-4	20	-50	71%
F3-R2		93	93	80	13	--	J-2718	91	-2	71	-9	11%
F4	Lindley	--	--	--	--	1,030	J-1476	83	--	--	--	--
F4-R1		86	86	82	4	--	J-1477	84	-2	80	-2	2%
F4-R2		80	80	76	4	--	J-2719	79	-1	76	0	0%
F5	Lindley	--	--	--	--	1,000	J-2710	64	--	--	--	--
F5-R1		88	88	72	16	--	J-2720	88	0	75	3	-4%
F5-R2		74	74	62	12	--	J-2721	76	2	61	-1	2%
F6	A-11	--	--	--	--	1,290	J-2696	109	--	--	--	--
F6-R1		113	116	81	34	--	J-2378	110	-3	75	-6	7%
F6-R2		128	128	112	16	--	J-2711	127	-1	116	4	-4%
F7	Reed Island	--	--	--	--	1,160	J-1176	93	--	--	--	--
F7-R1		80	80	72	8	--	J-1153	82	2	79	7	-10%
F7-R2		80	80	59	21	--	J-2508	87	7	65	6	-10%
F8	Park Hill	--	--	--	--	1,030	J-1769	61	--	--	--	--
F8-R1		70	70	64	6	--	J-1767	66	-4	65	1	-2%
F8-R2		72	72	65	7	--	J-1772	66	-6	59	-6	9%
F9	Royal Crest	--	--	--	--	900	J-2712	65	--	--	--	--
F9-R1		60	60	42	18	--	J-2722	55	-5	49	7	-17%
F9-R2		75	76	62	14	--	J-0539	75	0	68	6	-10%
F10	A-3	--	--	--	--	1,150	J-2591	187	--	--	--	--
F10-R1		92	92	82	10	--	J-2723	92	0	81	-1	1%
F10-R2		32	32	30	2	--	J-0728	33	1	29	-1	3%
F10-R3		25	25	23	2	--	J-2724	27	2	23	0	0%
F11	Reed	--	--	--	--	1,150	J-1025	96	--	--	--	--
F11-R1		80	80	53	27	--	J-1591	78	-2	44	-9	17%
F11-R2		82	82	82	0	--	J-0484	81	-1	81	-1	1%
F12	Vista Verde	--	--	--	--	1,525	J-0348	114	--	--	--	--
F12-R1		69	69	56	13	--	J-0330	68	-1	61	5	-9%
F12-R2		146	146	141	5	--	J-2714	134	-12	121	-20	14%

The difference between field and model pressures for Hydrant Tests F3, F7, F8 and F12 are explained as follows:

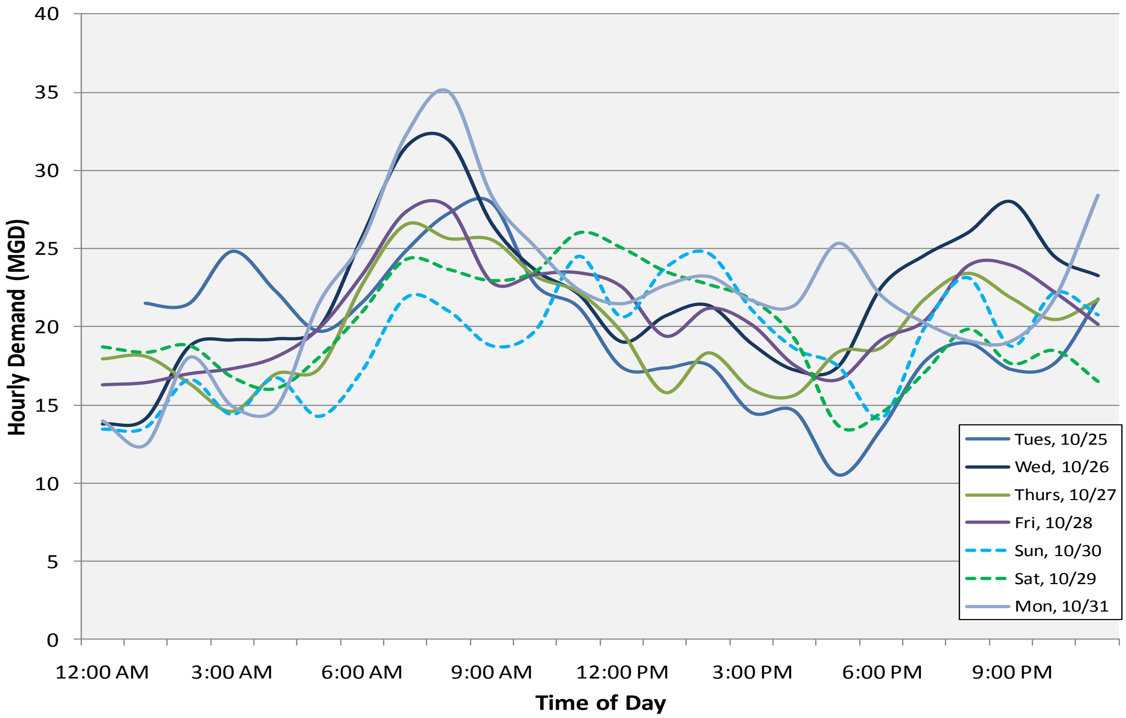
- In Hydrant Test F3, the residual pressures recorded in the field are much higher than in the model. When the model was rerun with the 8-inch diameter pipeline in North Broadway replaced with a 12-inch diameter pipeline, model pressures closely matched field pressures. Operations staff is in the process of verifying the diameter of the pipeline.
- The difference between the model and field pressures for Hydrant Test F7 is most likely due to the lag in the response time of the large diameter pressure reducing valve that supplies the Reed Island Zone (field condition), which is not accounted for in the model.
- The difference between the model and field pressures for Hydrant Test F8 was initially large, but upon further investigation water operations staff discovered a looped pipeline in the field that is not shown in the GIS. The pipeline was added to the model and the simulation was rerun, with good results.
- In Hydrant Test F9, three PRSs opened to deliver fire flow in the Royal Crest Zone. The difference between model and field pressures may be due in part to inaccurate pressure settings at one of more of the PRSs.
- For Hydrant Test F12 the field pressures are likely in error, since the pressure drop at the residual hydrant closest to the fire flow was less than the pressure drop at the hydrant further upstream.

Extended Period Calibration

In addition to steady state calibration, the hydraulic model was also calibrated for an extended period simulation. Extended period or macro calibration was performed to ensure the model accurately reflects how the overall system operates over time with respect to transmission mains, pumps, and reservoir operations under normal operating conditions. Prior to the extended period calibration, steady state calibration was conducted and believed to provide a reasonably accurate representation of actual system characteristics in terms of water main geometry, spatial demand allocation, and pipe roughness. As with steady state calibration, precise duplication of the data recorded at all locations within the water distribution system during extended period calibration is not realistic due to many factors that may influence the field test results. The goal of model calibration is to minimize the error between the field data and the model simulations, and create a “best fit” at all locations. Therefore, some error between the field data and model simulations is expected; however, limits to the amount of allowable error must be made to ensure the calibrated model is a reasonably accurate representation of the actual water distribution system.

For extended period calibration, a composite time-of-day demand curve was first determined for the Escondido water distribution system based on collected SCADA data of flow rates into the WTP Clearwell and reservoir water levels during the field work testing period of October 25 through 31, 2011. From reservoir water levels and tank dimensional data, the hourly volume of water entering or exiting each tank was calculated. The hourly system demand was then calculated based on the flow rate into the Clearwell from the WTP, plus the total net flow rate into or out of the tanks (negative flow for tanks filling, positive flow for tanks emptying). The peaking curves for each day during the calibration period are shown on Figure 6-2. The average daily demand during the seven-day calibration period ranged from 0.98 to 1.1 times the 2010 average annual demand.

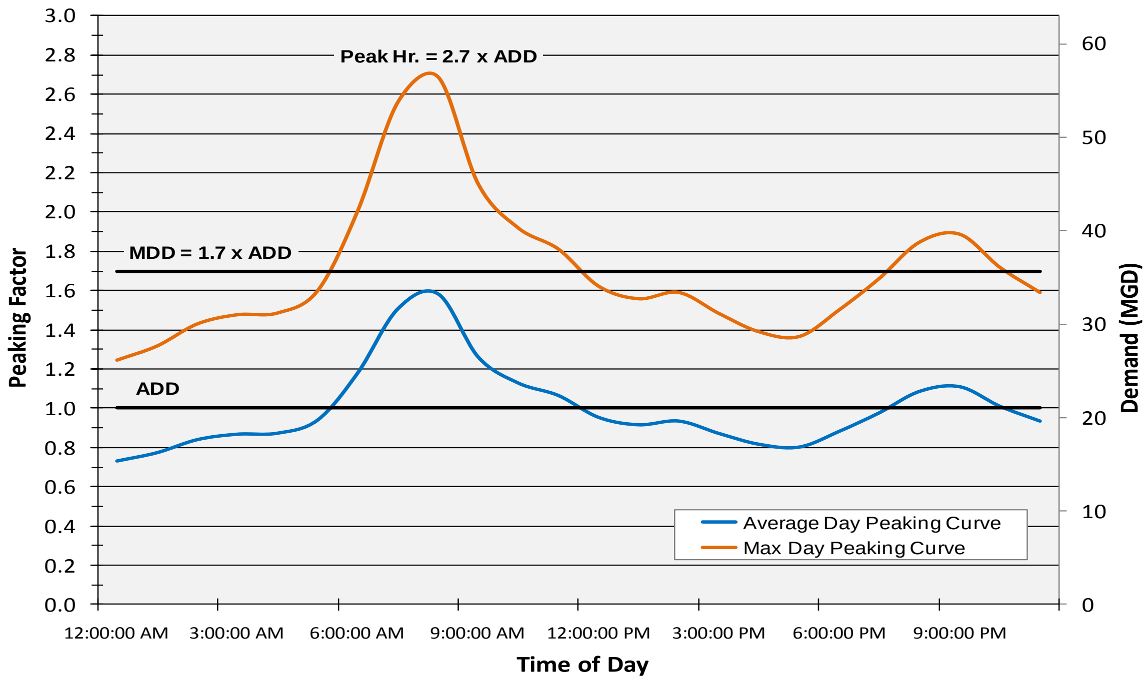
Figure 6-2 Escondido Daily Demand Curves for October 25-31, 2011



As can be seen from the daily demand curves, peaking is significantly higher on weekdays than on weekends. A composite diurnal demand curve was therefore developed based on the weekday curves from the calibration period. As discussed in Chapter 4, the time-of-day diurnal demand curve is a series of 24 hourly demand factors that define how water usage varies over the course of a day. Each demand factor is defined as the ratio of the hourly demand to the average annual demand. Since demands during the calibration week were approximately equal to the average annual demand, the composite curve developed from this data is considered to be the average day demand curve. The average day demand curve was then multiplied by the maximum day demand factor developed from historical data and "stretched" slightly so that it includes the peak hour demand factor, which is calculated based on peaking curves developed by the City of San Diego (City of San Diego curves have been developed over many years, take into account the demand of the service area, and have been found to be a good representation of many San Diego County agencies). Figure 6-3 illustrates the average day and maximum day diurnal demand curves developed from the extended period calibration data. It is noted that these curves are representative of the entire service area, and peaking within smaller geographic areas or specific pressure zones will likely be higher.

Extended period simulations were performed with the Escondido water model using the average day demand curve developed above. Instead of modeling each day individually, a typical average day was modeled and run for seven consecutive 24-hour periods. Control logic for automated valves to set the percent open position was developed based on recorded SCADA data and reservoir level operating ranges. For pump stations, on/off controls were input based on SCADA tank level controls.

Figure 6-3 City of Escondido Diurnal Demand Curves



Results of the extended period calibration are best illustrated from a comparison of tank levels. Figure 6-4 provides the recorded tank levels (field data) and model results for each reservoir during the seven day calibration period. In general, the tanks exhibited similar trending patterns in the model when compared to the field data collected, especially with regards to the fill and drain rates. The A-3 Reservoir exhibited several drops in tank levels that were not duplicated in the model. This is most likely due to a sudden change in position for the valve that supplies Rincon ID-A, which is controlled by Rincon MWD staff and is not recorded by the Escondido SCADA system. For the Park Hill Reservoir, tank levels in each basin are recorded separately. SCADA levels indicate that only one basin appears to be active in the system at a time. Basin 2 was active for the first several days, and during the evening of Thursday, October 28, the Basin 1 became the active basin for the duration of the calibration period. Operations staff has said that no changes to valves on Park Hill Reservoir inlet or outlet pipelines are made in the field. Since this phenomenon is not understood and therefore cannot be duplicated in the model, controls in the model are set to mimic tank operations with a single bay in service.

Pressures from the extended period calibration were also compared to pressures from the pressure data loggers. Figure 6-5 illustrates weekday pressures recorded during the calibration period from Pressure Logger 1 with model pressures from the first day of the calibration simulation. Pressure Logger 1 is installed at a hydrant on Honeysuckle Way, in the northwest end of the Clearwell Zone. While the model pressures exhibit a similar trend to recorded field pressures, there is less daily variance, which was typical at most pressure logger locations. At Pressure Logger 1 the greater variance in field pressures is likely due to localized demand fluctuations, especially for some of the larger irrigation and agriculture users in the vicinity.

Figure 6-4 Extended Period Calibration Reservoir Levels

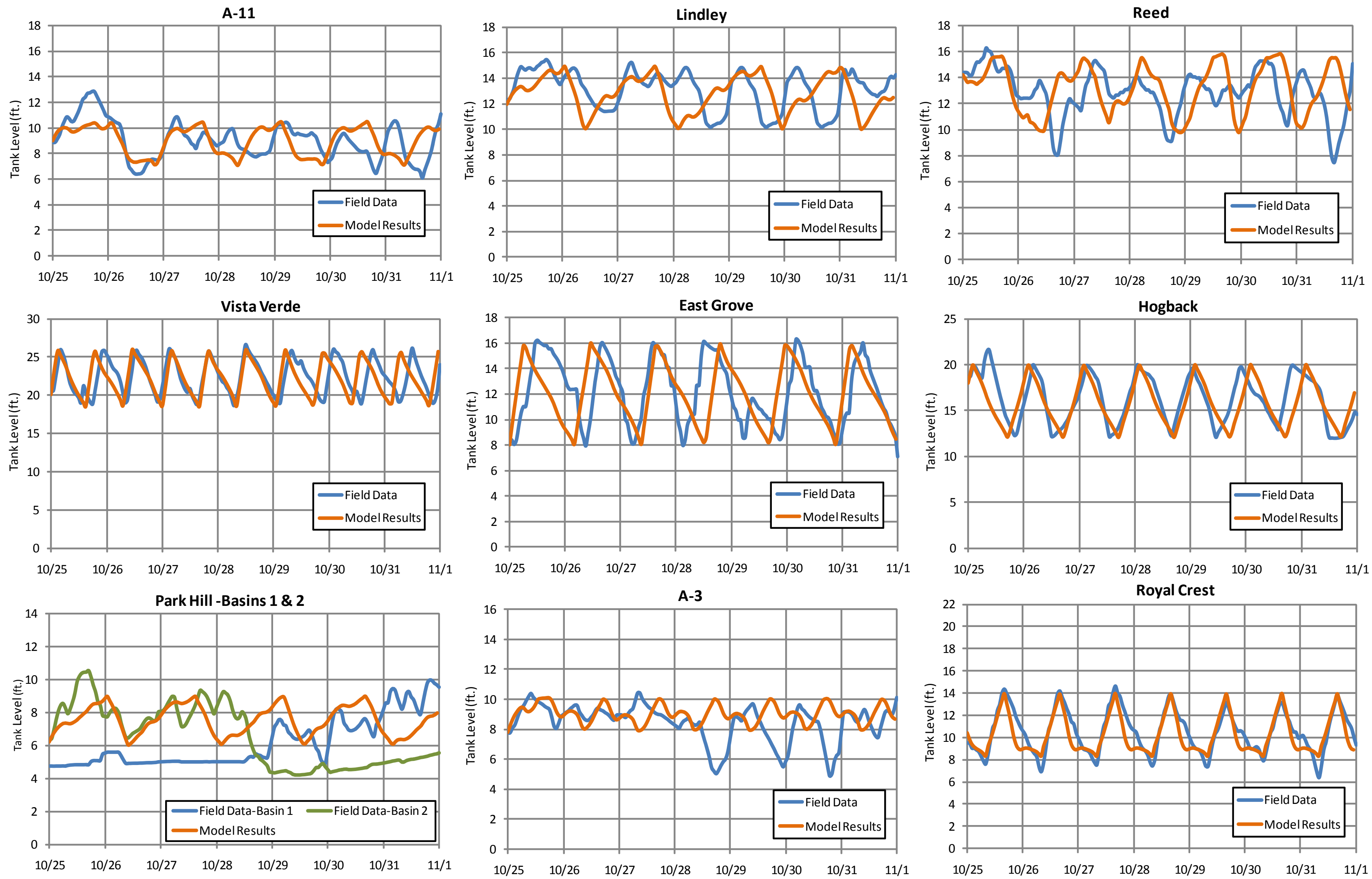
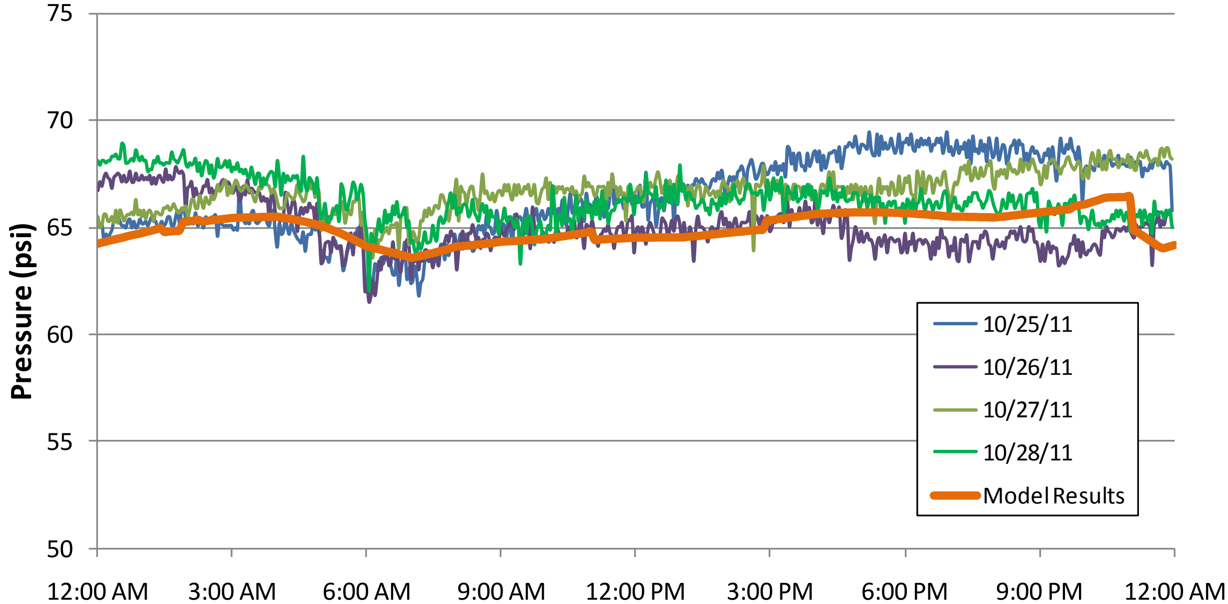


Figure 6-5 Field and Model Pressures at Pressure Logger 1 (Honeysuckle Way)



In reduced pressure zones, field pressures will vary more than model pressures because pressure reducing valves are not perfect and take time to react to demand changes. Furthermore, there are multiple valves of different sizes with different pressure settings at most PRSs. Only one or at most two valves are modeled at each PRS to avoid model convergence problems. It is noted that peaking factors for the maximum day diurnal curve are somewhat exaggerated to compensate for the model limitations, and modeling efforts are focused on duplicating minimum pressures in the system.

Calibration Summary

The hydraulic model was calibrated for both steady state and extended period conditions, and results from the model calibration effort were discussed in detail with City Staff at several project review meetings. It is concluded that the model is well-calibrated and sufficiently accurate for the existing and future system hydraulic analysis. In the future, additional water system mapping and the refinement of elevations and geometry information will improve the hydraulic model and lead to even higher levels of accuracy in modeling results.

6.3 Hydraulic Model Evaluation

The calibrated model is an accurate representation of the water distribution system as it operated on October 2010. At the direction of City Staff, several changes were made to the model prior to conducting the existing system simulations to incorporate planned system improvements. These improvements include:

- The “cemetery line” improvements in the Reed Zone were added to the model from design drawings.

- The original Reed Reservoir was removed and the two 2.5 MG Reed 1 and Reed 2 Reservoirs were added to the model based on design plans. These reservoirs are now in service.
- A-11 Reservoir is modeled with a single 4.0 MG bay, which is consistent with current operational procedures.

Existing system demands were also increased from 2010 demands. As stated in Section 2, water demands have decreased rather dramatically since 2007, and the low water usage in 2010 can be attributed to drought conditions and mandated water use restrictions, the economic recession, lower than average summer temperatures, and the continued rising cost of water. The reduction in water use can be considered mostly temporary for all the factors except for the rising cost of water. After discussion with City Staff, it was decided to conservatively increase 2010 water demands by 20 percent in the existing system analysis. This will bring demands back to approximately water use levels in 2008 for the purposes of evaluating existing system capacity. Demands in the existing system model are summarized by pressure zone in Table 6-3.

Table 6-3 Existing System Model Demands by Pressure Zone

	Average Annual Demand[1]		Max Day Demand[2]
Pressure Zone	**gpm**	**MGD**	**MGD**
Hogback	392	0.56	0.96
Vista Verde	275	0.40	0.67
East Grove	311	0.45	0.76
Parkhill Pumped	50	0.07	0.12
Clearwell	3,078	4.43	7.54
Reed	1,537	2.21	3.76
Reed Island	240	0.34	0.59
Lindley	5,927	8.53	14.51
A-11	1,896	2.73	4.64
A-3	753	1.08	1.84
Park Hill	996	1.43	2.44
Lomas West	417	0.60	1.02
Lomas East	81	0.12	0.20
Reed Regulated	346	0.50	0.85
Royal Crest	209	0.30	0.51
No. County Fair	83	0.12	0.20
Rincon ID-A	722	*1.04*	*2.91*
Totals	**17,314 gpm**	**24.9 MGD**	**43.5 MGD**

(1) July 09- June 2010 billings increased by 20%

(2) Maximum day demands are average demands x 1.7, except for Rincon ID-A demands, which are multiplied by 2.8 based on historical maximum day supply rates.

Maximum Day Demand Simulation

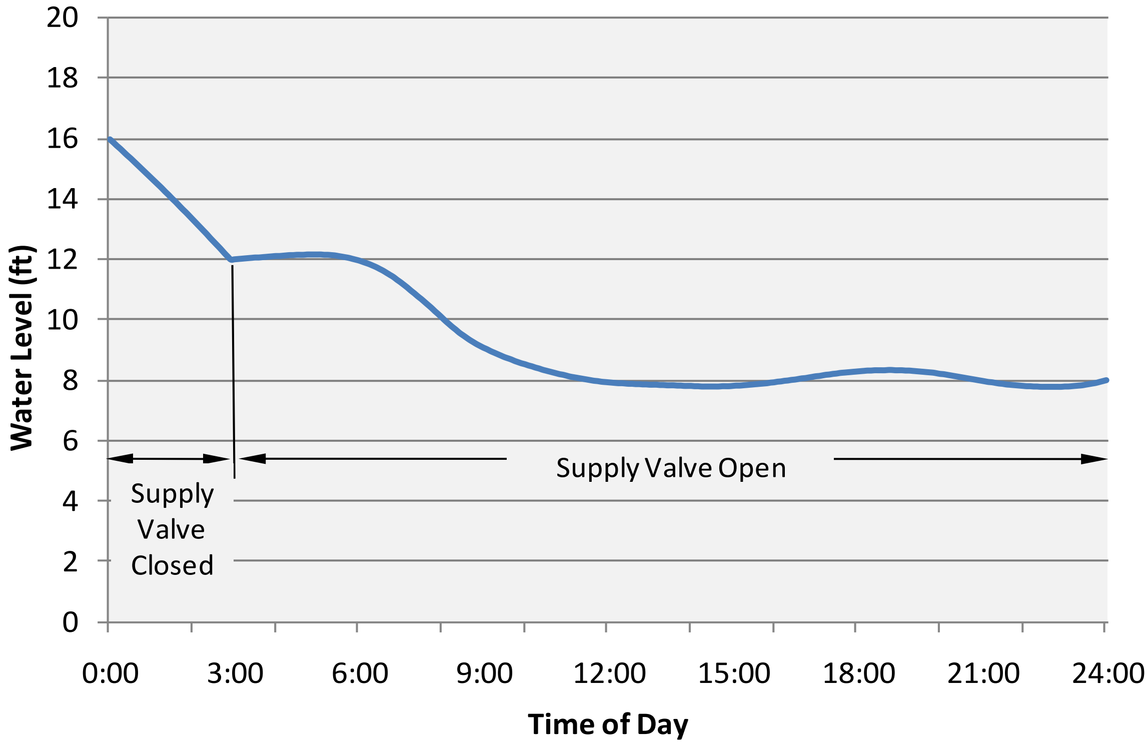
To assess performance of the existing distribution system under peak flow conditions, a 24-hour extended period simulation was performed with existing model demands peaked by the maximum day demand curve shown previously in Figure 6-3. All demands were peaked by the diurnal demand curve except for the Rincon ID-A demand, which was modeled as a constant 24-hour maximum day demand of 2.91 MGD (2,020 gpm) based on historical flow records. A constant flow of 44.3 MGD was input to the Clearwell and reservoir levels were set at approximately half full at the start of the simulation.

Output from the maximum day demand simulation was reviewed to assess reservoir operations (ability to provide peak flows and refill after draining) and identify pipelines with excessive velocities and/or head loss. Results indicated that pipeline velocities were less than 3 fps for the vast majority of pipelines and no pipelines exceeded the maximum allowable velocity of 7 fps during the simulation. Velocities over 5 fps occurred in only a few short sections of pipeline directly downstream of pressure reducing stations. Several of the larger transmission mains had velocities that were between 3 fps and 5 fps, including the dual mains supplying flow from the Clearwell, the 36-inch diameter Channel pipeline, a portion of the 27-inch diameter Bear Valley Pipeline south of Boyle Avenue, and the 18-inch diameter pipeline downstream of the Lindley Reservoir.

At peak hour demands there are several areas with pressures less than 40 psi, but these are generally at high elevation areas directly downstream of reservoirs. The only low pressure areas removed from reservoirs are in the vicinity of Hubbard Hill in the Clearwell Zone, along Howell Heights Drive in the A-11 Zone, near Crestview Estates in the Reed Zone, and at the north end of Mary Lane and near Tee Pee Hill in the A-3 Zone. The low pressures in these areas are due to high elevations and are not the result of excessive pipeline friction losses due to high velocities.

Water levels were maintained or refilled for every reservoir during the simulation except for the A-11 Reservoir. Due to its location, the A-11 Reservoir tends to stagnate in the system and operators must actively control and vary the water level to maintain water quality. Figure 6-6 illustrates A-11 Reservoir water levels with a single bay in operation during the maximum demand day simulation. At the start of the simulation the water level was set to approximately 16 feet (approximately 70 percent full) and the 12-diameter automated supply valve at Orange and Valley was closed. Once the reservoir had dropped four feet the valve was opened wide, but the tank continued to drop during the morning peak demand period and the tank could not be refilled. These results indicate that the 12-inch diameter valve at Orange and Valley cannot pass enough flow with the available pressure differential from the Clearwell Zone to supply A-11 Zone maximum day demands. It is noted that a backup PRS at El Dorado and Juniper can also supply water to the A-11 Zone, but this valve is set to open only in response to a large pressure drop (emergency condition) and was closed during the simulation.

Figure 6-6 A-11 Reservoir Water Levels from the Maximum Day Simulation



Fire Flow Analysis

A global fire flow analysis was performed with the existing system hydraulic model to determine the available fire flow at each node with a 20 psi residual pressure. The fire flow simulation was run with maximum day demands and water levels at reservoirs set to half full. While not every hydrant is modeled as a node, the model includes all pipelines with fire hydrants shown on the City's GIS. Small diameter pipelines without fire hydrants are not in the model, and dead end pipelines are included out to the location of the last fire hydrant.

Results from the fire flow simulation indicate that most areas in the distribution system can supply a flow of at least 2,500 gpm. However, the fire flow analysis also identified numerous small diameter pipelines that cannot provide the minimum 1,500 gpm fire flow, or even 1,000 gpm. Many of these are 4-inch diameter or dead-end 6-inch diameter pipelines. The largest concentration of 4-inch diameter pipelines is in the Royal Crest Zone. It is recommended that all 4-inch diameter pipelines that supply fire hydrants be replaced with 8-inch diameter pipelines. The Lindley Zone 8-inch diameter pipeline in Broadway cannot provide the minimum 1,500 gpm fire flow north of Vista Avenue, and this area is within the high fire severity zone. In addition to areas with undersized pipelines, there is an area near Mary Lane and Orangewood Drive in the A-3 Zone where a 1,000 gpm fire flow cannot be delivered at 20 psi because the service elevations are too high.

SDCWA Potable Water Emergency Supply Analysis

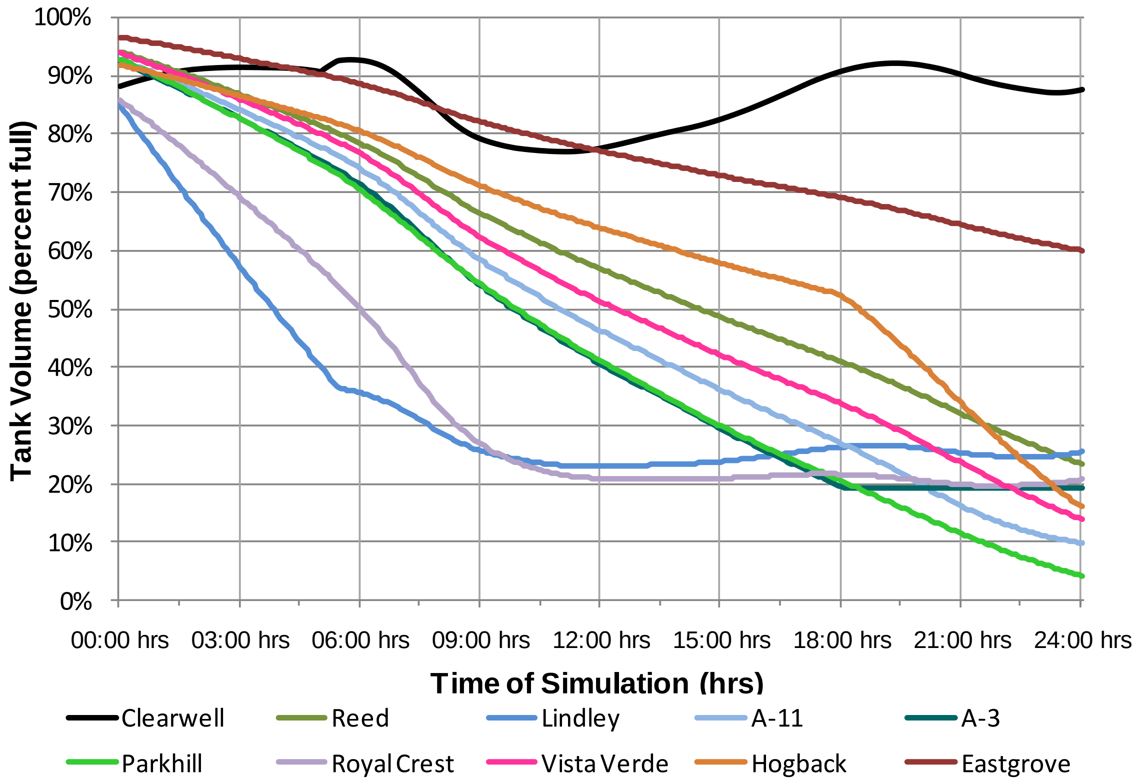
An additional simulation was made with no supply to the Clearwell from the WTP and an emergency supply from the ECS2 turnout location on the SDCWA aqueduct. ECS2, the southernmost treated water turnout on SDCWA Pipeline 2, is just north of the Hubbard Hill overflow near Rincon Avenue and Conway Drive in the Clearwell Zone. The turnout has not been used in many years, and the metering facility and most pipelines in the turnout structure have been removed. If facilities were constructed to put this turnout back into service, Escondido would no longer be dependent upon Rincon MWD for an emergency supply of treated water from the SDCWA. Furthermore, if water from the turnout can be supplied to the Lindley Zone it could be considered a back-up supply for that zone, eliminating the need for new storage facilities to satisfy emergency storage criteria.

For the emergency supply simulation, a flow control valve was modeled at the ESC2 connection and a new 24-inch diameter pipeline was modeled in Conway Drive from the ESC2 turnout south to connect with the existing 24-inch diameter Clearwell Zone pipeline at Lehner Avenue. A new PRS to the Lindley Zone was modeled at El Norte Parkway and Conway to supply an existing 21-inch diameter Lindley Zone transmission main. This PRS was set to pressure control, and effectively replaced supply normally provided through the Clearwell Channel Line. All reservoirs were started full, pumps supplying reservoirs were turned off, automated valves supplying reservoirs were closed, and a 24-hour simulation was run with average day demands and no supply from the WTP. In this simulation demands for Rincon ID-A and the San Diego Zoo Safari Park were also removed, since these offsite customers have their own storage facilities.

For the first simulation, the supply at the turnout was set to equal the demand of the Lindley Zone (6,000 gpm or 13 cfs). The automated valve at Ash/Channel was closed and supply to the Lindley Zone was provided from the ESC2 turnout through the new PRS and the automated PRS at Lindley Reservoir. Some adjustments were required at several PRSs to prevent reservoirs from emptying. At the end of the simulation most of the reservoirs, including the Clearwell, had drained to below 20 percent full. Results from this simulation indicate that supply can be provided from the ESC2 turnout to the Lindley Zone with minimal impact to pressures within the Lindley Zone. The pressure increase in the Clearwell Zone at the ESC2 supply location was less than 10 psi when compared to the normal system operations. The City would need to carefully monitor pressures at this location to avoid over pressurizing the system.

An additional simulation was made with higher flow rates supplied through the ESC2 connection, with the additional flow supplied back to the Clearwell. The limitation on supply from ESC2 would be the velocity in the downstream 24-inch transmission main and the resulting pressure increase in the Clearwell Zone. With 10,000 gpm (22 cfs) supplied through the ESC2 connection, model results indicated velocities of 6.4 fps in the 24-inch pipeline and a pressure increase of approximately 25 psi in the Clearwell Zone directly downstream of the turnout. This flow rate, which is approximately 60 percent of the existing ADD, is near the upper limit of the maximum flow that could be provided through ESC2 without larger transmission mains between the turnout and the proposed Clearwell to Lindley PRS. Reservoir storage volumes for the 24-hour emergency supply simulation with average day demands and 10,000 gpm supplied through the ESC2 turnout (no supply from the WTP) are shown on Figure 6-7. During this simulation, the hydraulic grade at the turnout was approximately 1020 feet, which is 45 feet higher than the HWL of the Clearwell. It is noted that the invert elevation on the SDCWA pipeline at Hubbard Hill is 1073 feet, and there would be no flow rejection under these simulated conditions.

Figure 6-7 Modeled Tank Volumes with a 10,000 gpm Treated Water Supply



6.4 A-11 Reservoir Hydraulic Study

The location of the A-11 Reservoir at the remote southwest end of the distribution system and hydraulic constraints prohibit the full capacity of the reservoir to be utilized effectively in the distribution system. A separate hydraulic study of the A-11 Reservoir was conducted to evaluate the operational performance and hydraulic limitations of the reservoir and the advantages/disadvantages of operating the system with both bays, one bay, or abandoning the reservoir. The A-11 Reservoir Hydraulic Study was completed in January 2012 and is provided in Appendix D. The study recommends rehabilitation of a single bay of the A-11 Reservoir for continued operation in a separate A-11 Zone as a 4.0 MG Reservoir.

6.5 Storage Capacity Assessment

Reservoir storage criteria is based on providing operational, fire and emergency storage within each major pressure zone (refer to the storage criteria in Section 4). Table 6-4 calculates the required storage for the water distribution system based on existing demands (2010 demands increased by 20 percent). Rincon ID-A and San Diego Zoo Safari Park demands were omitted from these calculations because both offsite customers have their own storage facilities. In addition, commercial agriculture accounts on the special agriculture water rate program (premise category = SAWR in the billing account database) were eliminated from the storage calculations since these customers are provided water at a reduce rate and would not be served in the event of a water supply emergency. The Lindley and A-11 Zones are considered separately in this table and only a single bay of the A-11 Reservoir is included as existing storage.

Table 6-4 Required Storage Based on Existing Demands

Reservoir/Zone *and Sub-Zones*	Average Annual Demand[1]		Required Storage - MG				Existing Storage MG	Surplus/ Deficit MG
	gpm	MGD	Operational 15% of MDD	Fire 2 hours	Emergency 1 ADD	Total		
Hogback	204	0.29	0.08	0.18	0.29	0.37	1.25	0.88
Vista Verde	257	0.37	0.09	0.24	0.37	0.46	0.75	0.29
East Grove	283	0.41	0.10	0.24	0.41	0.51	1.2	0.69
Clearwell	2,690	3.87	0.99	0.30	3.87	4.86	5.4	0.54
Reed Island	0							
Reed	1,257	1.81	0.46	0.30	1.81	2.27	5.0	2.73
Reed Regulated								
Lindley	5,917	8.52	2.17	0.30	8.52	10.69	2.0	(8.69)
A-11	2,302	3.32	0.85	0.30	3.32	4.16	4.0	(0.16)
Lomas West								
A-3	585	0.84	0.21	0.24	0.84	1.06	1.5	0.44
Parkhill	1,210	1.74	0.44	0.30	1.74	2.19	3.0	0.81
Parkhill Pumped								
Lomas East								
No. County Fair								
Royal Crest	209	0.30	0.08	0.18	0.30	0.38	0.25	(0.13)
Total	**14,915 gpm**	**21.5 MGD**				**27.0 MG**	**24.4 MG**	**-2.6 MG**

(1) Excludes Rincon ID-A, SD Zoo Safari Park and special rate agriculture demands. FY2010 water use is increased by 20% to account for temporary reductions in water use due to Level 2 water use restrictions, economic conditions, and lower than average summer temperatures.

Based on existing storage criteria, the Lindley Zone has a storage deficit of 8.7 MG (attributed mostly to the emergency component), and the A-11 and Royal Crest Zones have small deficits of 0.16 MG and 0.13 MG respectively. All other zones have a storage surplus, with the largest surplus in the Reed Zone due to the recently constructed Reed Reservoirs No. 1 and 2, which have a capacity of 2.5 MG each. The overall storage deficit is 2.6 MG.

Plans are being developed to replace the existing Lindley Reservoir with two new reservoirs, but site constraints will limit the total capacity to approximately 3.0 to 3.5 MG. The Vista Verde is also planned for replacement with a larger reservoir, and the replacement of these two tanks will eliminate the overall storage deficit. Although the design criteria allows emergency storage for one zone to be located in a higher zone if it can be supplied back down directly, this is not currently possible for the Lindley Zone, since there is only a small storage surplus in the Clearwell and there is no direct supply from the Reed Zone to the Lindley Zone. Since there are no new feasible storage sites in the Lindley Zone, options to provide emergency storage include:

- construct a second clearwell
- construct an additional reservoir at the site of the existing Reed Reservoirs and new pipelines to supply the Lindley Zone
- provide emergency storage from a separate back-up water supply

City Staff has proposed constructing new facilities at the City's SDCWA ESC2 potable water turnout to supply the Lindley Zone in an emergency. This would eliminate the emergency storage requirement for that zone.

6.6 Pump Station Capacity Assessment

Each pump station is required to have the pumping capacity to supply peak flows within its service zone with an additional pumping unit for standby capacity. Manufacture's pump curves were input to the hydraulic model and the capacity of each pump station was determined with both a single pump and two pumps in operation. The pump station capacity was then compared to the maximum demand condition for each zone. In the hydraulic model, a system-wide maximum day peaking factor of 1.7 is applied. This system-wide curve is not representative of smaller zones, which typically peak at higher values. To estimate maximum day demands for each pumped zone, a zone-specific maximum day peaking factor was determined from the average annual demand and the City of San Diego peaking curve for the north inland area. This resulted in maximum day peaking factors ranging from 2.7 to 3.2. Table 6-5 provides a comparison of the maximum day demand with pump station capacity. From this table it can be concluded that each pump station can provide maximum day flows with standby pumping capacity. It is noted that the maximum demand condition for the Park Hill Boosted Pump Station is a 1,500 gpm fire flow with maximum day demands. In the model, one duty pump was operated with the fire pump and the station capacity was verified during the hydraulic fire flow simulation, which indicated that a 1,500 gpm fire flow could be provided at a minimum pressure of 20 psi throughout the zone.

Table 6-5 Pump Station Capacity Evaluation

	Zone and Piping		Pumps			Station Operating Flow(1)	Existing MDD(2)	
Name	Suction	Discharge	No.	Motor Size	Design point	gpm	gpm	Comments
Vista Verde	Clearwell 12" diam.	Vista Verde 12" diam.	2	75 Hp	800 gpm @ 243'	1 - 1010 2 - 1,900	770	operating flow reflects 50' higher elevation for proposed Vista Verde Reservoirs
Hogback	Reed 14" diam.	Hogback 14" diam.	3	100 Hp	950 gpm @ 305'	1 - 1140 2 - 2110	1080	third pump is a standby pump
East Grove	Reed 30" diam.	East Grove 16" diam.	3	50 Hp	950 gpm @140'	1 - 1080 2 - 1990	860	pressure on SCADA; third pump is a standby pump
Park Hill Boosted	Park Hill 12" diam.	PH Boosted 12" diam.	2	10 Hp	120 gpm @ 165'	---(3)	160	variable speed drive pumps with hydropneumatic tank; Pump station must supply MDD + 1,500 gpm fire flow
			1	100 Hp	1600 gpm @ 120'			

(1) Average operating flow from the max day demand hydraulic simulation with both 1 and 2 pumps operating
(2) Maximum day peaking factors are based on the demand within each zone and City of San Diego peaking curves. The zone-specific peaking factors are higher than the system-wide max day peaking factor of 1.7.
(3) Pump station discharge equals the demand for a closed pressure zone with variable speed pumps

6.7 Recommended Improvements

The recommended Capital Improvement Projects based on the capacity analyses for the existing distribution system are summarized below. The projects are also included in Table 8-1 and shown on Figure 8-1.

- Twenty pipeline projects are recommended to provide the minimum fire flows in residential and commercial areas (CIP FF1 through FF20). Most of these projects replace 4-inch and 6-inch diameter pipelines serving fire hydrants with 8-inch diameter pipelines. If undersized pipelines are located in alleys, new pipelines are proposed in adjacent streets to allow the pipelines in alleys to be abandoned or to remain in service only to supply service laterals. Projects required to provide higher flows to areas within severe fire hazard areas are not included in the CIP.
- An additional valve and piping upgrades at the Orange/Valley automated PRS is recommended to increase the supply rate to the A-11 Reservoir (CIP 1). This project, which was also recommended in the 2000 master plan, will allow the reservoir to be maintained at higher water levels during peak demand periods and improve water turnover rates during periods of low demands by providing better control of tank drain and fill cycles.
- Three projects are recommended to provide an emergency treated water supply from the SDCWA ESC2 turnout (CIP 2 through 4). These projects include construction of pipelines and a meter at the existing turnout facility, 2,400 linear feet of 24-inch diameter transmission main in Conway Drive, and a new PRS to supply the Lindley Zone at El Norte Parkway and Conway Drive. The Clearwell to Lindley Zone PRS will be used only under emergency conditions and is in lieu of constructing additional emergency storage for the Lindley Zone. It is assumed that the existing turnout structure, which has not been used for many years, will require minimal rehabilitation. An initial site visit should be conducted with SDCWA staff to assess and verify the condition of the existing structure.
- Approximately 1.5 miles of Escondido Mutual Water District transmission main constructed in 1948 in the A-3 Zone is in very poor condition and needs to be replaced, since the pipelines are subject to rupture from small pressure surges and cannot withstand even a small increase in service pressures. A project is recommended to replaces the existing 14, 16 and 18-inch diameter pipelines with 16 and 20-inch diameter pipelines (CIP 5). This pipeline replacement project is required for the pipeline to withstand higher pressures that will result from the proposed abandonment of the A-3 Reservoir, which is discussed in the next report section.
- The City has initiated planning studies for the replacement of the Lindley and Vista Verde Reservoirs, which are older tanks in need of extensive rehabilitation. The reservoir replacement projects (R1 and R2) will construct new tanks to replace the existing reservoir and increase the storage capacity. Each existing reservoir will be replaced with two identical tanks so that one tank can remain in operation when the other is removed from service for repairs or rehabilitation.
- Rehabilitation of a single 4.0 MG bay of the A-11 Reservoir and construction of facilities to improve reservoir mixing and turnover is proposed based on the findings of the A-11 Reservoir Hydraulic Study (CIP R3).

Section 7
2030 Distribution System Analysis

The horizon planning year for this water master plan is 2030, at which time water demands are projected to be approximately 12 to 20 percent higher than existing demands, depending to a large extent upon the amount of "rebound" in water use after the recent drought and economic recession and the amount of remaining land devoted to agriculture. Many water purveyors are predicting a very low rebound effort in water use as many water users have made permanent changes in their water use and habits. This report section identifies the water system improvements required to supply the higher range of projected 2030 demands while satisfying the water system design criteria outlined in Section 4 and providing a reasonable level of conservativeness for facility sizing and construction phasing. Pipeline capacities are evaluated based on results from hydraulic computer simulations and additional pumping and storage facilities are identified.

7.1 Planned Water System Improvements

To evaluate the 2030 water system, the existing system hydraulic model was first updated to include planned improvements and recommendations proposed for the existing distribution system. The facility improvements initially included in the 2030 hydraulic model are:

- Storage capacity equivalent to two-1.5 MG tanks at the location of the existing 2.0 MG Lindley Reservoir. The modeled tanks have the same bottom elevation as the existing tank but a high water level that is four feet higher, per the preliminary design concept.

- Pipelines to supply the proposed Hidden Valley Ranch development in the Vista Verde Zone, which are identified in the *Hidden Valley Ranch Water Assessment* performed in 2002.

- Removal of A-3 Reservoir (described in following section).

- Two-1.0 MG replacement tanks for the existing 0.75 MG Vista Verde Reservoir. The tanks are located within the Hidden Valley Ranch development at the location identified in the 2002 water assessment. The new tanks have a high water level of 1160 feet, which is 49 feet higher than the existing tank.

- A second 12-inch diameter flow control/regulating valve at the automated Orange/Valley PRS, which supplies the A-11 Zone and Reservoir.

- SDCWA ESC2 potable water turnout connection, new 24-inch Clearwell Zone delivery main, and new Clearwell to Lindley Zone PRS for delivery of a backup emergency supply to the Lindley Zone.

- Replacement of 1.5 miles of old Escondido Mutual Water Company transmission main in the A-3 Zone.

- New pipelines recommended to increase fire flows at twenty locations.

7.2 Proposed A-3 Reservoir Removal Plan

The 1.0 MG A-3 Reservoir is in need of major repairs, and system operators must keep water levels in the tank very low to minimize leakage. Additionally, there are several high elevation areas in the A-3 Zone that cannot provide even the minimum 1,500 gpm fire flow without dropping pressures below 20 psi. At the request of City Staff, permanent removal of the A-3 Reservoir was investigated. A plan was proposed and reviewed with City Staff to convert the existing A-3 Zone service area into three separate gravity supplied pressure zones, which are illustrated on Figure 7-1. Per this proposed plan, the Reed Zone service area would be extended south to supply the higher elevations, a reduced pressure zone would supply a central area at existing A-3 Zone pressures, and the Park Hill Zone would be extended east to supply the lower southernmost area of the existing A-3 Zone. Details of each zone conversion are outlined below.

Reed Zone expansion:

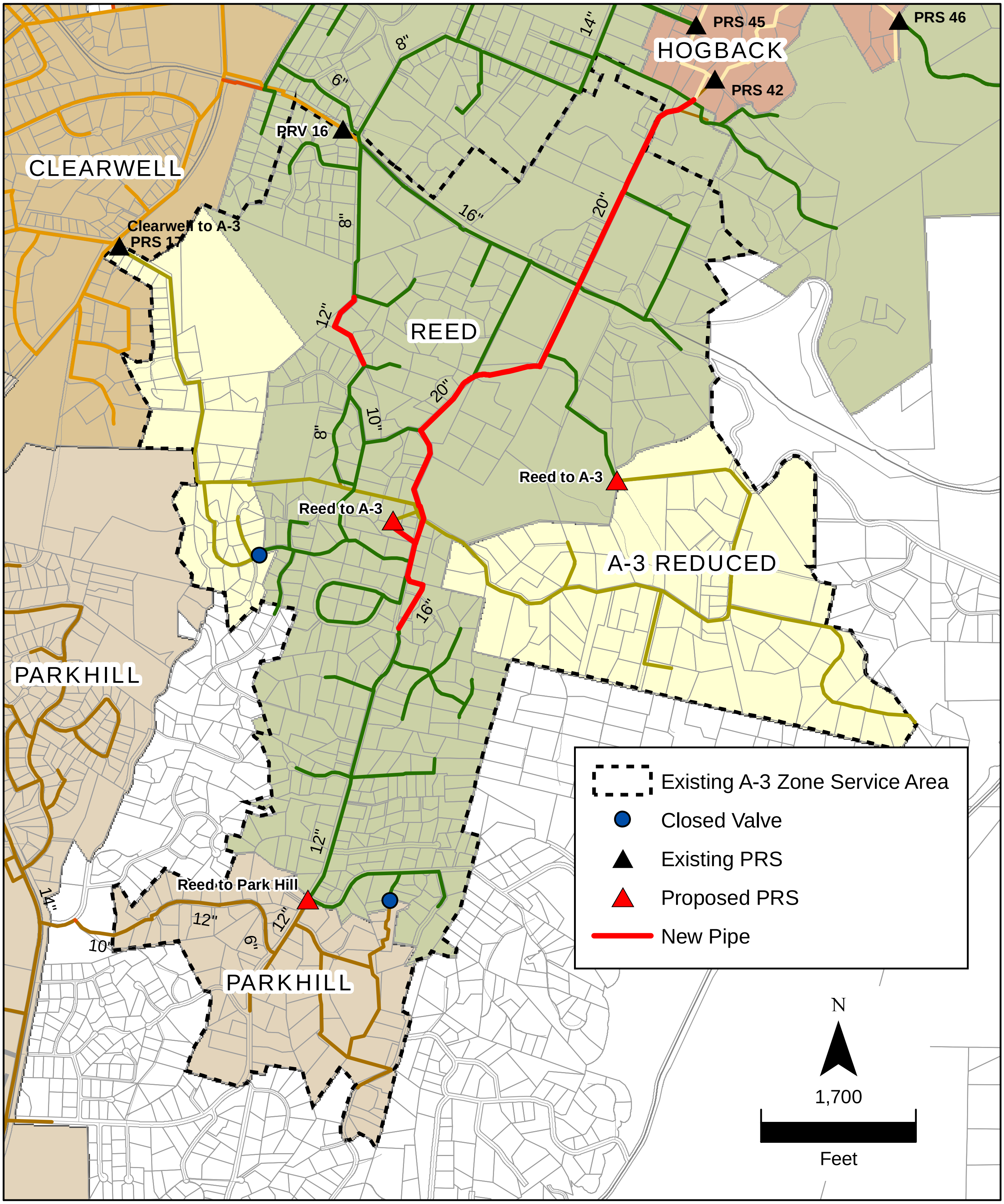
- Serves the majority of the former A-3 Zone, including the Rincon ID-A system and meter.
- Supply is from the north through the existing 20-inch diameter main in South Citrus Ave and 14-inch diameter main in Idaho Ave, and proposed A-3 Zone replacement pipelines in Highgrove Drive and Summit Avenue. An existing 8-inch diameter pipeline that continues south in Citrus Avenue will also provide some additional supply.
- Back-up supply is from the Clearwell Zone through the existing PRS at San Pasqual/Citrus, which will be set to pressure control.
- Automated PRS at the A-3 Reservoir will be removed.
- Short sections of “bypass” pipeline are required to separate zones at 3 locations.
- Static pressures will increase by approximately 34 psi.

Park Hill Zone expansion:

- Serves a small area of lower elevations south of Anaheim Street.
- Supply is from an existing 10-inch diameter pipeline in Canyon Road.
- Backup supply and fire flows are provided from a new Reed to Park Hill Zone PRS in Mary Lane.
- Static pressures will decrease by approximately 9 psi.

New A-3 Regulated Zone:

- Serves the central portion of the former A-3 Zone, primarily areas to the east along Summit Drive.
- Supply from two new Reed Zone to A-3 Regulated Zone PRSs.
- Back-up supply from the Clearwell Zone through the existing PRS at Bear Valley/El Dorado, which will be set to pressure control.
- Will operate at similar pressures to the existing A-3 Zone.



Proposed Zone Configuration Without A-3 Reservoir

Figure 7-1

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WaterMP_2011\mxd\19357_PZone_ReconfigureNoA3_Fig7-1.mxd

It is recommended that the City develop an implementation plan to allow for the orderly expansion of conversion. In many cases existing pipeline will need to be replaced because of increased service pressures. It is anticipated that the overall conversion could take two to three years.

7.3 2030 Hydraulic Model Evaluation

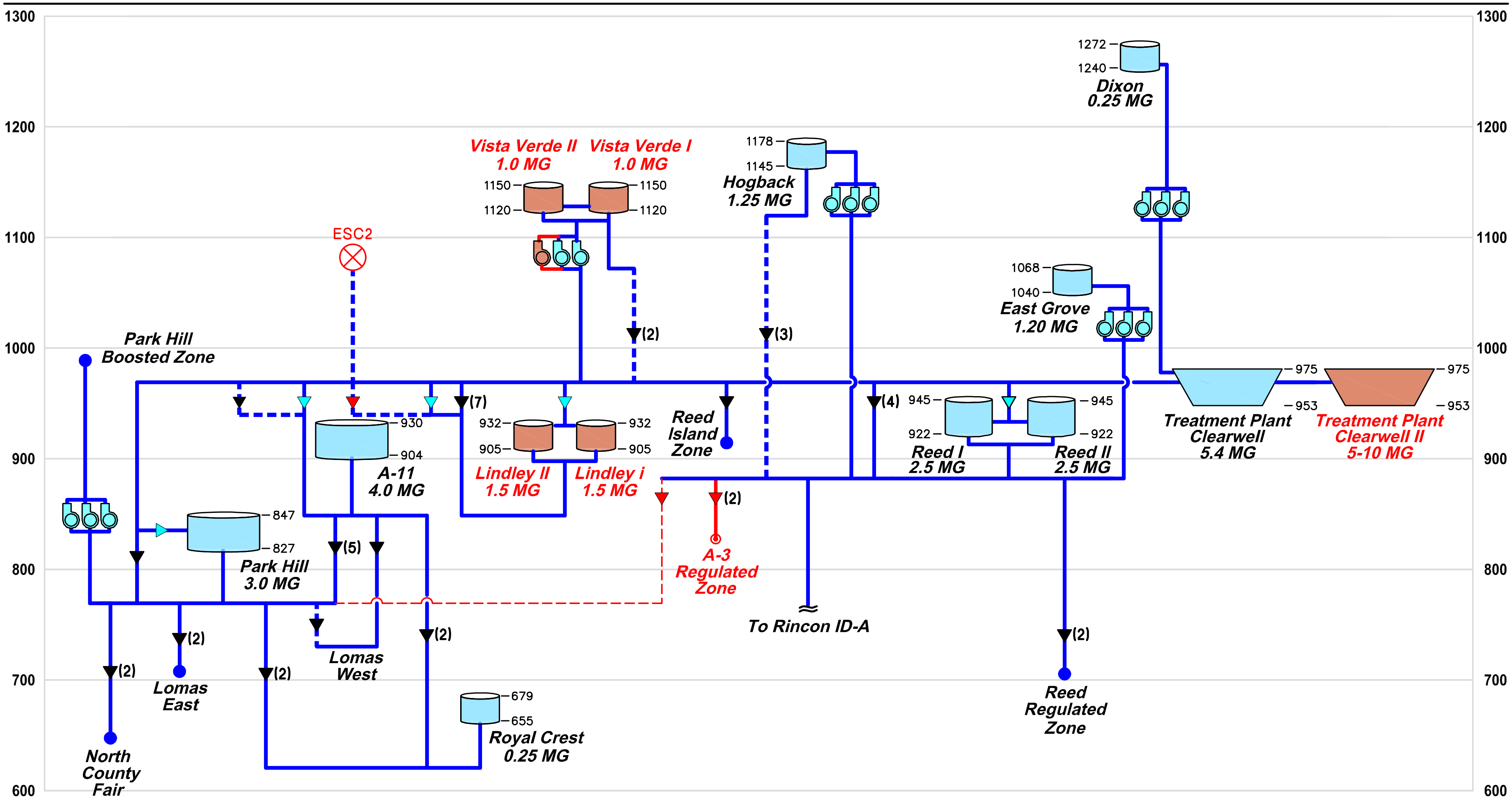
The 2030 model includes the planned improvements and recommendations proposed for the existing distribution system and the proposed A-3 Zone conversions as described above and illustrated schematically on Figure 7-2. Water demands are based on existing demands (2010 water billing records increased by 20 percent, or approximately 2008 water consumption levels) plus future demands projected for specific planned developments, development identified within the General Plan Study Areas, and SANDAG 2030 population projections, as discussed in Section 2.6. Demands in the 2030 model are summarized by pressure zone and compared with existing demands in Table 7-1. It is noted that demands are shown for the existing A-3 Zone service area, but the A-3 Reservoir has been removed in the 2030 model and pressure zones have been reconfigured as described above. In addition, the service areas of the East Grove and Hogback Zones have been expanded to include several parcels where future development is anticipated based on ground elevations.

Table 7-1 2030 Model Demands by Pressure Zone

	Average Annual Demand				2030 Max Day Demand(2)
	Existing(1)		2030 Projected		
Pressure Zone	**gpm**	**MGD**	**gpm**	**MGD**	**MGD**
Hogback	392	0.56	471	0.68	1.15
Vista Verde	275	0.40	589	0.85	1.44
East Grove	311	0.45	357	0.51	0.87
Parkhill Pumped	50	0.07	64	0.09	0.16
Clearwell	3,078	4.43	3,354	4.83	8.21
Reed	1,537	2.21	1,645	2.37	4.03
Reed Island	240	0.34	334	0.48	0.82
Lindley	5,927	8.53	7,354	10.59	18.00
A-11	1,896	2.73	2,383	3.43	5.83
A-3	753	1.08	831	1.20	2.03
Park Hill	996	1.43	1,382	1.99	3.38
Lomas West	417	0.60	419	0.60	1.03
Lomas East	81	0.12	80	0.11	0.20
Reed Regulated	346	0.50	484	0.70	1.19
Royal Crest	209	0.30	219	0.31	0.54
No. County Fair	83	0.12	89	0.13	0.22
Rincon ID-A	*722*	*1.04*	*722*	*1.04*	*2.18*
Totals	**17,314 gpm**	**24.9 MGD**	**20,776 gpm**	**29.9 MGD**	**51.3 MGD**

(1) July 09-June 2010 billings increased by 20%

(2) Maximum day demands are average demands x 1.7, except for Rincon ID-A demands, which are multiplied by 2.1 based on higher historical supply rates.



PIPELINE(S)
BACKUP SUPPLY PIPELINE(S)
PUMP STATION
HWL / BASE ELEV. — STORAGE RESERVOIR
(X) PRESSURE REGULATING STATION(S)
(X) AUTOMATED FLOW CONTROL VALVE(S)

PROPOSED SDCWA ESC2 TREATED WATER CONNECTION
PROPOSED PUMP
HWL / BASE ELEV. — PROPOSED STORAGE RESERVOIR
(X) PROPOSED PRESSURE REGULATING STATION(S)

Proposed 2030 Potable Water System Schematic

Figure 7-2

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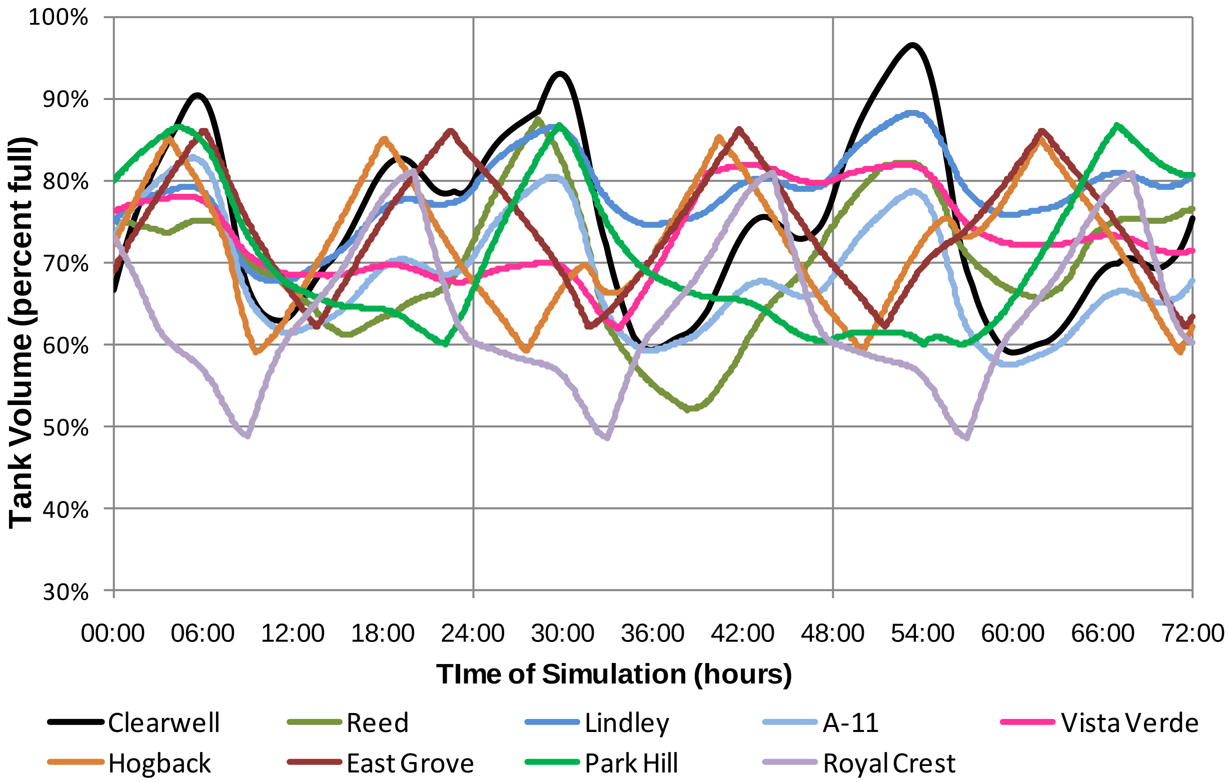
19357-Hydro-POTABLE 2030 F7-2.dwg June 4, 2012

To assess performance of the existing distribution system under 2030 peak flow conditions, a 24-hour extended period simulation was performed with 2030 model demands peaked by the maximum day demand curve shown previously in Figure 6-3. The Rincon ID-A demand is an exception, and a separate peaking curve was used to simulate nighttime filling of the Rincon ID-A tanks based on the assumed future operation with an automated flow control valve. A constant flow of approximately 35,600 gpm (51.3 MGD) was input to the Clearwell from the Escondido-Vista WTP and reservoir volumes were controlled through the automated PRSs to range between approximately 60 and 80 percent full.

Output from the maximum day demand simulation was reviewed to assess reservoir operations (ability to provide peak flows and refill after draining) and identify pipelines with excessive velocities and/or head loss. Not all reservoirs had filled with the programmed automated PRS settings after 24 hours, so the simulation was run over a period of 72 hours. Figure 7-3 illustrates reservoir volumes during the simulation and verifies that all reservoirs are able to refill with maximum day demands, including the A-11 Reservoir (simulated as a 4.0 MG reservoir). The automated valves are generally opened wider in the 2030 simulation compared to current conditions. The 2030 model includes a second 12-inch diameter valve at the Orange/Valley PRS, which is a recommended improvement project based on existing conditions or higher pressure loss, and both valves were fully open during the entire simulation. It is noted that the flow rate through the Orange/Valley PRS is very sensitive to pressure drops in the Clearwell Channel Pipeline and minor losses at the PRS. Operators may find that even with a second valve, it may be difficult to maintain water levels and fill the A-11 Reservoir during peak demand periods. The model indicated that the existing PRS at El Dorado and Juniper could provide a supplemental supply to improve fill rates and water turnover in the A-11 Reservoir if the valve controls at this station are automated. Model results indicated that operation of the El Dorado and Juniper PRS should be limited to daily off-peak demand periods (nighttime or mid-day) and a supply rate of approximately 1,500 gpm to avoid excessive pressure drops in the southern area of the Clearwell Zone.

During peak flows, pipeline velocities in several of the larger transmission mains in the Clearwell Zone were between 4.5 and 5.5 fps. These include both of the 42-inch diameter transmission mains downstream of the Clearwell and the 36-inch diameter portion of the Channel Line. While these velocities do not exceed the design criteria, the long lengths of the transmission mains result in significant pressure drops or pressure “swings” during peak demand periods. In general, pressure swings in water systems should be limited to approximately 20 to 25 psi. The maximum pressure variation within the Clearwell Zone was at the southern end of the Bear Valley pipeline service area, where daily pressures fluctuated by 26 psi with maximum day demands. Pressure fluctuations in the Clearwell Zone are affected by valve positions of any of the five automated PRSs and the operation of the Vista Verde Pump Station, and can therefore be potentially higher than the swings in this single simulation. Furthermore, portions of the distribution system will experience higher pressure swings due to localized demand fluctuations. Operators at the WTP can minimize pressure swings in the Clearwell Zone by balancing and offsetting flows through the various PRSs, and by filling reservoirs at higher rates overnight and curtailing flow during the peak morning demand periods. However, operators also need to balance distribution system demands with varying supply rates from the WTP. A larger Clearwell would provide more flexibility for the operators to regulate flows and minimize pressure swings in the distribution system.

Figure 7-3 Modeled Reservoir Volumes with 2030 Maximum Day Demands



Most of the supply to the Lindley Zone is provided through the automated PRS at Ash/Channel. Operators do not typically vary the position of this valve throughout the day, and the valve was set at 45 percent open throughout the simulation. Daily demand peaks are therefore supplied from the Lindley Reservoir and the manual PRSs. During peak morning demands, pipeline velocities in the Lindley Reservoir 18-inch diameter discharge main were over 6 fps and some of the smaller diameter pipelines downstream of the manual PRSs at Washington/Citrus, Bear Valley/Midway, and Valley Parkway/Escondido were between 5 and 7 fps. The PRS at Washington/Citrus was also wide-open for a short period. These high velocities resulted in a small pressure drop of approximately 5 to 10 psi during the peak morning demands throughout most of the Lindley Zone.

The highest pipeline velocities in the maximum day demand simulation were in the 14-inch diameter Reed Zone pipeline in Idaho Avenue and Skyline Drive, which supplied the portion of the former A-3 Zone that is proposed to be converted to the Reed Zone. Pipeline velocities were in excess of 7 fps during peak hour demands, which resulted in unacceptable downstream pressure swings. To reduce the pressure swings, either the 14-inch diameter section of pipeline will need to be replaced with larger pipe, or the 8-inch diameter pipeline in South Citrus, Lemon Place & Kinross Court can be upsized. The latter option will also increase reliability by providing a looped supply system for the expanded Reed Zone area. Additionally, the PRS at San Pasqual/Citrus could be set to provide a supplemental supply during peak demand periods, and supply to Rincon ID-A could be restricted during peak demand periods.

At peak hour demands there are several areas in the distribution system with pressures less than 40 psi, but these are generally the same high elevation areas that had low pressures with existing system demands in the model. Despite the large pressure drop in the southern portion of the expanded Reed Zone with the zone reconfiguration, pressures at the north end of Mary Lane and near Tee Pee Hill in the former A-3 Zone were still higher than existing pressures.

Fire flows were simulated in the 2030 model with maximum day demands at multiple locations in the reconfigured areas of the existing A-3 Zone. Results indicate that with the zone reconfigurations and proposed pressure reducing stations, a fire flow of 1,500 gpm can be supplied at a minimum pressure of 20 psi at all model nodes. This is an improvement over existing conditions, where the existing system model indicated that high elevation areas along Mary Lane and Orangewood Drive could not be supplied with even a 1,000 gpm fire flow from the A-3 Zone. Furthermore, these high elevation areas had restricted fire flows to downstream areas supplied from Mary Lane.

7.4 Storage Capacity Assessment

Reservoir storage criteria is based on providing operational, fire and emergency storage within each major pressure zone (refer to the storage criteria in Section 4). Table 7-2 calculates the required storage for the water distribution system based on the projected 2030 demands, the planned replacements for the Vista Verde and Lindley Reservoirs, abandonment of the A-3 Reservoir and planned zone conversions, and the proposed SDCWA ESC2 connection, which will provide emergency storage for the Lindley Zone. Rincon ID-A and San Diego Zoo Safari Park demands were omitted from the demand calculations because both off-site customers have their own storage facilities. In addition, commercial agriculture accounts on the special agriculture water rate program (premise category = SAWR in the billing account database) were also eliminated since these customers are provided water at a reduce rate and would not be served in the event of a water supply emergency. Demands within the existing A-3 Zone have been reallocated to the Reed, Park Hill or A-3 Reduced Zone per the proposed zone reconfigurations.

With the SDCWA ESC2 connection supplying the emergency storage for the Lindley Zone (equivalent of the average annual demand or 10.46 MGD), the 2030 distribution system is projected to have an overall storage surplus of 1.8 MG. On a zone-by-zone basis, storage surpluses are projected in the three pumped zones and the Reed Zone, and only the A-11 Zone is projected to have any significant storage deficit. In the event of an emergency, surplus water stored in the higher zones could be supplied by gravity to any of the lower elevation zones, including the A-11 Zone. It is noted that while the volume of the existing Clearwell is approximately equal to the required 2030 storage for the Clearwell Zone based on the demand criteria, no additional storage volume has been allocated for treatment plant operations or possibly lower zone emergency storage. Supply from the Escondido-Vista WTP to the Clearwell is adjusted based on Clearwell levels, and the supply rate can vary throughout the day due to treatment plant operations, such as filter backwashing. A larger capacity Clearwell would provide increased operational flexibility for water production and system operations, as well as additional storage for immediate use during emergencies. Although there is no well documented industry standard for Clearwell sizing, it is typical that about 10 to 20 percent of plant capacity be maintained in storage.

Table 7-2 Required Storage Based on 2030 Demands

Reservoir/Zone *and Sub-Zones*	Average Annual Demand[1] gpm	Average Annual Demand[1] MGD	Required Storage - MG: Operational 15% of MDD	Required Storage - MG: Fire 2 hours	Required Storage - MG: Emergency 1 ADD	Required Storage - MG: Total	Planned/ Existing Storage MG	Surplus/ Deficit MG
Hogback	283	0.41	0.10	0.18	0.41	0.51	1.25	0.74
Vista Verde	571	0.82	0.21	0.24	0.82	1.03	2.0	0.97
East Grove	329	0.47	0.12	0.24	0.47	0.59	1.2	0.61
Clearwell	2,664	3.84	1.10	0.30	4.31[3]	5.41	5.4	(0.01)
Reed Island	331	0.48						
Reed	1,896	2.73	0.88	0.30	3.44	4.31	5.0	0.69
Reed Regulated	310	0.45						
A-3 Reduced	182	0.26						
Lindley	7,262	10.46	2.67	0.30	-- [2]	2.97	3.0	0.03
A-11	2,383	3.43	1.03	0.30	4.03	5.06	4.0	(1.06)
Lomas West	419	0.60						
Parkhill	1,444	2.08	0.62	0.30	2.41	3.03	3.0	(0.03)
Parkhill Pumped	64	0.09						
Lomas East	80	0.11						
No. County Fair	89	0.13						
Royal Crest	219	0.31	0.08	0.18	0.31	0.40	0.25	(0.15)
Totals	**18,524 gpm**	**26.7 MGD**				**23.3 MG**	**25.1 MG**	**1.8 MG**

(1) Excludes Rincon ID-A, SD Zoo Safari Park and special rate agriculture demands.
(2) Emergency storage is assumed provided by the SDCWA ESC2 potable water turnout
(3) Does not include any lower zones or WTP operational storage.

7.5 Pump Station Capacity Assessment

Each pump station is required to have the pumping capacity to supply peak flows within its service zone with an additional pumping unit for standby capacity. Pump station capacities were determined from the 2030 hydraulic model and then compared to the maximum day demand condition for each zone. The maximum day demand for each zone is based on demand dependent peaking factors determined from the City of San Diego peaking curve for the north inland area, which results in higher demands than would be calculated using the system-wide peaking factor of 1.7. Table 7-3 provides a comparison of the maximum demand condition with pump station capacity based on one or two pumps operating.

The planned Vista Verde replacement reservoirs will be constructed at an elevation approximately 50 feet higher than the existing Vista Verde Reservoir. While the higher elevation will reduce the Vista Verde PS pumping capacity by approximately 10 percent, pump efficiencies will improve based on the original pump curve. As shown in Table 7-3, two pumps will need to operate at the Vista Verde Pump Station to supply the projected 2030 maximum day demand. This will require installation of a third pump to provide the required standby pumping capacity. In addition, the City may also need to consider interim closed system pumping operations depending on the schedule to remove the existing wastewater reservoir and construction of the new tanks.

Table 7-3 2030 Pump Station Capacity Evaluation

Name	Zone and Piping		Pumps			Station Operating Flow[1]	2030 MDD[2]	Comments
	Suction	Discharge	No.	Motor Size	Design point	gpm	gpm	
Vista Verde	Clearwell 12" diam.	Vista Verde 12" diam.	2	75 Hp	800 gpm @ 243'	1 - 900 2 - 1,700	1530	operating flow reflects 50' higher elevation for proposed Vista Verde Reservoirs
Hogback	Reed 14" diam.	Hogback 14" diam.	3	100 Hp	950 gpm @ 305'	1 - 1140 2 - 2110	1270	third pump is a standby pump
East Grove	Reed 30" diam.	East Grove 16" diam.	3	50 Hp	950 gpm @140'	1 - 1080 2 - 1990	980	pressure on SCADA; third pump is a standby pump
Park Hill Boosted	Park Hill 12" diam.	PH Boosted 12" diam.	2	10 Hp	120 gpm @ 165'	---[3]	210	variable speed drive pumps with hydropneumatic tank; Pump station must supply MDD + 1,500 gpm fire flow
			1	100 Hp	1600 gpm @ 120'			

(1) Average operating flow from the max day demand hydraulic simulation with both 1 and 2 pumps operating
(2) Maximum day peaking factors are based on the demand within each zone and City of San Diego peaking curves. The zone-specific peaking factors are higher than the system-wide max day peaking factor of 1.7.
(3) Pump station discharge equals the demand for a closed pressure zone with variable speed pumps

7.6 Recommended 2030 Improvements

The recommended Capital Improvement Projects based on the 2030 capacity analyses include the planned reservoir replacement and rehabilitation projects and the proposed projects to reconfigure the A-3 service area, which are necessary for abandonment of the A-3 Reservoir. These projects and additional recommended projects based on the hydraulic analysis are summarized below. The projects are also included in Table 8-2 and shown on Figure 8-1 (located in map pocket).

- A third pump will be required at the Vista Verde Pump Station to provide standby pumping capacity (PS1). The pump should be installed as part of the Vista Verde Reservoir replacement project, which will construct new reservoirs approximately 50 feet higher than the existing tank and reduce the capacity of the two existing pumps.
- Two new PRSs will be required to supply the proposed A-3 Regulated Zone, one for the primary supply and a second for a backup supply and to provide fire flows to the eastern portion of the service area (CIP 6)
- One new PRS will be required to convert the southern portion of the existing A-3 Zone to the Park Hill Zone (CIP 9). Primary supply to this area will be from opening an existing closed valve in Canyon Road, and the new PRS will provide a backup supply and fire flows.
- A short section of 8-inch pipeline will be required in an existing easement near the end of Briarwood Court to separate the Reed and A-3 Regulated Zones (CIP 8).

- A larger capacity 12-inch diameter pipeline is recommended to replace the existing 6-inch and 8-inch diameter pipelines in South Citrus Avenue, Lemon Place and Kinross Court. This will reduce pipeline velocities in the 14-inch transmission main in Idaho Avenue and Skyline Drive and the associated downstream pressure swings, and provide a second source of supply to the expanded Reed Zone (CIP 7).
- The A-3 Reservoir is proposed to be abandoned and removed after construction of the four projects listed above (CIP R4).
- A new 12-inch diameter pipeline is recommended in Summit Drive between Summit Place and Summit Trail to provide a looped supply to the southern portion of the expanded Reed Zone (CIP 10). Construction of this pipeline will likely coincide with development of the large vacant parcel directly to the west.
- Replacement of a nearly one-mile section of 14-inch diameter transmission main (Escondido Mutual Pipeline) is recommended with larger diameter pipeline to increase the supply capacity and reliability of the Reed Zone expansion (CIP 11).
- Automated SCADA controls are recommended for the existing PRS at El Dorado/Juniper for increased supply rates to the A-11 Reservoir to improve water turnover during low demand periods and maintain high water levels during peak demand periods (CIP 12).
- A second Clearwell is recommended at the Escondido-Vista WTP to provide increased operational flexibility for water production and additional storage for immediate use during emergencies (CIP R5). The recommended capacity of the second Clearwell is between 5 and 10 MG.

7.7 General Plan Redevelopment Areas

One of the unique elements of the City's new General Plan is a shift to focused redevelopment areas within the City to increase both residential housing and commercial/industrial uses. One of the benefits of redevelopment and urban village concepts is the ability to utilize existing infrastructure and capacity. In the case of water infrastructure, fire flow requirements are typically the driver for facility sizing on these types of urban projects. This Master Plan was able to demonstrate that in many of these focused redevelopment areas the City's backbone water system can deliver the required maximum fire flow of 2,500 gpm and should be able to support large scale redevelopment plans.

Although this Master Plan does not specifically address focused redevelopment area improvements, the City should require studies by proposed developments in these areas to confirm the ability to meet fire flow requirements at specific hydrants. In some cases the City may find it prudent to upgrade smaller distribution lines based on new fire flow requirements, hydrant spacing, age of facilities, and new circulation elements within the proposed redevelopment area. Also, additional looping may be necessary based on specific development proposals. One added benefit of the new water model is to easily evaluate fire flows with the 2030 maximum day demand hydraulic scenario.

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Section 8
Recommendations and Capital Improvement Projects

This section summarizes the recommended Capital Improvement Projects (CIP) for the City of Escondido potable water distribution system based on the findings of this master plan. The recommended projects are capacity, reliability, or rehabilitation improvements for the existing distribution system and a future system which will supply projected 2030 demands. The projects are grouped into three phases based on existing capacity deficiencies, planned rehabilitation projects, and facilities required to deliver 2030 demands. An estimate of probable construction cost is provided for each improvement project. It will be in the best interest of the City to conduct feasibility or preliminary engineering evaluations before embarking on a major capital investment.

8.1 Unit Costs

The unit cost estimates reflect full capitalization inclusive of planning, engineering design, environmental, legal, construction, construction management and contract administration. The values are presented in mid-2012 dollars based on an anticipated ENR Construction Cost Index (ENR-CCI) of 10300 for the Los Angeles/Orange County area. These estimates are based on representative available data at the time of this report; however, since prices of materials and labor fluctuate over time, new estimates should be obtained at or near the time of construction of proposed facilities.

Unit costs were developed based in part on input from City staff on recent construction projects in the community, comparison with local bid documents for similar projects and unit costs used by other local agencies. Many of the projects, especially pipelines, require public involvement, traffic control, utility re-locations, and paving replacement, and accordingly may have fairly high unit costs. Since some of the pipeline projects are relatively short in distance, a scaling factor has been included to address the economy of scale of constructing smaller scale projects.

Pipelines

Base unit costs for pipelines include material costs and installation, including repaving and system appurtenances. Base unit costs for standard diameter potable water mains are provided in Table 8-1. Polyvinyl chloride (PVC) is the assumed material for pipelines with diameters of 24-inches and less.

Table 8-1 Pipeline Unit Costs

Pipeline Diameter (inches)	Probable Unit Costs ($/LF)
8	205
12	275
16	375
20	525
24	600

The unit costs provided above reflect an average cost for full capitalization inclusive of planning, engineering design, environmental, legal, construction (including all appurtenances), construction management and contract administration. Special circumstances (e.g., jacking, trenchless installations, tunnels, etc.) are considered separately on a case-by-case basis. A scaling factor was applied to each project to account for the economy of scale for short distance pipelines and project specific issues such as difficult conditions, constrained access, congested areas, etc.

Reservoirs

The cost for new reservoirs is based on total capacity and includes planning, engineering design, environmental, legal, construction, limited site work, piping upgrades, valve replacements, re-painting and coating, construction management and contract administration. Reservoir rehabilitation costs are based on our review of San Diego County costs for recent steel tank rehabilitation projects, and are generally assumed to be about $0.30 per gallon for a typical 1 to 3 million gallon steel tank. Smaller tanks requiring upgrades were adjusted accordingly, based on an economy of scale. An allowance was included for concrete tank upgrades.

Pump Stations

Pump station capital costs for upgrades are based on the specific upgrade proposed. The cost for pump station projects typically would include pump station building and landscaping, pumps and motors, miscellaneous piping and valving, instrumentation, controls, engineering design, environmental, legal, construction, construction management and contract administration needs.

8.2 Recommended Projects

The recommended CIP identify facilities needed to meet existing system needs based on City of Escondido design criteria for the water systems as well as the needs to accommodate future growth and development projected for 2030. It should be noted that should the 2030 demands not be fully realized, there may be opportunities to defer or eliminate some projects. The City should monitor annual water demands to assess the potential impact to CIP phasing. The next master plan update in five to ten years should evaluate water use trends to determine the amount of “rebound” from water use restrictions imposed during drought conditions and the impact of recent and future water rate increases.

The CIP has been divided into three phases as follows:

- Phase 1 – 2012-2015
- Phase 2 – 2016-2020
- Phase 3 – 2021-2030

The proposed projects recommended for the water distribution system are shown on Figure 8-1 (located in map pocket) and listed in Table 8-2. The projects are assigned an identifier that indicates the type of project: projects for improved fire flow (FF1 to FF20), water supply and pipeline transmission projects (1 to 14), reservoir improvements (R1 to R9), and pump station projects (PS1). As previously discussed, the projects are presented in three major phases of work based on priority needs. The recommended water CIP for Phases 1 through 3, which are anticipated to satisfy the needs of the City through 2030, total approximately $34.8 million.

Table 8-2 Draft Recommended Potable Water Capital Improvement Projects

ID No.	Zone	Project Type	Description/Location	Units	Base or Unit Cost	Scale Factor	CIP Cost	Project Phase		
								1	2	3
FF1	Lindley	Upsize Pipe	Upsize existing 8" pipeline to a 12" in Broadway from Leslie Ln to Vista Av	2000 LF	$275/LF	1	$550,000	X		
FF2	Royal Crest	Upsize Pipe	Upsize 4" pipeline to 8" in Verda Av and Cranston Dr.	3800 LF	$205/LF	1	$780,000	X		
FF3	Lindley Regulated	Upsize Pipe	Upsize 6" pipeline to 8" in Las Palmas Av from Cranston Dr to Ross Ln	1100 LF	$205/LF	1	$230,000	X		
FF4	A-11	New Pipe	New 8" pipeline in west end of Autopark Wy to Howard Av.	600 LF	$205/LF	1	$120,000	X		
FF5	Lindley/ fut Reed	New Pipe	New 8" conn in Circle Dr to 18" Reed Z pipe; close valve in Halecrest Dr	50 LF	$205/LF	5	$50,000	X		
FF6	Clearwell	Upsize Pipe	Upsize 4" pipeline to 8" in Stanley Wy, between Thomas Wy & N Rose St	900 LF	$205/LF	1	$180,000	X		
FF7	Lindley	Upsize Pipe	Upsize 4" pipeline to 8" in Linview Av	400 LF	$205/LF	1	$80,000	X		
FF8	Lindley	Upsize Pipe	Upsize 4" pipeline to 8" in E Pennsylvania Ave, between S Juniper St & N Hickory St	1100 LF	$205/LF	1	$230,000	X		
FF9	Lindley	New Pipe	8" pipelines in S Cedar St and S Beech St, between alleys at 21/2 & & 41/2	1500 LF	$205/LF	1	$310,000	X		
FF10	Park Hill	Upsize & New Pipes	Upsize 4" pipeline in Quince St from ally at 91/2 south to 12th St; new 8" pipeline in Redwood, between alleys at 91/2 and 101/2.	1700 LF	$205/LF	1	$350,000	X		
FF11	Clearwell	New Pipe	8" pipeline in Country Ln, south of 17th Av, & abandon 4" in an easement to the east	800 LF	$205/LF	1.1	$180,000	X		
FF12	Clearwell	Upsize Pipe	Upsize 4" pipeline to 8" in Viewmont Dr	700 LF	$205/LF	1	$140,000	X		
FF13	Clearwell	Upsize Pipe	Upsize 4" pipeline to 8" in Suburban Hills Dr & abandon looped portion not in roadway	800 LF	$205/LF	1	$160,000	X		
FF14	Clearwell	Upsize Pipe	Upsize 4" pipeline to 8" in Pedrigal Dr	300 LF	$205/LF	1	$60,000	X		
FF15	Reed (ex A-3)	Upsize Pipe	Upsize 6" pipeline to 8" in Valencia Dr	1100 LF	$205/LF	1	$230,000	X		
FF16	Lindley	New Pipe	8" pipeline in N Cedar St, between alleys to the North & South of Ohio Av	400 LF	$205/LF	1	$80,000	X		
FF17	ex A-3/ fut Reed	Upsize Pipe	Upsize 6" pipeline to 8" in Mary Lane Pl	1100 LF	$205/LF	1	$230,000	X		

Table 8-2 continued

ID No.	Zone	Project Type	Description/Location	Units	Base or Unit Cost	Scale Factor	CIP Cost	Project Phase		
								1	2	3
FF18	Reed Island	Upsize Pipe/ New Pipe	Upsize 6" pipeline to 8" in Idaho Ln and new 8" pipe in Landavo Rancho Rd & Landavo Dr	1300 LF	$205/LF	1	$270,000	X		
FF19	Reed Island	Upsize Pipe	Upsize 6" pipeline to 8" in Paul Way	1400 LF	$205/LF	1	$290,000	X		
FF20	A-11	Upsize Pipe	Upsize 6" pipelines to 8" in Caroline Dr, from Upas St to end of Howell Heights Dr	1200 LF	$205/LF	1	$250,000	X		
1	A-11	New Valve	Install 2nd 12" valve at Orange/Valley PRS to increase A-11 Res fill rate	--	LS	--	$75,000	X		
2	Clearwell	Emergency Water Supply	Rehabilitate the CWA ESC2 turnout structure at Rincon/Conway & install new meter & piping	--	LS	1	$1,000,000	X		
3	Clearwell	New Watermain	24" main in Conway Dr. from Rincon Av (@ CWA ESC2) to Lehner Av for emergency supply to Clearwell & Lindley Zones	2400 LF	$600/LF	1	$1,440,000	X		
4	Lindley	PRS	12" PRV at El Norte Pkwy/Conway Dr for emergency supply to Lindley Zone from CWA ESC2 connection	--	LS	--	$100,000	X		
5	ex A-3/ fut Reed	Replace Watermain	Replace Esc Mutual 18", 16" and 14" diam pipelines with 16" and 20" pipelines	1900 LF 5900 LF	$375/LF $525/LF	1	$3,810,000	X		
6	A-3 Reduced	PRS (2)	PRSs from Reed Zone to new A-3 Reduced Zone: Primary - Summit Dr / Mary Ln, Back-up - easement west of Old San Pasqual Rd	--	LS	--	$250,000		X	
7	Reed	Upsize Pipe	Replace 6" and 8" pipelines in S Citrus Av, Lemon Pl & Kinross Ct w/12" pipelines	2500 LF	$275/LF	1.0	$690,000		X	
8	ex A-3/ future Reed	New Pipe	Short section of 8" pipeline in easement S of Briarwood Ct. to separate Reed/A-3 Regulated Zone & provide looping	50 LF	$205/LF	5	$50,000		X	
9	ex A-3/ future Parkhill	PRS	Reed→Parkhill PRS at Mary Ln, south of Anaheim St, for back-up supply to expanded Parkhill Zone	--	LS	--	$100,000		X	
10	ex A-3/ future Reed	New Pipe	900' of 12" pipeline in Summit Dr between Summit Pl & Summit Trail for looped supply to expanded Reed Zone	900 LF	$275/LF	1.0	$250,000			X
11	Reed	Replace Watermain	Replace Esc Mutual 14" pipeline in Idaho Av, Skyline Dr & easement with 20" pipe	4700 LF	$525/LF	1.0	$2,470,000			X

Table 8-2 continued

ID No.	Zone	Project Type	Description/Location	Units	Base or Unit Cost	Scale Factor	CIP Cost	Project Phase		
								1	2	3
12	A-11	Automate PRS	Automate the El Dorado/Juniper PRS thru SCADA to increase fill rate of the A-11 Res	--	LS	--	$75,000		X	
R1	Lindley	Reservoir Replacement	Demolish existing 2 MG tank and construct 2-1.5 MG tanks near the existing site	3.0 MG	$1.40/gal	--	$4,200,000		X	
R2	Vista Verde	Reservoir Replacement	Demolish existing 0.75 MG tank and construct 2-1.0 MG tanks on a different site	2.0 MG	$1.40/gal	1.2	$3,360,000		X	
R3	A-11	Reservoir Rehabilitation	Rehabilitate one bay of the A-11 Reservoir	--	LS	--	$300,000	X		
R4	A-3	Reservoir Demolition	Abandon and remove the A-3 Reservoir after construction of CIP 5-9	--	LS	--	$75,000			X
R5	Clearwell	New Reservoir	Construct additional 5-10 MG Clearwell at the WTP	--	LS	--	$10,000,000			X
R6	Clearwell	Reservoir Rehabilitation	Dewater and Rehabilitate the Clearwell	5.4 MG	$0.25/gal	1.0	$1,350,000		X	
R7	Royal Crest	Reservoir Rehabilitation	Dewater and Rehabilitate the Royal Crest Reservoir	0.25 MG	$0.35/gal	1.3	$114,000	X		
R8	Dixon	Reservoir Rehabilitation	Dewater and Rehabilitate the Dixon Reservoir	0.25 MG	$0.35/gal	1.3	$114,000		X	
R9	Multiple	Cathodic Protection Repairs	Inspect and re-calibrate the impressed current cathodic protection systems at Hogback, East Grove, Royal Crest & Dixon Reservoirs	--	LS		$50,000		X	
PS1	Vista Verde	New Pump	Install additional pump at the existing Vista Verde Pump Station	--	LS	--	$150,000	X		
					Total		**$34,793,000**			

Fire Flow Capacity Projects

Twenty pipeline capacity projects are recommended to deliver the minimum required fire flow (FF1 to FF20). The projects are either replacement of existing 4, 6 and 8-inch diameter pipelines with larger diameter pipeline, or construction of new pipelines in existing roadways. Existing pipeline diameters should be verified from as-built plans or field reconnaissance, and available fire flows should be confirmed with field tests before the pipeline projects are constructed.

Water Supply and Transmission Projects

The water supply and transmission projects identified in this master plan are for the delivery of potable water to and within the water distribution system. The water supply projects are:

- Two projects are recommended to increase water supply rates to the A-11 Zone from the Clearwell Zone to improve water turnover and maintain higher water levels in A-11 Reservoir (CIP 1 and 12). The A-11 Reservoir will be converted to a single bay 4.0 MG reservoir as part of a rehabilitation project.

- Three projects are identified to provide an emergency potable water supply from the SDCWA to the Clearwell Zone from the existing ESC2 turnout structure (CIP 2 and 3), and to the Lindley Zone through a new Clearwell to Lindley Zone PRS (CIP 4). The Lindley Zone PRS would eliminate the need for in-zone emergency reservoir storage capacity.

- Seven projects are associated with the permanent removal of the A-3 Reservoir and conversion of the existing A-3 Zone service area to the Reed Zone, Park Hill Zone, and a new A-3 Regulated Zone (CIP 5 through 11). CIP 5 replaces 1.5 miles of the oldest remaining Escondido Mutual Water Company transmission main in the existing A-3 Zone to withstand higher Reed Zone pressures. There may be additional pipelines which will need to be replaced due to age and condition prior to the Reed Zone conversion. CIP 7 and 11 increase the Reed Zone supply capacity to reduce pressure swings during peak demand periods. CIP 10 constructs a pipeline for additional looping and supply capacity, and would likely be constructed with new development. The sequencing, timing, and funding of the A-3 Zone conversions will require careful planning as facilities may need to be replaced before pressure zones are modified. It is recommended that the City conduct an implementation study to determine the sequencing of projects by fiscal year and to identify any additional replacement projects.

Storage Facility Projects

Storage facility projects include the construction of new reservoirs and major tank rehabilitation projects. The rehabilitation projects are based on inspection reports from visual assessments conducted in 2009 and 2010 by Aquatic inspections, Inc. and are included only for tanks that will require de-watering, as it is assumed that minor rehabilitation will be performed as part of normal operations and maintenance tasks.

- Two projects are included for the planned replacement of the Lindley and Vista Verde Reservoirs (CIP R1 and R2).

- Four Reservoir rehabilitation projects are included for the A-11, Royal Crest, and Dixon Reservoirs (CIP R3, R7, and R8) and the Clearwell (CIP R6). Each rehabilitation project should include a hydraulic study to identify temporary facilities and/or operational modifications required to remove the tank from service.

- Additional storage capacity of 5 to 10 million gallons is recommended at the Escondido WTP for the Clearwell Zone (CIP R5). Space at the WTP is limited, and a siting study will be required to determine the maximum amount of storage that can be reasonably constructed.

- A separate project has been included for inspection and recalibration of the existing impressed current cathodic projection systems at the Hogback, East Grove, Royal Crest and Dixon Reservoirs (CIP R9). This project is based on recommendations from the Aquatic inspections, Inc. reports.

- A CIP project is included to decommission and remove the A-3 Reservoir after the recommended A-3 Zone conversion projects are constructed (R4).

Pump Station Projects

One pump station project is recommended to increase pumping capacity at the Vista Verde Pump Station (CIP PS1). This project adds a third pump to the existing pump station and will be constructed as part of the Vista Verde Reservoir replacement project, which will decrease the capacity of the existing pumps by approximately 10 percent due to the higher elevation of the new tanks.

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Appendix A – 2011 General Plan Study Areas

Within the General Plan Update boundary, the General Plan Update identifies 15 study areas, which are areas proposed for land use changes as compared to the existing General Plan. The 15 study areas are shown in Figure 3-3. Characteristics of each study area are described in Table 3-2, General Plan Update Study Area, and summarized below. The land use designations identified for each study area are defined in Table 3-3, Definitions of Proposed Land Use Categories.

1. **Imperial Oakes Specific Planning Area (SPA) (Imperial Oakes SPA).** The Imperial Oakes SPA is approximately 163 acres in size and bounded by I-15 on the west, Country Club Lane on the north, El Norte Parkway on the south, and Iris Lane and Centre City Parkway on the east. Under the proposed General Plan Update, Imperial Oakes SPA would have a land use designation of Specific Plan Area that accommodates employment-oriented land uses (office, Research and Development, minor supporting commercial uses, etc.) integrated with existing residential, open space and commercial uses in a master planned environment).

2. **Hwy-78/Broadway Target Area.** The SR-78/Broadway Target Area is approximately 122 acres in size and located at the terminus of SR-78, north of downtown, east of Centre City Parkway, and west of Juniper Street. Under the proposed General Plan Update, the SR-78/Broadway Target Area would have a land use designation of General Commercial.

3. **Transit Station Target Area.** The Transit Station Target Area is approximately 296 acres in size and is located southeast of I-15 and SR-78. Under the proposed General Plan Update, the Transit Station Target Area would have the following land use designations: General Commercial, General Industrial and Light Industrial.

4. **South Quince Street Target Area.** The South Quince Street Target Area is approximately 184 acres in size and located south of downtown and north of 15th Avenue along both sides of Quince Street. Under the proposed General Plan Update, the South Quince Target Area would have the following land use designations: Urban I, Urban II, Planned Commercial, General Commercial and Office Industrial.

5. & 6. **Escondido Research Technology Center (ERTC) North Specific Planning Area (SPA) and ERTC South SPA.** Combined, ERTC North SPA and ERTC South SPA are approximately 476 acres in size and located along Citracado Parkway between Auto Park Way and Avenida del Diablo. Under the proposed General Plan Update, ERTC North SPA and ERTC South SPA would have a land use designation of Specific Plan Area.

7. **I-15/Felicita Road Corporate Office Target Area**. The I-15/Felicita Road Corporate Office Target Area is approximately 87 acres in size and located at the interchange of I-15 and Felicita Road. Under the proposed General Plan Update, the I-15/Felicita Road Corporate Office Target Area would have a land use designation of Planned Office.

8. **Promenade Retail Center and Vicinity Target Area.** The Promenade Retail Center and Vicinity Target Area is approximately 106 acres in size and is located in the area of I-15, Auto Park Way and Valley Parkway. Under the proposed General Plan Update, the Promenade Retail Center and Vicinity Target Area would have a land use designation of Planned Commercial.

9. **Nutmeg Street Study Area.** The Nutmeg Street Study Area is approximately 7 acres in size and located on both sides of Nutmeg Street, east of I-15 and west of Centre City Parkway. The existing General Plan designation is Estate II (single family residential; 20,000 SF minimum lot size). Under the proposed General Plan Update, the site would have a land use designation of Urban II.

10. **Downtown Specific Planning Area (Downtown SPA).** Downtown SPA is approximately 475 acres in size and located in central Escondido, east of I-15, north of 6th Avenue, south of Mission Avenue and west of Fig Street. Under the proposed General Plan Update, the Downtown SPA would have a land use designation of Specific Plan Area.

11. **East Valley Parkway Target Area.** The East Valley Parkway Target Area is approximately 331 acres in size and bounded generally by Escondido Creek, Grand Avenue, the existing Palomar Hospital campus and Midway Drive. Under the proposed General Plan Update, the East Valley Parkway Target Area would have a Mixed-Use Overlay with land use designations of Office and General Commercial.

12. **South Escondido Boulevard/Center City Parkway Target Area.** The South Escondido Boulevard/Center City Parkway Target Area is approximately 80 acres in size and bound by 6th and 15th Avenues, Escondido Boulevard, and Centre City Parkway. Under the proposed General Plan Update, the South Escondido Boulevard/Center City Parkway Target Area would have the following land use designations: Urban V and General Commercial.

13. **South Escondido Boulevard/Felicita Road Target Area.** The South Escondido Boulevard/Felicita Road Target Area is approximately 167 acres in size and located south of 15th Avenue between Escondido Boulevard and Centre City Parkway (on both sides of both streets). Under the proposed General Plan Update, the South Escondido Boulevard/Felicita Road Target Area would have a Mixed-Use overlay with land use designations of General Commercial, Urban III, and Urban IV.

14. **Centre City Parkway/Brotherton Road Target Area.** The Centre City Parkway/Brotherton Road Target Area is approximately 55 acres in size and located in the vicinity of Brotherton Road and Citracado Parkway on both sides of Centre City Parkway. Under the proposed General Plan Update, the Centre City Parkway/Brotherton Road Target Area would have a Mixed-Use overlay with land use designations of Urban III, General Commercial and Planned Commercial.

15. **Westfield Shoppingtown Target Area.** The Westfield Shoppingtown Target Area is approximately 77 acres in size and located at the I-15 and Via Rancho Parkway interchange. Under the proposed General Plan Update, the Westfield Shoppingtown Target Area would have a land use designation of Planned Commercial.

The following discussion provides General Plan Update background information, buildout information, a summary of each General Plan element, and the updated quality of life standards.

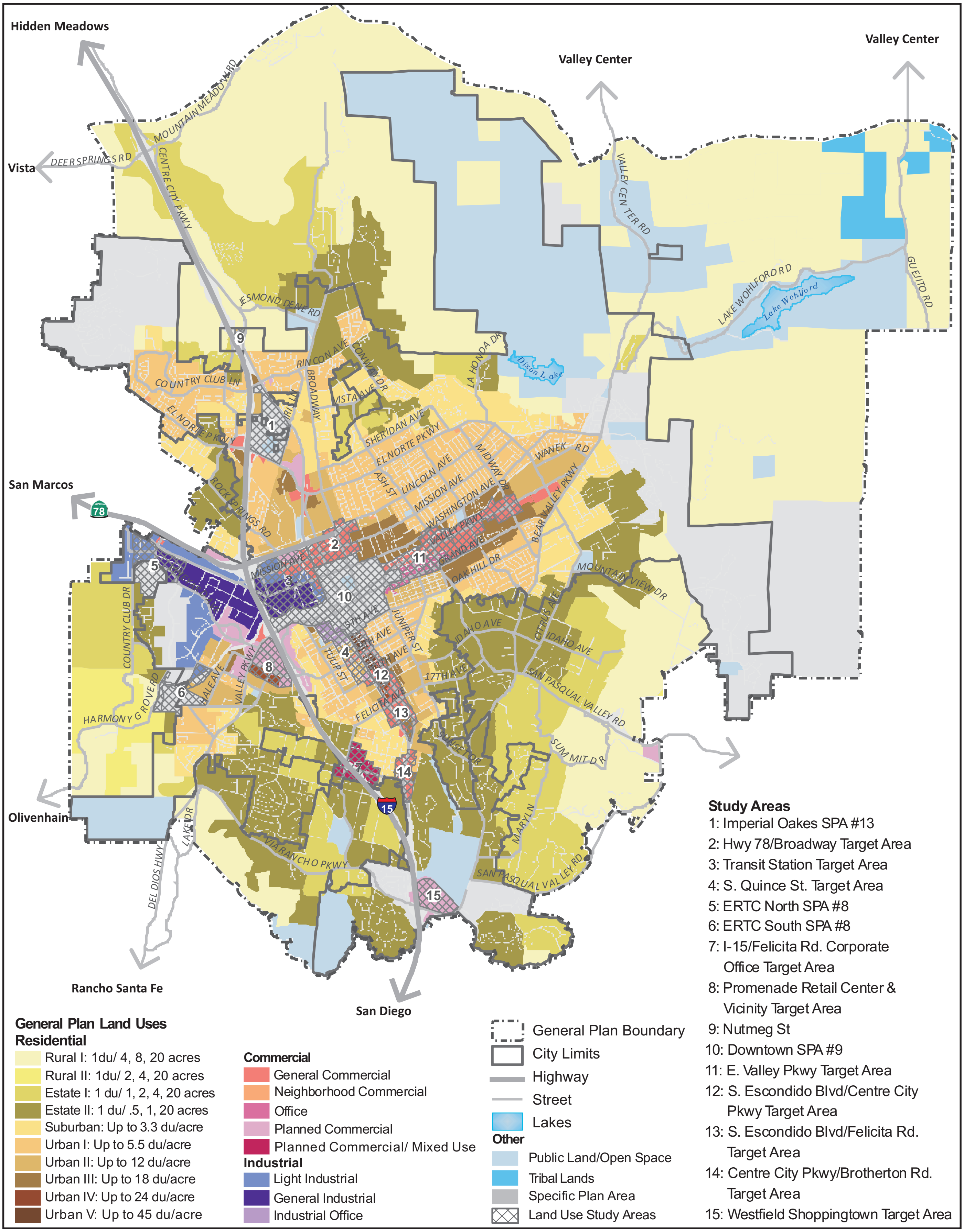
3.1.1.1 General Plan Buildout

The term buildout refers to the maximum number of potential residential units and maximum amount of commercial, industrial and non-residential square footage allowable under implementation of the General Plan Update. The horizon year for the General Plan Update is 2035, by which time a large portion, but not all, of the planned development under the Plan will have occurred. Full buildout of the General Plan Update would not occur until all development allowed under the Plan is achieved, the exact timing of which is unknown. 2035 buildout is considered to be a reasonable development scenario for the General Plan Update and buildout to this level has been estimated for all the study areas in the General Plan Update. Table 3-4, General Plan Update Buildout Conditions, identifies 2035 buildout scenarios for each study area. Buildout assumptions for each study area are based on dwelling units and densities being distributed in smart growth areas and established neighborhoods, taking into account community input and visioning as well as infrastructure capabilities and quality of life standards. 2035 buildout estimates are used as the basis for the analysis of impacts in this EIR. Therefore, all references to General Plan Update buildout in the EIR should be assumed to mean 2035 buildout, unless stated otherwise. Should any future development be proposed that is beyond 2035 buildout estimates, additional environmental review under CEQA would be required.

The General Plan Update buildout estimates shape how the City will look and feel and drive municipal infrastructure and facility needs. Detailed public facility plans that delineate the location and improvements associated with each public facility are prepared once the buildout and quality of life standards are determined. Once facility plans are developed, development fees are determined. If buildout estimates are too high, unnecessary improvements will be planned and the per-unit fees will be too low. If buildout is underestimated, then facility plans will not be able to accommodate actual development.

Table 3-4, General Plan Update Buildout Conditions, identifies the residential and non-residential 2035 buildout conditions under implementation of the proposed General Plan Update by study area, total city, and SOI. The 2035 buildout conditions for the General Plan Update boundary would result in 39,825 single family residential units, 24,883 multi-family residential units, 18,036,00 square feet of commercial/retail uses, 9,628,000 square feet of office uses, and 15,467,000 square feet of industrial/other uses.

General Plan Update Study Areas 5 and 9 and portions of 1, 6 and 7 are outside of the existing Escondido water service area and within the Rincon ID-1 service area. Due to lack of existing infrastructure, City Staff has determined that future development in Study Area 1 would best be served from Rincon MWD. Table A-1 shows existing water demands and projected 2035 demands within each of the twelve General Plan Update Study Areas that will be supplied with potable water from the City of Escondido.



Source: City of Escondido 2011

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STUDY AREA AND PROPOSED LAND USES
FIGURE 3-3

Table 3-2 General Plan Update Study Areas

Study Area (Refer to Figure 3-3)	Location	Size (in acres)	Adopted General Plan Land Use Designation	General Plan Update Land Use Designation	Current Status	Guiding Principles
#1 Imperial Oakes SPA	In the northern portion of the General Plan Update planning area, bounded by I-15 on the west, Country Club Lane on the north, El Norte Parkway on the south, Iris Lane and Centre City Parkway on the east	163	Suburban; Planned Commercial; General Commercial; Park; Office	Specific Plan Area	The Specific Plan Area is developed with visitor service and general retail uses, church, office, Rod McLeod Community Park, single family residential and vacant land. The site is bisected by SDG&E overhead utility lines and there is limited access to the interior.	▪ The SPA shall establish provisions for a comprehensively planned development focused on high paying, high employee density employment opportunities. The SPA shall include smart growth principles, and provide details on appropriate access, unifying design themes, attractive development standards and guidelines, appropriate land uses, and the prioritization of infrastructure improvements to accommodate growth. In addition, opportunities for a trail system or other recreational amenities that will connect with Rod McLeod Community Park shall be integrated into the plan. ▪ Increased building heights and intensities shall be focused along I-15 and in areas more distanced from residential uses to ensure compatibility. Specific attention shall be given to achieving compatibility with semi-rural residential areas along "edges" near Iris Lane by incorporating lower intensity land uses, building materials, heights, orientation, colors, heights, screening, lighting and signage. ▪ The SPA shall include programs addressing legal non-conforming residential uses that ensure their eventual integration into future planned business park operations while allowing their continued operation prior to transitioning to non-residential uses. Criteria and standards for proposed grading, circulation, and utility extensions shall be included to avoid adverse impacts and allow integration of adjacent SPA properties. ▪ Floor Area Ratio (FAR): 1.25 ▪ 5,740,593 square feet non-residential development at buildout.
#2 Hwy-78/ Broadway Target Area	Terminus of SR-78, north of downtown, east of Centre City Parkway, and west of Juniper Street	122	General Commercial	General Commercial	Low intensity general and auto-related retail, restaurants, office and commercial services and supply	▪ Evaluate opportunities to enhance vehicular entrance to the community along SR-78 and consider a gateway element to the City along Lincoln Avenue. ▪ Promote higher intensities along Broadway and consider establishing a unifying architectural and landscaping theme as a means to improve the overall image and serve as an entry into downtown. ▪ Consider opportunities and incentives for increasing employment densities and attracting businesses with salaries that raise the City's median income and improves the jobs/housing balance. ▪ FAR: 1.25 ▪ 330 residential dwelling units (du) and 2,573,320 square feet non-residential development at buildout.

Table3-2 continued

Study Area (Refer to Figure 3-3)	Location	Size (in acres)	Adopted General Plan Land Use Designation	General Plan Update Land Use Designation	Current Status	Guiding Principles
#3 Transit Station Target Area	Southeast of I-15 and SR-78	296	General Industrial (148 acres); Light Industrial (74 acres); General Commercial (74 acres)	General Commercial (74 acres) General Industrial (148 acres); Light Industrial (74 acres)	Developed with low intensity general and auto-related retail, restaurants, manufacturing, commercial/ industrial services, building/landscaping/irrigation supply, concrete/asphalt production	▪ Establish the area north of the transit station and generally east of Reidy Creek for locating a regional attraction involving entertainment, employment, commercial and residential uses incorporating unified development standards and design guidelines that also provides a strong pedestrian connection to downtown. ▪ Consider opportunities and incentives for increasing employment densities and attracting businesses with salaries that raise the City's median income and improves the jobs/housing balance. ▪ Allow existing construction material manufacturing, trash transfer, and agricultural supply land uses west of Reidy Creek to continue operating and prohibit similar new uses. ▪ FAR 1.25 ▪ 960 du and 4,850,741 square feet non-residential development at buildout.
#4 South Quince Street Target Area	South of downtown, north of 15th Avenue, and along both sides of Quince Street	184	Industrial Office ; Urban I; Urban II; Planned Commercial; General Commercial	Urban I (20 acres); Urban II (25 acres); Urban V (44 acres); Planned Commercial (5 acres); General Commercial (51 acres); Industrial Office (39 acres)	Mid-range density multi-family, low intensity general retail, office restaurants, small scale industrial and manufacturing services	▪ Establish an Area Plan that incorporates smart growth principles, promotes increased density and intensity near the transit center, encourages façade improvements, property revitalization and integrates public/private recreational space. ▪ Consider opportunities and incentives for increasing employment densities and attracting businesses with salaries that raise the City's median income and improves the jobs/housing balance. ▪ FAR: 1.0 ▪ 400 du and 1,764,833 square feet non-residential development at buildout.
#5, #6 ERTC North & South SPA	On the western side of the General Plan Update planning area along Citracado Parkway between Auto Park Way and Avenida del Diablo	476	North SPA: Light Industrial; General Industrial; Estate I; Estate II South SPA: Public; Urban I; Estate I; Estate II	Specific Plan Area	Partially developed with industrial and commercial uses, an SDG&E power plant and a hospital campus	▪ The SPA envisions a high quality business park, encouraging clean research and development, medical office and industrial park uses to expand Escondido's employment base, increase median incomes and improve the jobs/housing balance. The SPA includes attractive design standards, landscape features, integrated recreation, and compatible land uses. ▪ Increased building heights and intensities shall be focused along Citracado Parkway and in areas more distanced from residential uses to ensure compatibility. Specific attention shall be given to achieving compatibility with semi-rural residential areas along "edges" near Harmony Grove Road, Kauna Loa Drive and in Eden Valley by incorporating lower intensity land uses, building materials, heights, orientation, colors, heights, screening, lighting and signage.

Table3-2 continued

Study Area (Refer to Figure 3-3)	Location	Size (in acres)	Adopted General Plan Land Use Designation	General Plan Update Land Use Designation	Current Status	Guiding Principals
						▪ The SPA shall include programs addressing legal non-conforming residential uses that ensure their eventual integration into future planned business park operations while allowing their continued operation prior to transitioning to non-residential uses. Criteria and standards for proposed grading, multimodal transportation, and utility extensions shall be included to avoid adverse impacts and allow integration of adjacent SPA properties. ▪ The drainage areas running north and south through the center of this SPA, as well as Escondido Creek, represent a desirable visual amenity. The SPA shall include provisions for the enhancement of riparian areas and for the incorporation of the Escondido Creek Trail into the ultimate development plans while minimizing impacts to these resources. ▪ North SPA FAR: 1.50 ▪ South SPA FAR: 1.0 ▪ North SPA: 7,256,007 square feet non-residential development at buildout. ▪ South SPA: 1,555,092 square feet non-residential development at buildout.
#7 I-15/Felicita Road Corporate Office Target Area	I-15 and Felicita Road interchange area	87	Office; Suburban; Estate II	Planned Office	Low intensity medical offices, single family units, churches, agriculture, and vacant properties	▪ Promote opportunities and incentives for increasing employment densities and attracting businesses with salaries that raise the City's median income and improving the jobs/housing balance. ▪ Land uses shall be consistent with the Planned Office designation with a focus on attracting high paying, high employee density employment opportunities. ▪ Development shall incorporate high quality, unified design elements that provide for superior architecture and features such as building height, mass, colors, materials, signage, landscaping, lighting, parking and circulation that are sensitive to adjacent single family zoning. Increased building heights and intensities shall be located closer to the freeway and distanced from lower density residential with appropriate buffers to ensure compatibility. ▪ FAR: 1.75 ▪ 3,042,281 square feet non-residential development at buildout.

Table3-2 continued

Study Area (Refer to Figure 3-3)	Location	Size (in acres)	Adopted General Plan Land Use Designation	General Plan Update Land Use Designation	Current Status	Guiding Principals
#8 Promenade Retail Center and Vicinity Target Area	In-15, Auto Park Way and Valley Parkway	106	Planned Commercial; Urban IV	Planned Commercial	Retail shopping center with several anchor tenants, smaller shops, auto dealership, middle school, and apartments	▪ Work with the school district to coordinate a transition to retail use. Establish high quality, unified architectural design features for new development with particular attention to visibility from I-15 and southern residential areas. ▪ Consider opportunities and incentives for increasing employment densities and attracting businesses including offices, theaters, hotels, entertainment and visitor serving uses that complement existing retail and offer salaries that raise the city's median income and improving the jobs/housing balance. ▪ A planning alternative will evaluate mixed use commercial uses on the south side of Ninth Avenue in this study area. ▪ FAR: 1.50 ▪ 628 du and 6,153,148 square feet non-residential development at buildout.
#9 Nutmeg Street	Both sides of Nutmeg Street east of I-15 and west of Centre City Parkway	7	Estate II	Urban II	Site is vacant. Approximately 2-acres on the north side of Nutmeg Street is constrained by topography and sensitive habitat. Southern areas of the site have been disturbed.	▪ The site will be evaluated for Urban II residential densities. Given the site's "Gateway" location at the northern entrance of the community attention shall be given to high quality unified architecture with particular attention to visibility from I-15. ▪ A planning alternative will evaluate an office use for the site with the same design considerations noted above. ▪ FAR: 0.45 ▪ 50 du and 75,000 square feet non-residential development at buildout.
#10 Downtown SPA	Central Escondido generally located east of I-15, north of 6th Avenue, south of Mission Avenue and west of Fig Street	475	Specific Planning Area; General Commercial; Planned Commercial; Industrial Office	Specific Plan Area	The SPA is divided into seven districts and is partially developed. The SPA includes a historic, walkable retail and service core around Grand Avenue with suburban-style shopping centers on the western and northern ends. A historic residential neighborhood borders the downtown on the south with office and retail to the east.	▪ The Downtown SPA is envisioned as a dynamic, attractive, economically vital city center providing a social, cultural, economic, and residential focus while respecting its historic center. The environment is pedestrian-oriented, attracting local and non-local visitors to experience an atmosphere that is entertaining and vibrant with activity occurring throughout the day, evening and weekend hours. The SPA is intended to increase employment densities and attract businesses with salaries that raise the City's median income and improve the jobs/housing balance. The SPA is also intended to: – Prioritize infrastructure improvements to accommodate growth. – Target residential development around Grape Day Park. – Expand Grape Day Park to Washington Avenue to promote additional recreation opportunities and facilitate more convenient access from northern areas.

Table3-2 continued

Study Area (Refer to Figure 3-3)	Location	Size (in acres)	Adopted General Plan Land Use Designation	General Plan Update Land Use Designation	Current Status	Guiding Principals
						– Expand the Grand Avenue pedestrian environment through-out downtown by encouraging vertical mixed-use developments. – Strengthen the Escondido Creek path connection with downtown. – Provide convenient transit access, innovative housing options and pedestrian-oriented design. – Link downtown to the future regional attraction within Target Area #1 with attractive and safe pedestrian access. – FAR: 2.00 – 5,275 du and 13,566,484 non-residential development at buildout.
#11 East Valley Parkway Target Area	Generally between Escondido Creek, Grand Avenue, Palomar Hospital and Midway Drive	331	General Commercial; Office	Office (70 acres); General Commercial (261 acres); Mixed Use Overlay	Low intensity general retail, office, restaurants, and small-scale service businesses. Existing adopted plan is East Valley Parkway Area Plan.	▪ Update the Area Plan for the Target Area that includes smart growth principles, enhanced Escondido Creek path connections, aesthetically improved streetscapes along Lincoln Avenue and Ash Street, and integrated public/private recreational spaces. ▪ Establish a Mixed Use Overlay between Palomar Hospital and Ash Street to focus residential growth with increased building heights and intensities distanced from lower density residential uses and appropriate buffers to ensure compatibility. ▪ Promote opportunities and incentives for attracting job training, technical, vocational schools and educational institutions that enhance employment opportunities for residents. ▪ FAR: 1.25 ▪ 2,100 du and 8,328,596 square feet non-residential development at buildout.
#12 South Escondido Boulevard/ Felicita Road Target Area	South of 15th Avenue between Escondido Boulevard and Centre City Parkway (on both sides of both streets)	167	General Commercial; Urban IV	Urban III (29 acres); Urban IV (12 acres); General Commercial (126 acres); Mixed Use Overlay	Mid-range density multi-family, low intensity suburban shopping, general retail, office, restaurants, and small scale services. Existing adopted Plan is S. Escondido Boulevard Commercial Area Plan.	▪ Update the existing Area Plan for the Target Area to include smart growth principles, strong connections to transit, and integration of public/private recreational space. ▪ Establish a Mixed Use Overlay with increased density and intensity in close proximity to transit and services. Ensure compatibility with adjacent lower density residential with appropriate building heights, intensities, and buffers. ▪ FAR: 1.25 ▪ 740 du and 714,366 square feet non-residential development at buildout.

Table3-2 continued

Study Area (Refer to Figure 3-3)	Location	Size (in acres)	Adopted General Plan Land Use Designation	General Plan Update Land Use Designation	Current Status	Guiding Principals
#13 South Escondido Boulevard/ Centre City Parkway Target Area	Between 6th and 15th Avenues, Escondido Boulevard and Centre City Parkway	80	General Commercial; Urban III; Urban IV	Urban V (44 acres); General Commercial (36 acres)	Single family and mid-range density multi-family, small scale commercial services. Existing adopted plan is South Escondido Boulevard Commercial Area Plan.	▪ Update the existing Area Plan for the Target Area to include smart growth principles, strong connections to transit and integration of public/private recreational space. ▪ Ensure building heights and intensities are compatible with the adjacent Old Escondido Neighborhood Historic District. ▪ FAR: 1.25 ▪ 1,847 du and 2,063,500 square feet non-residential development at buildout.
#14 Centre City Parkway/ Brotherton Road Target Area	In the vicinity of Brotherton Road and Citracado Parkway on both sides of Centre City Parkway	55	General Commercial; Urban III	Urban III (7 acres); General Commercial (48 acres); Planned Commercial; Mixed Use Overlay	Mid-range density mixed use, low intensity suburban shopping, general retail, office, and small scale services. Existing adopted Plan is S. Escondido Boulevard Commercial Area Plan.	▪ Update the existing Area Plan for the Target Area to include smart growth principles, a gateway element for the City, aesthetic enhancements along Centre City Parkway, strong connections to transit, integration of public/private recreational space, and features to ensure pedestrian safety. ▪ Establish a Mixed Use Overlay with increased density and intensity in close proximity to transit and services. Ensure compatibility with adjacent lower density residential uses with appropriate building heights, intensities, and buffers. ▪ FAR: 1.50 ▪ 1,625 du and 1,565,120 square feet non-residential development at buildout.
#15 Westfield Shoppingtown Target Area	I-15 and Via Rancho Parkway interchange	77	Planned Commercial	Planned Commercial	Multi-story regional shopping center with several anchor tenants, smaller shops and free-standing up-scale dining establishments. Site is owned by the City under long-term lease contract to Westfield.	▪ Coordinate future shopping center expansion efforts that continue to attract a regional customer base and support City revenues. Opportunities for amending parking requirements shall be evaluated as transit use to and from the site increases. ▪ Consider opportunities and incentives for increasing employment densities and attracting businesses including offices, theaters, hotels, entertainment and visitor-serving uses that complement existing retail uses and offer salaries that raise the City's median income and improve the jobs/housing balance. ▪ Promote transit access and connections for the site and consider opportunities for amending parking requirements as transit use to and from the site increases. ▪ FAR: 1.25 ▪ 2,896,325 square feet non-residential development at buildout.

Table 3-3 Definitions of Proposed Land Use Categories

Land Use Category	Land Use Definition
Rural I Rural II	The Rural designation applies to areas that are not intended to receive substantial urban services, distant from the developed valley floor, or steep (generally over 25 percent in slope) or contain sensitive natural resources. Development clustering is permitted pursuant to General Plan Residential Clustering policies.
Estate I Estate II	The Estate designation accommodates detached single-family homes on large lots. This designation applies to areas that are on the edge of urban development or in areas that are already characterized by an estate development pattern. Development clustering is permitted pursuant to General Plan Residential Clustering policies.
Suburban	The Suburban designation applies to areas that generally surround the urbanized core of the community and accommodate single family detached homes on relatively large lots. Development clustering is permitted pursuant to General Plan Residential Clustering policies.
Urban I	The Urban I designation applies to many residential areas of the main Escondido “valley floor” and accommodates single family detached homes on smaller urban lots. Development clustering is permitted pursuant to General Plan Residential Clustering policies
Urban II and Urban III	The Urban II and III designations accommodate a wide range of housing types and generally applies to transitional areas between single family neighborhoods and higher density residential and commercial areas.
Urban IV and Urban V	The Urban IV and Urban V designations accommodate higher densities for urban multi-family housing characterized by taller structures in more densely developed areas that provide convenient access to a wider range of facilities and services.
Neighborhood Commercial	The Neighborhood Commercial designation accommodates very small scale neighborhood-oriented limited retail and office activities designed to serve residents in the immediate vicinity.
General Commercial	The General Commercial designation accommodates a wide variety of retail and service activities intended to serve a broad customer base.
Planned Commercial	The Planned Commercial designation accommodates a variety of commercial activities within a self-contained comprehensively planned development.
General Office	The General Office designation accommodates a variety of activities in an office environment and in Mixed Use Overlay areas and is intended to prevent the proliferation of individual isolated offices.
Planned Office	The Planned Office designation accommodates a variety of office activities within a self-contained comprehensively planned development.
Industrial Office	The Industrial Office designation accommodates a variety of activities in an industrial environment adjacent to downtown near the transit station.
Light Industrial and General Industrial	The Light Industrial and General Industrial designations accommodate a variety of activities in an industrial environment.
Vertical Mixed-Use and Horizontal Mixed-Use	The Vertical Mixed-Use and Horizontal Mixed-Use overlay designations accommodate a combination of commercial and/or office activities that include a residential component within a self-contained comprehensively planned development in specified General Plan locations.
Specific Planning Areas	Specific Planning Areas accommodate areas which require submittal of Planned Development or Specific Plans prior to development as described in the General Plan.
Public Facility Overlay	The Public Facility Overlay accommodates public facilities including government facilities, libraries, community centers, and schools.
Parks and Open Space	The Parks and Open Space designation accommodates land for public recreational activity and habitat preservation. Permitted uses include active and passive parks as well as land to protect, maintain, and enhance the community’s natural resources and includes detention basins and creek corridors.
Native American Tribal Lands	Native American Tribal Lands accommodate areas that are federally recognized reservations or Indian Villages. The City has no land use authority over Tribal Lands.

Table 3-4 General Plan Update Buildout Conditions

ID No.	Study Area	Existing Conditions	Adopted General Plan Full Buildout	General Plan Update Full Buildout	Buildout by 2035 (Horizon Year)	2035 Growth in New General Plan Above Existing Conditions	General Plan Update Full Buildout Above Adopted General Plan Full Buildout
Single Family Residences (in dwelling units)							
1.	Imperial Oakes SPA	64	289	0	0	-64	-289
2.	Hwy-78/Broadway Target Area	0	0	0	0	0	0
3.	Transit Station Target Area	0	0	0	0	0	0
4.	South Quince Street Target Area	140	150	150	150	10	0
5.	ERTC North SPA	39	135	0	0	-39	-135
6.	ERTC South SPA	20	200	0	0	-20	-200
7.	1-15/Felicita Road Corporate Office Target Area	19	155	0	0	-19	-155
8.	Promenade Retail Center and Vicinity Target Area	0	0	0	0	0	0
9.	Nutmeg Street	0	10	0	0	0	-10
10.	Downtown SPA	0	0	0	0	0	0
11.	East Valley Parkway Target Area	100	0	0	0	-100	0
12.	South Escondido Blvd/Centre City Pkwy Target Area	0	0	0	0	0	0
13.	South Escondido Blvd/Felicita Road Target Area	0	0	0	0	0	0
14.	Centre City Parkway/Brotherton Road Target Area	0	0	0	0	0	0
15.	Westfield Shoppingtown Target Area	0	0	0	0	0	0
Remainder of City (Non-Study Areas)		30,725	35,200	35,200	32,725	2,000	0
Total City		***31,107***	***36,139***	***35,350***	***32,875***	***1,768***	***-789***
Total SOI		***6,450***	***7,800***	***7,800***	***6,950***	***500***	***0***
Total City + SOI		***37,557***	***43,939***	***43,150***	***39,825***	***2,268***	***-789***
Multifamily Residences (in dwelling units)							
1.	Imperial Oakes SPA	0	0	0	0	0	0
2.	Hwy-78/Broadway Target Area	330	330	330	330	0	0
3.	Transit Station Target Area	160	160	960	800	640	800
4.	South Quince Street Target Area	170	250	250	250	80	0
5.	ERTC North SPA	0	0	0	0	0	0
6.	ERTC South SPA	0	0	0	0	0	0
7.	1-15/Felicita Road Corporate Office Target Area	0	0	0	0	0	0

Table 3-4 continued

ID No.	Study Area	Existing Conditions	Adopted General Plan Full Buildout	General Plan Update Full Buildout	Buildout by 2035 (Horizon Year)	2035 Growth in New General Plan Above Existing Conditions	General Plan Update Full Buildout Above Adopted General Plan Full Buildout
8.	Promenade Retail Center and Vicinity Target Area	628	628	628	628	0	0
9.	Nutmeg Street	0	0	50	50	50	50
10.	Downtown SPA	674	2,000	5,275	4,000	3,326	3,275
11.	East Valley Parkway Target Area	600	1,100	2,100	1,300	700	1,000
12.	South Escondido Blvd/Centre City Pkwy Target Area	690	1,072	1,847	1,300	610	775
13.	South Escondido Blvd/Felicita Road Target Area	440	640	740	740	300	100
14.	Centre City Parkway/Brotherton Road Target Area	300	500	1,625	1,000	700	1,125
15.	Westfield Shoppingtown Target Area	0	0	0	0	0	0
Remainder of City (Non-Study Areas)		12,485	17,327	17,327	13,735	1,250	0
Total City		***16,477***	***24,007***	***31,132***	***24,133***	***7,656***	***7,125***
Total SOI		***0***	***0***	***0***	***0***	***0***	***0***
Total City + SOI		***16,477***	***24,007***	***31,132***	***24,883***	***7,656***	***7,125***
Total Housing Units (in dwelling units)							
1.	Imperial Oakes SPA	64	289	0	0	-64	-289
2.	Hwy-78/Broadway Target Area	330	330	330	330	0	0
3.	Transit Station Target Area	160	160	960	800	640	800
4.	South Quince Street Target Area	310	400	400	400	90	0
5.	ERTC North SPA	39	135	0	0	-39	-135
6.	ERTC South SPA	20	200	0	0	-20	-200
7.	1-15/Felicita Road Corporate Office Target Area	19	155	0	0	-19	-155
8.	Promenade Retail Center and Vicinity Target Area	628	628	628	628	0	0
9.	Nutmeg Street	0	10	50	50	50	40
10.	Downtown SPA	674	2,000	5,275	4,000	3,326	***3,275***
11.	East Valley Parkway Target Area	700	1,100	2,100	1,300	600	1,000
12.	South Escondido Blvd/Centre City Pkwy Target Area	690	1,072	1,847	1,300	610	775
13.	South Escondido Blvd/Felicita Road Target Area	440	640	740	740	300	100
14.	Centre City Parkway/Brotherton Road Target Area	300	500	1,625	1,000	700	1,125
15.	Westfield Shoppingtown Target Area	0	0	0	0	0	0

Table 3-4 continued

ID No.	Study Area	Existing Conditions	Adopted General Plan Full Buildout	General Plan Update Full Buildout	Buildout by 2035 (Horizon Year)	2035 Growth in New General Plan Above Existing Conditions	General Plan Update Full Buildout Above Adopted General Plan Full Buildout
Remainder of City (Non-Study Areas)		43,210	52,527	52,527	46,460	3,250	0
Total City Residential		***47,584***	***60,146***	***66,482***	***57,008***	***9,424***	***6,336***
Total SOI Residential		***6,450***	***7,800***	***7,800***	***6,950***	***500***	***0***
Total Housing Units City + SOI		***54,034***	***67,946***	***74,282***	***63,958***	***9,924***	***6,336***
Commercial/Retail Units (in square feet)							
1.	Imperial Oakes SPA	0	0	0	0	0	0
2.	Hwy-78/Broadway Target Area	666,000	900,000	2,445,000	1,200,000	534,000	1,545,000
3.	Transit Station Target Area	596,000	625,000	970,000	850,000	254,000	345,000
4.	South Quince Street Target Area	165,000	179,000	538,000	300,000	135,000	359,000
5.	ERTC North SPA	82,000	87,000	726,000	87,000	5,000	639,000
6.	ERTC South SPA	0	0	0	0	0	0
7.	1-15/Felicita Road Corporate Office Target Area	0	0	437,000	186,000	186,000	437,000
8.	Promenade Retail Center and Vicinity Target Area	420,000	516,000	1,846,000	775,000	355,000	1,330,000
9.	Nutmeg Street	0	0	0	0	0	0
10.	Downtown SPA	2,053,000	2,466,000	9,442,000	3,600,000	1,547,000	6,976,000
11.	East Valley Parkway Target Area	1,895,000	2,100,000	5,414,000	2,250,000	355,000	3,314,000
12.	South Escondido Blvd/Centre City Pkwy Target Area	817,000	897,000	1,960,000	1,153,000	336,000	1,063,000
13.	South Escondido Blvd/Felicita Road Target Area	238,000	299,000	679,000	375,000	137,000	380,000
14.	Centre City Parkway/Brotherton Road Target Area	169,000	290,000	861,000	576,000	407,000	571,000
15.	Westfield Shoppingtown Target Area	1,600,000	1,600,000	2,462,000	2,034,000	434,000	862,000
Remainder of City (Non-Study Areas)		4,300,000	4,778,000	4,778,000	4,500,000	200,000	0
Total City		***13,001,000***	***14,737,000***	***32,558,000***	***17,886,000***	***4,885,000***	***17,821,000***
Total SOI		***0***	***300,000***	***300,000***	***150,000***	***150,000***	***0***
Total City + SOI		***13,001,000***	***15,037,000***	***32,858,000***	***18,036,000***	***5,035,000***	***17,821,000***
Office (in square feet)							
1.	Imperial Oakes SPA	15,000	30,000	4,592,000	2,100,000	2,085,000	4,562,000
2.	Hwy-78/Broadway Target Area	35,000	47,000	129,000	84,000	49,000	82,000
3.	Transit Station Target Area	149,000	156,000	728,000	550,000	401,000	572,000

Table 3-4 continued

ID No.	Study Area	Existing Conditions	Adopted General Plan Full Buildout	General Plan Update Full Buildout	Buildout by 2035 (Horizon Year)	2035 Growth in New General Plan Above Existing Conditions	General Plan Update Full Buildout Above Adopted General Plan Full Buildout
4.	South Quince Street Target Area	18,000	20,000	60,000	60,000	42,000	40,000
5.	ERTC North SPA	660,000	694,000	5,805,000	1,200,000	540,000	5,111,000
6.	ERTC South SPA	4,000	4,000	156,000	78,000	74,000	152,000
7.	1-15/Felicita Road Corporate Office Target Area	150,000	154,000	2,477,000	950,000	800,000	2,323,000
8.	Promenade Retail Center and Vicinity Target Area	180,000	221,000	1,231,000	443,000	263,000	1,010,000
9.	Nutmeg Street	0	0	0	30,000	30,000	0
10.	Downtown SPA	969,000	1,025,000	3,921,000	1,250,000	281,000	2,896,000
11.	East Valley Parkway Target Area	1,020,000	1,131,000	2,915,000	1,400,000	380,000	1,784,000
12.	South Escondido Blvd/Centre City Pkwy Target Area	43,000	47,000	103,000	78,000	35,000	56,000
13.	South Escondido Blvd/Felicita Road Target Area	13,000	33,000	36,000	30,000	17,000	3,000
14.	Centre City Parkway/Brotherton Road Target Area	139,000	237,000	704,000	345,000	206,000	467,000
15.	Westfield Shoppingtown Target Area	0	0	434,000	284,000	284,000	434,000
Remainder of City (Non-Study Areas)		696,000	773,000	773,000	746,000	50,000	0
Total City		***4,091,000***	***4,572,000***	***24,064,000***	***9,628,000***	***5,537,000***	***19,492,000***
Total SOI		***0***	***0***	***0***	***0***	***0***	***0***
Total City + SOI		***4,091,000***	***4,572,000***	***24,064,000***	***9,628,000***	***5,537,000***	***19,492,000***
Industrial/Other (in square feet)							
1.	Imperial Oakes SPA	60,000	120,000	1,148,000	550,000	490,000	1,028,000
2.	Hwy-78/Broadway Target Area	0	0	0	0	0	0
3.	Transit Station Target Area	2,234,000	2,346,000	3,638,000	2,800,000	566,000	1,292,000
4.	South Quince Street Target Area	357,000	388,000	1,167,000	500,000	143,000	779,000
5.	ERTC North SPA	82,000	87,000	726,000	87,000	5,000	639,000
6.	ERTC South SPA	36,000	36,000	1,400,000	700,000	664,000	1,364,000
7.	1-15/Felicita Road Corporate Office Target Area	129,000	129,000	129,000	129,000	129,000	0
8.	Promenade Retail Center and Vicinity Target Area	0	0	0	0	0	0
9.	Nutmeg Street	0	0	0	0	0	0
10.	Downtown SPA	31,000	50,000	203,000	91,000	60,000	153,000
11.	East Valley Parkway Target Area	0	0	0	0	0	0

Table 3-4 continued

ID No.	Study Area	Existing Conditions	Adopted General Plan Full Buildout	General Plan Update Full Buildout	Buildout by 2035 (Horizon Year)	2035 Growth in New General Plan Above Existing Conditions	General Plan Update Full Buildout Above Adopted General Plan Full Buildout
12.	South Escondido Blvd/Centre City Pkwy Target Area	0	0	0	0	0	0
13.	South Escondido Blvd/Felicita Road Target Area	0	0	0	0	0	0
14.	Centre City Parkway/Brotherton Road Target Area	0	0	0	0	0	0
15.	Westfield Shoppingtown Target Area	0	0	0	0	0	0
Remainder of City (Non-Study Areas)		9,460,000	11,771,000	11,771,000	10,610,000	1,150,000	0
Total City		***12,389,000***	***14,927,000***	***20,182,000***	***15,467,000***	***3,078,000***	***5,255,000***
Total SOI		***0***	***0***	***0***	***0***	***0***	***0***
Total City + SOI		***12,389,000***	***14,927,000***	***20,182,000***	***15,467,000***	***3,078,000***	***5,255,000***
Nonresidential Summary							
1.	Imperial Oakes SPA	75,000	150,000	5,740,000	2,650,000	2,575,000	5,590,000
2.	Hwy-78/Broadway Target Area	701,000	947,000	2,574,000	1,284,000	583,000	1,627,000
3.	Transit Station Target Area	2,979,000	3,127,000	5,336,000	4,200,000	1,221,000	2,209,000
4.	South Quince Street Target Area	540,000	587,000	1,765,000	860,000	320,000	1,178,000
5.	ERTC North SPA	824,000	868,000	7,257,000	1,374,000	550,000	6,389,000
6.	ERTC South SPA	40,000	40,000	1,556,000	778,000	738,000	1,516,000
7.	1-15/Felicita Road Corporate Office Target Area	279,000	283,000	3,043,000	1,265,000	986,000	2,760,000
8.	Promenade Retail Center and Vicinity Target Area	600,000	737,000	3,077,000	1,218,000	618,000	2,340,000
9.	Nutmeg Street	0	0	0	30,000	30,000	0
10.	Downtown SPA	3,053,000	3,541,000	13,566,000	4,941,000	1,888,000	10,025,000
11.	East Valley Parkway Target Area	2,915,000	3,231,000	8,329,000	3,650,000	735,000	50,980,000
12.	South Escondido Blvd/Centre City Pkwy Target Area	860,000	944,000	2,063,000	1,231,000	371,000	1,119,000
13.	South Escondido Blvd/Felicita Road Target Area	251,000	332,000	715,000	405,000	154,000	383,000
14.	Centre City Parkway/Brotherton Road Target Area	308,000	527,000	1,565,000	921,000	613,000	1,038,000
15.	Westfield Shoppingtown Target Area	1,600,000	1,600,000	2,896,000	2,318,000	718,000	1,296,000
Remainder of City (Non-Study Areas)		14,456,000	17,322,000	17,322,000	15,856,000	1,400,000	0
Total City Nonresidential		***29,481,000***	***34,236,000***	***76,804,000***	***42,981,000***	***13,500,000***	***42,568,000***
Total SOI Non-Residential		***0***	***300,000***	***300,000***	***150,000***	***150,000***	***0***
Total City + SOI Non-residential Total		***29,481,000***	***34,536,000***	***77,104,000***	***43,131,000***	***13,650,000***	***42,568,000***

Table A-1 2035 Buildout Conditions and Projected Water Demands for General Plan Update Study Areas

Study Areas within the City of Escondido Water Service Area	Pressure Zone	Existing Demand Remaining gpd	2035 Growth in New General Plan: Residential SFDU	MFDU	Non-Residential, square-feet: Comm	Office	Industrial	Future Demand[2] gpd	Projected 2035 Demand gpd	Comments
2. Hwy-78/Broadway	Lindley	171,110	-	-	534,000	49,000	-	78,680	249,790	FAR = 1.25
3. Transit Station	Lindley	251,057	-	640	254,000	401,000	424,500	242,400	493,457	FAR = 1.25
	A-11	394,780					141,500	11,320	406,100	
4. S. Quince Street	Park Hill	53,401	10	60	135,000			36,100	89,501	MFDU - Urban I & Urban II; FAR = 1.0
	Lindley	100,839	-	20		42,000	143,000	19,200	120,039	
6. ERTC South SPA	A-11[1]	-	-	-	-	-	121,331	9,706	9,706	existing SFDUs to be replaced; includes wetlands; FAR=1.0
7. 1-15/Felicita Rd Corp. Office	A-11[1]	9,741	-	-	-	118,926	-	9,514	19,255	7.34 ac vacant; FAR 1.75
8. Promenade Retail Center	A-11	229,716	-	-	355,000	263,000	-	70,740	300,456	ex school to be replaced; MFDU =Urban IV; FAR=1.5
10. Downtown SPA	Lindley	622,087	-	3,326	1,361,360	281,000	60,000	949,590	1,571,678	existing park irrigated with recycled water; FAR=2.0
	A-11	37,095	-	-	185,640	-	-	25,990	63,084	
11. East Valley Parkway	Lindley	600,690	-	700	355,000	380,000	-	234,100	834,790	SFDUs to be replaced; FAR=1.25
12. S Escondido Blvd/ Centre City Pkwy	Park Hill	88,645	-	150	68,500	8,500	-	43,270	131,915	MFDU - Urban V; FAR = 1.25
	Lindley	84,298		150	68,500	8,500	-	43,270	127,568	
13. S Escondido Blvd/Felicita Rd	Park Hill	188,515	-	610	285,600	35,000	-	176,984	365,499	MFDU - Urban III & IV; FAR = 1.25
	A-11	97,618		-	50,400			7,056	104,674	
14. Centre City Pkwy/Brotherton Rd	A-11/Lindley	82,484	-	700	407,000	206,000	-	227,460	309,944	MFDU - Urban III; FAR= 1.5
15. Westfield Shoppingtown	N County Fair	109,341	-	-	434,000	284,000	-	83,480	192,821	FAR = 1.25
Total for Study Areas:		**3,121,419**	**10**	**6,356**	**4,494,000**	**2,076,926**	**890,331**	**2,268,861**	**5,390,279**	

(1) A portion of the study area extends outside of the Escondido water service area boundary. Future development within the service area is estimated.

(2) Future demand projections are based on: 400 gpd/SFDU, 220 gpd/MFDU, 1,400 gpd/10,000 square feet of commercial building area and 800 gpd/10,000 square feet of office & industrial building area

A.1 WATER QUALITY

Appendix A discusses water quality generally, followed by a detailed discussion of the water quality for each hydrologic component. Schematic locations of pollutant sources and water quality testing are shown in Figures A-1 through A-4.

GENERAL WATER QUALITY

The local water is characteristic of natural waters derived from granitic source rock and does not significantly change in quality from its source to delivery. The watersheds that contribute runoff are 80 percent undeveloped and relatively free of potential contaminant sources. No significant growth or changes in contaminant sources are expected within the next several years.

WATER SOURCES

The quality of the local water supply is largely a reflection of its source area. On an annual average, approximately 40 percent of the inflow is direct surface runoff to Lake Henshaw, 30 percent is runoff from watersheds below Lake Henshaw Dam, and 30 percent is pumped groundwater from the Warner Basin aquifer. In dry years, groundwater is the major component; in wet years, surface water runoff comprises the majority of the flow.

GEOLOGIC SETTING

The water quality is typical of a mixed granitic-metamorphic source area (that is, a moderately hard bicarbonate type with about equal proportions of calcium, sodium, chloride, and sulfate). Low to absent carbonate concentration keeps the water relatively soft in spite of moderate concentrations of total dissolved salts. Although a few mineral hot springs in the Warner Basin have atypical water, they do not contribute significantly to the overall water supply. Granitic source areas do not generally produce water with high background radioactivity, excessive acid conditions, or high concentrations of dissolved heavy metals; however, granitic source rocks often produce water that exceeds secondary water standards for iron, manganese, and aluminum. The regional metamorphic rocks can contain trace elements that would be mobilized if waters became acidic.

Pollutant Types

Table A-1 summarizes the pollution types and gives a general indication of the magnitude of the potential problems. Although considerable focus has been on the discharge from small treatment facilities, the volume of potential pollutants is negligible compared to the more widespread use of pesticides and herbicides and rural septic systems. Specific pollutant sources will be discussed under each watershed area.

TABLE A-1
POLLUTION SOURCES BY POTENTIAL SIGNIFICANCE AND WATER QUALITY CATEGORY

Significance	Organic, Pesticides, Herbicides	Microbial	Turbidity	Nutrients	Minerals	Hardness	Metals	Radiological
More Significant	Golf courses, highway weed control	Cattle, horses, and wildlife	Floods, high runoff, landslides	Agriculture, cattle	Geologic (natural)	Geologic (natural)	Geologic (natural)	Highway accident
↑	Highway accidents	Septic systems	Fire, landslides	Septic systems	Reservoir operations	Reservoir operations	Highway accident	Illegal dumping
↓	Residential runoff	Wastewater effluent	Water sports, dirt roads	Wastewater effluent	Floods, landslides	Floods, landslides	Illegal dumping	
Less Significant	Illegal dumping, landfills	Campgrounds, water sports, accidents	Earthquakes	Camp-grounds	Waste-water effluent	Waste-water effluent	Landfills	Geologic (natural)

A sanitary survey was conducted by James M. Montgomery Engineers, Inc., in 1996 and identifies eight categories of potential pollutants: microbial and turbidity, nutrients, minerals, hardness, metals, organics, radiological, and disinfectant by-products. Microbial constituents and turbidity indicate human- and animal-derived pollutants, as the presence of *E. coli* indicates that *Giardia* and *Cryptosporidium* may be present. Nutrients indicate potential agricultural pollution and cause taste and odor problems in the water.

Minerals and hardness are not considered pollutants, but can make the water undesirable. Mineral content reflects source water and generally increases down the hydrologic system. Groundwater generally has slightly higher mineral content than the local watershed runoff. Metals detected in the water often indicate a point-source facility, but can also occur naturally, such as the iron and manganese typical of some of the local water.

Organic and radioactive pollutants usually indicate industrial activity. Hydrocarbons have been occasionally detected in the water supply. There are no known point sources of radiological contamination in the watershed although geologic conditions could produce low background levels.

CURRENT WATER QUALITY TESTING

Water is tested weekly at the intake and outlet of the treatment plant for microbes, nutrients, minerals, metals, radioactivity, organics, and microbes. Water is tested twice yearly at Lake Henshaw for general physical and chemical constituents, periodically for radioactivity, and weekly for *E. coli*. Groundwater is tested annually at the wellhead for nitrates and occasionally for hydrocarbons. When the Warner Basin wells were drilled (during the 1950s to the 1970s), the water was tested for general chemical and physical properties and selected testing was also conducted in the 1950s and 1960s at wells and springs.

WATER QUALITY ABOVE LAKE HENSHAW DAM

The locations of the upper watersheds of the Warner Basin are shown on Figure 3-1. On an annual average, about 14,000 acre-feet of surface runoff enters Lake Henshaw in addition to about 7,000 acre-feet of groundwater and 3,000 acre-feet of direct rainfall.

The results of water quality testing from 1984 to 1995 in Lake Henshaw are shown in Table A-2. The proportion of major chemical constituents is higher in the late fall because reduced inflow and releases tend to allow evaporation to concentrate the minerals. Nevertheless, total mineral concentration generally remains under 400 mg/L. It should be noted that the water in Lake Henshaw often has a large component of groundwater and, therefore, does not necessarily indicate the quality of surface runoff. Tests conducted during the rainy season and during wet years are more representative of upper watershed water quality.

TABLE A-2
WATER QUALITY IN LAKE HENSHAW (1984 TO 1995)
(PARTS PER MILLION OR MILLIGRAMS PER LITER, UNLESS OTHERWISE SPECIFIED)

Constituent	Annual Average	Summer Average	Summer Standard Deviation	Summer Maximum	Winter Average	Winter Standard Deviation	Winter Maximum
General Characteristics							
pH (unitless)	8.4	8.4	0.3	9.1	8.3	0.4	8.8
MBAS	0.049	0.080	0.062	0.150	0.017	0.006	0.020
Turbidity	17	17	9	25	not tested	not tested	not tested
TDS	316	298	97	450	334	87	420
Hardness	154	148	39	209	160	30	200
Mineral Composition							
Bicarbonate	182	175	42	243	188	28	211
Carbonate	3	3	3	12	3	3	9
Calcium	43	41	10	55	45	8	54
Magnesium	11	10	4	17	11	2	14
Sodium	52	48	21	81	55	20	79
Potassium	4	4	1	5	3	1	5
Chloride	35	32	15	55	38	14	53
Fluoride	0.6	0.05	0.2	0.8	0.6	0.2	0.7
Sulfate	64	61	32	106	67	30	96
Nitrate	0.046	0.047	0.042	0.100	0.044	0.069	0.200
Metals							
Iron	0.554	0.535	0.430	1.300	0.573	0.514	1.800
Manganese	0.105	0.097	0.052	0.160	0.112	0.065	0.220
Aluminum	1.154	1.120	0.660	1.800	1.188	0.868	2.400
Arsenic	0.006	0.002	0.001	0.003	0.010	0.006	0.014
Barium	0.239	0.185	0.290	0.770	0.293	0.361	0.710
Cadmium	0.003	0.001	*	*	0.005	*	*
Mercury	<MCL	<MCL	*	*	<MCL	*	*
Zinc	0.023	0.026	0.014	0.042	0.019	0.014	0.360
Copper	0.058	0.015	0.008	0.021	0.100	*	*
Selenium	0.004	0.003	*	*	0.005	*	*

*Insufficient samples to calculate statistical values.
MCL = Minimum contaminant level.

As seen in Figure A-1, the upper watershed of the San Luis Rey River contains the most potential pollutant sources. Three wastewater facilities discharge a total of about 0.12 mgd, which constitutes an insignificant proportion of inflow to Lake Henshaw; however, the golf course irrigation return flows (potential sources of pesticide) and cattle grazing (potential source of microbial contaminants) are more significant constant sources of pollutants. Although the SERE Camp, a 0.014 mgd facility in the Agua Caliente watershed, has exceeded standards in effluent discharge, the minor amount of high TDS discharge it produces could increase TDS in Lake Henshaw by only a few parts per million.

The Buena Vista watershed also contains sources of contaminants, including three paved roads, cattle grazing, and a campground. The lowlands surrounding Lake Henshaw could also significantly contribute pollutants from cattle grazing, an air strip, two highways, agricultural activity, Lake Henshaw Resort, and rural housing.

Because the Carrista and Matagual watersheds contribute very little water to Lake Henshaw, they are not anticipated to be major sources of contamination.

Roads cross most of the surface water features above Henshaw Dam. Spills from State Road 79, which crosses the San Luis Rey River and Carrista, Carrizo, Matagual, Buena Vista, and Agua Caliente Creeks, could travel to Lake Henshaw. Highway maintenance involves regular chemical applications of herbicides and dust control oils.

The largest single pollution event would most likely result from an accidental spill, flood, or earthquake. The most significant constant source of pollutants appears to be cattle grazing, pesticide and herbicide use, and unregulated rural septic systems.

WATER QUALITY OF THE WARNER BASIN AQUIFER

Much of the local water supply is groundwater. An average of about 7,000 acre-feet of groundwater flows into Lake Henshaw, either as seepage or pumped groundwater. In wet years, Lake Henshaw primarily contains surface water, whereas it contains a mix of surface and groundwater during dry years. During the driest years, Lake Henshaw is comprised entirely of groundwater.

Table A-3 shows the water quality of Warner Basin groundwater, gathered primarily in the 1950s to 1960s when the wells were drilled. Groundwater often exceeds secondary standards for iron, manganese, and aluminum. Primary standards for chromium and mercury were exceeded in two wells, but there has been insufficient testing to discern if this is a widespread problem. Water from one well contained a trace of the pesticide aldrin. Historically, several wells in the Carrista Creek area (north of Morettis Junction), on the Agua Caliente drainage, and in the Buena Vista area around Warner Ranch have historically shown nitrate concentrations that exceed standards; however, tests conducted from 1992 to 1994 did not indicate high nitrate concentrations.

TABLE A-3 WATER QUALITY OF WARNER BASIN AQUIFER (PARTS PER MILLION OR MILLIGRAMS PER LITER, UNLESS OTHERWISE SPECIFIED)								
Chemical Constituent	Total Well Field	Carrista Forebay	Buena Vista	Aqua Caliente	Upper San Luis Rey River	Warner Basin Southeast	West Fork Forebay	Monkey Hill
General Characteristics								
pH (unitless)	8.1	7.1	7.4	8.1	7.1	8.1	7.8	8.9
TDS	286	294	278	320	285	299	380	252
Hardness	112	112	134	108	132	116	151	36
Mineral Composition								
Bicarbonate	142	120	158	183	153	174	174	104
Calcium	26	32	16	27	38	34	43	12
Magnesium	6	8	10	7	10	7	11	2
Sodium	68	30	36	66	51	63	71	78
Potassium	2	4	2	3	2	2	2	1
Chloride	45	29	34	33	35	472	52	47
Fluoride	1.2	0.2	0.3	1.6	0.4	0.5	1.2	1.6
Sulfate	50	23	6	33	66	44	88	26
Nitrate[2]	3.0	17.0	4.7	8.3	3.4	3.8	3.8	0.9

[1]Based on testing when wells were drilled from 1950 to 1960.
[2]Reported in the 1950s and 1960s. Annual testing of wells from 1992 to 1994 shows all well test below 3 mg/L concentration of nitrate.

Areas of highest risk of direct pollution to the aquifer are the alluvial deposits at the San Luis Rey River, Agua Caliente Creek, and the confluence of the West Fork and San Luis Rey River, which are major recharge areas. The southern Warner Basin appears to have sufficient clay above the main aquifer to reduce the risk of pollution from the surface, and the Buena Vista drainage does not appear to have extensive direct connection to the main aquifer.

Recent testing show that the small water treatment facilities are not significantly polluting the aquifer. The SERE Camp monitor wells exceeded TDS standards in 1993 and 1994, and the sulfate and chloride concentrations adjacent to all wastewater discharge points are slightly elevated over the typical well field concentrations, but remain within standards. The volume of water seeping into the aquifer at discharge points is minor and would likely be diluted in a short distance; therefore, wastewater facilities are not considered to be a major problem.

Pesticides and nutrient loading could be a serious potential groundwater pollution problem, although heavy rains are likely to route these contaminants directly to Lake Henshaw. VID's production wells access water from depth of about 100 to 500 feet. Water percolating to these depths is usually pure, although in the 1950s and early 1960s, a few VID wells had high nitrate concentrations.

Although iron and manganese do not pose a human health risk, high levels make the Warner Basin aquifer an ideal environment for iron bacteria. Several of VID's wells have been shut down because of the presence of iron bacteria. Infected wells could contaminate clean wells unless precautions are taken. Unchecked, iron bacteria could significantly impact well field production capacity and reduce the yield of the entire local water supply. There are several kinds of iron bacteria and several methods of mitigation which should be considered in the overall maintenance program for the Warner Basin well field. High iron and manganese may also contribute to algal blooms in Lake Henshaw when levels are low and the lake is comprised primarily of groundwater.

WATER QUALITY FROM LAKE HENSHAW DAM TO THE ESCONDIDO CANAL

Water in the San Luis Rey River below Henshaw Dam has not been extensively tested. Figure A-2 schematically shows the potential sources of contaminants as water is conveyed from Lake Henshaw to the intake of the Escondido Canal. About 30 percent of the local runoff accrues between Henshaw Dam and the intake. Potential sources of pollution are recreational facilities (campgrounds, water park, auto racing, and river floating), an estimated 51 unregulated septic systems, a two-acre landfill, cattle grazing, and two paved roads.

WATER QUALITY IN THE ESCONDIDO CANAL

Less than 1 percent of the runoff originates upslope of the Escondido Canal. The potential contaminant sources, including an industrial park, agricultural lands, and an estimated 457 unregulated septic systems, are shown in Figure A-3. The most significant problem may be the rural septic systems. To a large part, enclosure and sealing of the Escondido Canal could mitigate most of the septic system contaminants. Copper sulfate is occasionally used to treat diverted canal water for algal blooms and may temporarily increase sulfate concentrations in the canal and in Lake Wohlford.

WATER QUALITY OF LAKE WOHLFORD

Results of water quality testing from 1984 to 1995 at Lake Wohlford are shown in Table A-4.

Table A-4
Water Quality in Lake Wohlford (1984 to 1995)
(parts per million or milligrams per liter, unless otherwise specified)

		Summer			Winter		
Constituent	Annual Average	Average	Standard Deviation	Maximum	Average	Standard Deviation	Maximum
General Characteristics							
pH (unitless)	8.0	8.1	0.2	8.4	7.9	0.2	8.1
MBAS	0.055	0.055	0.007	0.6	not tested	not tested	not tested
Turbidity	8	8	10	32	8	7	29
TDS	287	272	77	374	302	99	476
Hardness	142	132	23	151	151	31	205
Mineral Composition							
Bicarbonate	146	118	60	174	174	54	255
Carbonate	2	2	na	na	1	na	na
Calcium	40	38	7	48	41	9	59
Magnesium	10	9	3	13	11	3	15
Sodium	46	43	21	71	48	24	85
Potassium	4.2	4.0	1.7	5.2	4.3	0.6	5.6
Chloride	34	30	13	48	38	15	61
Fluoride	0.42	0.41	0.18	0.67	0.43	0.22	0.83
Sulfate	48	40	23	70	56	29	106
Nitrate	0.5	0.4	0.2	0.6	0.5	0.5	1.7
Metals							
Iron	0.373	0.326	0.194	0.620	0.420	0.183	0.750
Manganese	0.124	0.057	0.034	0.095	0.190	0.235	0.760
Aluminum	1.490	0.308	0.176	0.460	0.671	0.559	2.000
Arsenic	<MCL	<MCL	na	na	<MCL	na	na
Chromium	0.0028	0.0011	na	na	0.0045	0.0007	0.0050
Mercury	<MCL	<MCL	na	na	<MCL	na	na
Selenium	<MCL	<MCL	na	na	<MCL	na	na
Cadmium	0.0004	0.0001	na	na	0.0007	0.0010	0.0020
Barium	0.0696	0.0734	0.0127	0.0860	0.0658	0.0215	0.1140
Zinc	0.0031	0.0003	0.0002	0.0010	0.0059	0.0110	0.0280
Lead	0.0014	0.0009	0.0002	0.0010	0.0018	0.0014	0.0028
Copper	0.0074	0.0087	0.0059	0.0160	0.0060	0.0024	0.0090

The proportions of mineral constituents are generally constant, although the concentrations vary seasonally. In the summer, bicarbonate concentrations are generally similar to those found in Warner Basin well water, indicating a large portion of Lake Wohlford is groundwater.

Sources of potential contaminants are shown on Figure A-4. Two small regulated wastewater treatment facilities produce up to 0.037 mgd of discharge, which is negligible compared to the inflow to Lake Wohlford. The 110 septic systems, a resort, and other recreational facilities present a more significant potential source of pollutants. A horse ranch at the inlet of Lake Wohlford could potentially be a source of pathogens.

Floods are the most likely cause of pollution, particularly increasing turbidity and residue from prescribed burn areas. Although there are numerous point sources around Lake Wohlford, the large volume of water that flows through the reservoir may dilute contaminants. Sources near the intake to the treatment plant would have the greatest impact.

Bacteriological Water Quality

Limited watershed monitoring for *E. coli* and *Enterococcus* has been conducted since March 1996. Total and fecal coliform testing is conducted weekly on treatment plant influent (Lake Wohlford, Dixon Reservoir, and SDCWA imported water) and at several locations in the watershed (Jack Creek, Wohlford boat dock, Wohlford East Bridge, the inlet and outlet of the Escondido Canal, and the Lake Henshaw outlet). Total coliforms are generally higher at Lake Wohlford than for any other water source. During rainfall events, concentrations of coliforms increase at Lake Wohlford. Total coliform levels at Lake Henshaw were always well below those at other sampling locations.

Possible sources of coliform contamination may exist within the Bear Valley area and adjacent to the Escondido Canal. Potential sources of coliform contamination in the Bear Valley area are equestrian facilities at Skyline Ranch Country Club and cattle grazing. Agricultural land overlies the Escondido Canal and unauthorized use of the canal within residential areas may be possible sources of coliforms in the canal. Cattle grazing along the San Luis Rey River may also contribute to coliforms at the intake of the canal. Campgrounds and body-contact recreation may also contaminate the San Luis Rey River.

COMPARISON OF SOURCE WATER QUALITY

Figure A-5 compares the mineral content of Lake Wohlford to that of Lake Henshaw and the groundwater supply. Total mineral content is similar in the winter. The slightly lower mineral content in the spring and summer reflects both the operation of Lake Wohlford as a re-regulating reservoir in which the turnover time is short and the additional inflows of low TDS water from the watersheds below Henshaw Dam.

Bacteriologic testing indicates that major pollutant sources appear to be in the lower part of the local water supply system, although cattle grazing above Lake Henshaw may also contribute to a lesser degree.

A.2 WATER RIGHTS

Several agreements between the various water users have been entered into from 1894 to the present. Current water rights were previously held by entities no longer in existence; water rights now held by the City have previously been held by the Escondido Irrigation District (EID) and Escondido Mutual Water Company (EMWC); water rights now held by VID include those previously held by William Henshaw (Henshaw) and the San Diego County Water Company (SDCWC). Several Indian bands (Indians) have held rights for which the Secretary of Interior (USDI) has acted on their behalf in litigation. The following summaries will use these acronyms and names in discussion.

HISTORY OF AGREEMENTS

June 1884: Right of Way

EID and the Indians entered into an agreement on June 4, 1884. Right-of-way was given to EID to construct the Escondido Canal in exchange for an "... ample supply or quantity of water for the use of said Indians for agricultural and domestic purposes, and for stock belonging to said Indians." Supplying Indian water was designated as an obligation of EID.

June 1912: Right to Build Dam

Henshaw and EMWC entered into an agreement on June 21, 1912, that gave him the right to build a dam. Water rights above the dam would be held by Henshaw; rights between the dam and intake would be held by EMWC. The contract delivery point was agreed to be at the intake, prior to diversion. Henshaw was obligated to deliver EMWC's priority right of 4,143 acre-feet annually to the intake.

February 1914: Indian-EMWC Agreement

EMWC and the Indians entered into an agreement on February 2, 1914, that gave EMWC the right to divert Indian water through the Rincon Power Plant. This agreement defined the Indian obligation as 6 cfs measured at or near the intake, except for the months of July through September or "extremely dry" years, when the obligation would be 3 cfs. EMWC could halt power generation if flows were less than 2 cfs.

June 1922: Indian-Henshaw Agreement

The Indians and Henshaw entered into an agreement on June 28, 1922, in which the Indian obligation, natural flows, and shortages were further defined. Natural flow was defined as the flow in the San Luis Rey River at the intake prior to the construction of the dam. It gave Henshaw the right to include the Indian obligation as part of EMWC's 4,143 acre-feet. (Note: EMWC was not a party to this agreement). Further agreements that either party entered into with a third party would not affect the current agreement with the Indians. This agreement gave Henshaw the option of using several alternative methods to deliver the 6 cfs to the Indians.

<u>November 1922: Joint Operating Agreements</u>

In September 1922, Henshaw sold out to SDCWC. The subsequent November 10, 1922 EMWC/SDCWC agreement became the major joint operating agreement for the local water supply system. The net safe yield was designated as 28,000 acre-feet annually; in retrospect, it has become evident that contract volumes were based on an overly optimistic system yield. SDCWC could, after meeting the 4,143 acre-feet EMWC obligation, sell up to 87 percent of the remaining net safe yield and could proportionately increase sales by storing an additional 36,000 acre-feet of local water in "other places." EMWC agreed to buy 2,500 acre-feet annually from SDCWC and had until 1926 to decide on an additional 2,500 acre-feet.

The agreement gave SDCWC rights to two-thirds of the capacity of the Escondido Canal (or full capacity upon EMWC's permission) and storage rights in Lake Wohlford from May 1 to December 1. SDCWC could raise the height of Lake Wohlford Dam at its own expense. Cost sharing for the Escondido Canal was set at two-thirds SDCWC, one-third EMWC. The canal was to be run at full capacity during floods; during droughts, 50 percent of EMWC deliveries would be priority, after which shortages would shared. System losses would be assigned proportionately to EMWC and SDCWC waters. It is interesting to note that it was also recognized that measuring devices could only approximate flows within 3 percent accuracy.

Changes were made in the 6 cfs obligation to the Indians and the exact calculation of "natural flow" at the intake was stipulated. From July 1 to November 1, the Indian obligation would be taken from EMWC's water storage account, and from January 1 to July 1, it would be taken from SDCWC's water storage account. If the Indians did not request their entitlement (up to 6 cfs), EMWC could utilize the Indian water and not debit it against their 4,143 acre-foot priority right.

Vista Irrigation District was formed in 1923. Several agreements cover the operation during the 25 years of interim water deliveries until 1946. During this time, Lake Wohlford Dam was raised and several agreements addressed the joint operation of the power plants.

October 1941: Contract Water Defined
SDCWC and EMWC entered into an agreement on October 1, 1941. This agreement is significant in that it lays out what is now the ownership classifications ("A", "B") and water accounting methods that are currently being used (described in the next section). Although no water rights were transferred, they were more specifically defined. Maximum capacity of the canal was recognized as 64 cfs, whereas it had previously been set at 70 cfs. "B" water was adjusted in 1943 and a definition for "C" water (cloud seeding water—never used) was added in 1948.

September 1950: Well Field Agreement
VID and EMWC entered into an agreement on September 11, 1950, that covered the development and pumping of the Warner Ranch Well Field. The original pumping agreement restricted development of part of the Warner Basin that was reserved for EMWC. This area was eventually developed with joint wells, stipulated in a 1957 temporary joint well pumping agreement. All wells are under VID operation, but costs and extracted groundwater are shared for joint wells.

WATER OWNERSHIP

Water contracts specify eight types of water: "A", "B", "in-lieu A", "in-lieu B", "Escondido Replacement", "VID Replacement", "Joint Well", and "Indian." The first four are the City's water and replacement water is VID's water. Joint well water is shared. River gains and runoff gains to the Escondido Canal and Lake Wohlford belong to the City, but are not specifically tracked in all water accounts. VID keeps a water balance at Lake Henshaw that tracks storage of the eight water types and calculates system losses including canal losses. The Joint Canal Agency keeps records only of bulk water inflow, outflow, and delivery to the Rincon Power Generating Facility. The City keeps a water balance at Lake Wohlford that tracks delivery of the water types, excluding Indian water, which is tracked by VID.

It should be noted that contract point of delivery is at the intake, yet for all practical purposes, ownership is primarily accounted for as deliveries from Lake Wohlford. On paper, the water can be exchanged, replaced, held over, have negative balances, and accumulate residual errors (bank storage), whereas actual deliveries have physical limits. To complicate matters further, actual delivery volumes are made from the treatment plant after imported water and net gains at Lake Dixon have been added. The result is that ownership based on Lake Henshaw records for any given short period may not remotely match ownership of deliveries from the treatment plant, although over the long term, differences should decrease.

INDIAN WATER

Indian water is defined as the first 6 cfs of flow at the intake or, in deficient years, all water that would have flowed to the Lake Henshaw Dam site under pre-development conditions. Currently, the 6 cfs is always delivered, and the Indians have a small storage account in Lake Henshaw to accommodate maintenance shutdowns of the Escondido Canal in October and November.

ESCONDIDO PRIORITY-RIGHTS WATER

"A" water is the priority 4,143 acre-feet per year of water originating above Lake Henshaw Dam (or in deficient years, the remaining flow after the Indian obligation has been met). Delivery, set in the 1922 agreement, is made in increments of one-third each in July, August, and September, up to 1,000 acre-feet per month, with the remainder equally divided between October and November. Because the canal is generally shut down in October and November, delivery during those months is usually made from Lake Wohlford storage. During shortages, at least 50 percent of all water stored in Lake Henshaw, after the Indian obligation has been met, must be used to meet "A" water obligations. Since the availability of "A" water is based on the predevelopment flow of the river, there may be an increment of undelivered "A" water in deficient years.

"In-lieu A" is that increment of undelivered "A" water, calculated each July 1 for the previous fiscal year and usually delivered as a one-time volume in July. VID assumes that all "in-lieu A" water is groundwater and accounts for it as such. The contract defines "in-lieu A" simply as the missing increment of priority right water to be delivered.

River gains between Lake Henshaw Dam and the intake in excess of Indian water, if diverted, are another source of priority rights water for the City, as are all net canal gains and net runoff gains at Lake Wohlford.

ESCONDIDO CONTRACT WATER

Water originating above Lake Henshaw Dam that VID sells to the City is called "B" water. The City has purchased 5,000 acre-feet annually, to be delivered in increments of 1,000 acre-feet per month from June to September and 500 acre-feet per month in October and November. Half has priority delivery in deficient years. If there is any water in the system after Indian deliveries and after all "A" water has been delivered, the City gets the next 2,500 acre-feet. All additional water is prorated until the City's entire obligation has been met. In reality, the canal is usually shut down in October and November for repairs and the City may draw on its own account in Lake Wohlford and credit its account in Lake Henshaw.

In the event there is no water in the City's Lake Henshaw storage accounts to meet the "B" obligation, VID can choose to either draw on its own storage or pump more groundwater to make this delivery. This water is designated as "in-lieu B". VID always accounts for "in-lieu B" water as pumped groundwater.

The City receives one-half of all joint well water. The amount is minor and is often lumped in with the "in-lieu" waters. The joint wells have not been operated in the last six years.

VISTA IRRIGATION DISTRICT WATER

VID owns all the remaining water originating above Lake Henshaw Dam. This water must be conveyed to Lake Wohlford before it can be delivered to VID's distribution system. VID water is referred to as "replacement water," that is, water that is released from Lake Henshaw (debit to the Lake Henshaw account) to "replace" VID water released from Lake Henshaw. VID has limited storage rights in Lake Wohlford and, depending on how much VID water resides in Lake Wohlford, "replacement" accounting is either a volume-to-volume exchange or 10 percent conduit losses are applies. For example, if VID needs 100 acre-feet delivered to treatment, 110 acre-feet of VID storage in Lake Wohlford is debited and 100 acre-feet of the City's storage in Lake Henshaw is credited.

3.2 HYDROLOGY

Four hydrologic subsystems comprise the local water supply: (1) the watersheds above Lake Henshaw dam, (2) the San Luis Rey River between the Lake Henshaw Dam and the intake to the Escondido Canal, (3) the Escondido Canal, and (4) Lake Wohlford. Each is located on Figure 3-1 and discussed below with an accompanying schematic drawing (see Figures 3-2 through 3-5). Local water is defined as water that originates up the system from Lake Wohlford Dam. The City has an original right to some of this water and some is purchased from the VID. Runoff from Lake Dixon has been considered negligible over the long term.

LAKE HENSHAW AND THE WARNER BASIN

The 201-square-mile watershed above Lake Henshaw Dam includes 45 square miles of gently sloping surface under which lies the Warner Basin aquifer. Runoff flows onto alluvial fans that channel the water to Lake Henshaw and form forebays that recharge the aquifer. Six major contributing watersheds and their estimated contributions are Buena Vista-San Ysidro (15 percent), West Fork (21 percent), Agua Caliente (13 percent), the San Luis Rey (15 percent), Carrista (8 percent), and Matagual (5 percent). Over the watershed area, annual average precipitation varies from 30 to 15 inches, west to east. Precipitation at Lake Henshaw Dam varies annually from 8 to 60-inches. Droughts generally last from four to seven years.

The Warner Basin aquifer is crossed by several major faults and may receive a small amount of base flow, although this has never been measured. When pumped heavily, the faults act as temporary semi-permeable barriers to groundwater flow. When full, the aquifer equilibrates to a uniform westward gradient and seeps to the surface at several locations. Sediments extend as deep as 1,000 feet and contain three identifiable zones of gravel and sand separated by leaky aquicludes. Only the upper aquifer is considered a feasible production zone with the current configuration of VID wells. Although recent alluvium from the San Luis Rey River and Agua Caliente Creek provides a conduit for recharge to the main aquifer over most of the basin, silt and clay at the surface prevent direct recharge. At some locations, perched water forms a shallow aquifer, but most of the VID wells do not access perched water.

Figure 3-3 schematically shows the water balance of the system above Henshaw Dam. Over the long term, runoff flows directly to Lake Henshaw, is lost to evapotranspiration, or recharges the aquifer. The system also gains direct rainfall on Lake Henshaw and may receive gains from out-of-basin base flow. System losses include evaporation, spills, and releases. Under certain conditions, the aquifer and Lake Henshaw exchange considerable amounts of water. Generally, there is a steady seepage of groundwater into Lake Henshaw, although the flow may temporarily reverse during heavy pumping. In addition to the natural exchange, the Warner Ranch Well Field pumps water to the surface, where it is conveyed to Lake Henshaw, incurring some evaporative and ditch seepage losses. When the aquifer is full, it "spills" to the surface, with some of the water being lost to evaporation and some flowing to Lake Henshaw.

SAN LUIS REY RIVER

Flow in the San Luis Rey River below Lake Henshaw Dam is comprised of natural flow plus Lake Henshaw releases and spills. There are no minimum flow requirements for the San Luis Rey River. Water passing Lake Henshaw Dam flows down the San Luis Rey River, which receives additional runoff from a 30-square-mile watershed before it reaches the intake to the Escondido Canal. At the northeastern edge of the watershed, the Palomar Mountain rain gage receives an average annual precipitation of 30-inches, and at the southwestern edge of the watershed, the Sutherland Reservoir gage receives an average annual precipitation of 23-inches. Low intensity precipitation is consumptively used by native vegetation or is stored in the soil; high intensity precipitation produces significant runoff to the river.

The components for the water balance are shown schematically in Figure 3-4. The water balance for the river is linked to the system above Lake Henshaw via the spills and releases from Lake Henshaw Dam. Note that the outflow from Lake Henshaw Dam is not the operational yield of the local water supply system because neither the City nor the VID can use the water until it is conveyed to Lake Wohlford. The intake to the Escondido Canal is, however, the point at which contract agreements between the City and the VID apply. Diversion at the intake is determined by (1) the demand, (2) the water available, (3) available canal capacity, and (4) maximization of diversions during high flow events.

ESCONDIDO CANAL

From the intake to the terminus of the Escondido Canal, flow in the canal is subject to both losses (primarily leakage from the canal) and gains (primarily cross-drainage that enters the canal prism). About 3 square miles of steep mountain slopes flank the canal, and runoff from high intensity storms can fill the canal or supplement diversions. There are no rain gages in the vicinity of the canal, but average precipitation was extrapolated from nearby gages to about 20-inches per year. Leakage from the canal roughly increases as flows increase. Daily flow measurements kept at the inlet and outlet of the canal show a cumulative net total leakage of about 40,000 AF over 71 years. Landslides occasionally destroy or block portions of the canal, resulting in spills and loss of water. Water is generally not diverted into the Escondido Canal during the months of October and November, when the canal is shut down for scheduled maintenance.

The Escondido Canal hydrologic system, shown in Figure 3-5, conveys water from the intake to the terminus. Inflows are diversions and canal gains. Outflows are deliveries to Rincon Hydroelectric Generating Facility, discharge at the terminus, or canal leakage. The yield at the terminus of the Escondido Canal is defined in this report as the operational yield of the local water supply system.

The City can divert Indian water through the canal and discharge it to the Rincon Hydroelectric Generating Facility. Indian water is usually diverted except when all the canal capacity is needed for the City's and VID's diversions. No gains or losses are applied to Indian water. During low flows, the Rincon Hydroelectric Generating Facility is operated only when there is sufficiently steady flow to economically provide power.

LAKE WOHLFORD

The Escondido Canal discharges into Lake Wohlford, which is operated primarily as a reregulating reservoir, with Lake Henshaw being the major surface storage facility. The exception is during high rainfall events, when Lake Wohlford is used to catch and store the substantial runoff produced below Lake Henshaw Dam. Lake Wohlford is generally emptied by the fall, filled in the winter and early spring, and stabilized during bass spawning in late spring. Maximum releases are made during the summer months.

The upper part of Figure 3-6 schematically shows the water balance of Lake Wohlford. Over the long term, discharge from the Escondido Canal comprises the majority of the inflow. Occasionally, all inflow can be produced from local runoff supplemented by a small amount of rain falling directly on the reservoir surface. The majority of the water is released to the Bear Valley Pipeline, which diverts water through the Bear Valley Hydroelectric Generating Facility; occasionally the Vista bypass is used. The reservoir spills rarely because the outlet capacity is sufficiently larger than the inlet capacity. Lake Wohlford loses proportionately much less water to evaporation than does Lake Henshaw because it has a smaller surface area per volume of water and, as a reregulating reservoir; storage detention time is much shorter. Leakage losses are insignificant.

The lower part of Figure 3-6, in light gray, shows the system below the Bear Valley Hydroelectric Generating Facility. Lake Dixon primarily receives water from the SDCWA pipeline. During storms, local runoff may fill and spill from the lake; however, over the long term, the major outflow is release to the treatment plant.

Evaporation and leakage losses are minor. Imported water is mixed with local water at the treatment plant and delivered to the City through a clearwell connected to the distribution system and through the Vista Flume to VID.

3.3 OPERATIONAL YIELD

Operational yield of the local water supply system is defined as the long-term annual volume of water that can be delivered to the terminus of the Escondido Canal with almost 100 percent reliability and without depleting water storage in Lake Henshaw and the Warner Basin Aquifer. An operations model, based on historical records, was developed (by Bookman-Edmonston under separate contract to the City on water supply) and run at various demands to determine operational yield. Aquifer limitations were determined by analyzing the historical performance of the Warner Basin well field and aquifer. The volumes discussed below are model-generated estimates, rounded to the nearest 10 AF, based on system operation that would be required to achieve the long-term operational yield.

ANNUAL AVERAGE OPERATIONAL YIELD

The long-term average annual operational yield of the local water supply system is approximately 15,630 AF per year. This operational yield is based on the 71-year historical hydrologic record for the water years 1925 through 1995 and operation of the facilities owned by the City and VID. Annual yield ranged from a low of 13,910 AF to a high of 23,870 AF. These annual yields reflect operation of the system to provide carryover storage for increased reliability.

The long-term average inflow to the Warner Basin is 25,480 AF per year, which is comprised of 13,800 AF of surface inflow to Lake Henshaw, 2,780 AF of direct precipitation on Lake Henshaw, 7,410 AF of deep percolation to the Warner Basin aquifer, and 1,500 AF of base flow to the aquifer from unidentified sources. Natural inflow (before losses) to the San Luis Rey River between Lake Henshaw and the intake to the Escondido Canal averages 9,950 AF per year.

On the average, about 10,590 AF per year is lost, including 6,880 AF to evaporation at Lake Henshaw, 470 AF to evaporation of groundwater during conveyance, 2,570 AF to riparian consumptive use on the San Luis Rey River between Lake Henshaw and the Escondido Canal, and 670 AF to seepage from the Escondido Canal.

The long-term annual average delivery to the Mission Indians is 9,150 AF, comprised of 1,900 AF of the first 6 cfs that is delivered through the Rincon Hydroelectric Generating Facility, 500 AF delivered to the San Luis Rey River as part of the first 6 cfs, and 6,750 AF per year of surplus water undivertable at the intake of the Escondido Canal because of capacity constraints.

On the average, approximately 6,210 AF of groundwater is extracted from the Warner Basin Aquifer. The maximum annual extraction required to achieve operational yield is estimated to be about 20,000 AF and is likely to occur only once in 70 years. (Annual average pumping during five- to seven-year drought cycles is about 15,000 AF.)

After delivery to Lake Wohlford at the terminus of the Escondido Canal, small additional net gains are obtained from the Lake Wohlford drainage.

OPERATIONAL YIELD UNDER VARIOUS HYDROLOGIC CONDITIONS

Table 3-1 presents the operational yield, system gains, and system losses under five additional hydrologic conditions. The five annual average yields achievable under various hydrologic conditions are:

- 15,100 AF on the average when groundwater is pumped (dry)
- 16,350 AF on the average when groundwater is not pumped (wet)
- 13,930 AF for the single year of maximum pumping (severe drought)
- 13,970 AF for the single year of maximum pumping lift (maximum aquifer depletion)
- 23,870 AF for the year of maximum delivery (extremely wet)

Inflow in the wettest year is about five times greater than average and, in the driest year, is only about 15 percent of the average inflow. The difference between the average of years when groundwater is pumped (41 years) or not pumped (30 years) is much less. Although the maximum groundwater is pumped in a very dry year, the maximum pumping lift occurs at minimum aquifer storage regardless of rainfall.

Those years in which pumping does not occur are usually wet years during which the aquifer recharges. Because the aquifer has limited infiltration rates, the maximum recharge rate is estimated at about 28,000 AF per year. When the aquifer is full or when rainfall exceeds recharge rates, excess water become surface runoff. Although dry years outnumber wet years, system capacity constraints do not allow full utilization of the excess during wet years. During the year of maximum delivery to Lake Wohlford, flooding exceeds aquifer recharge rate; excess inflow, therefore, directly enters Lake Henshaw, spills over Lake Henshaw Dam, and exceeds the capacity of the Escondido Canal. The end result is over 100,000 AF of surplus lost to the San Luis Rey River. In 20 of the 30 wet years, significant surplus is available at the intake to the Escondido Canal; however, most of the surplus occurs in only six years with hydrologic conditions similar to 1980, 1983, or 1993.

Table 3-1. Water Balance of the Local Water Supply and Operational Yield for Various Hydrologic Conditions

	Pumping Years Only[a] (AF)	No Pumping[b] (AF)	Maximum Pumping Year[c] (AF)	Maximum Cost Year[d] (AF)	Maximum Delivery Year[e] (AF)
System Inflows					
Runoff to Lake Henshaw	10,940	17,710	390	930	88,070
Precipitation on Lake Henshaw	1,650	4,310	380	1,270	6,330
Runoff to Aquifer	5,780	9,640	320	760	26,530
Base Flow to Aquifer	1,500	1,500	1,500	1,500	1,500
San Luis Rey River Inflow	8,110	12,450	2,670	2,480	50,050
Canal Gains	120	180	20	50	300
Total Inflow:	**28,100**	**45,790**	**5,280**	**6,990**	**172,780**
System Outflows					
Evaporation from Lake Henshaw	4,710	9,850	3,240	2,400	9,020
Unrecovered Aquifer Losses	860	670	1,500	1,310	0
Riparian Consumptive Losses	2,520	2,560	3,230	2,240	2,060
Canal Losses	640	710	590	590	1,150
Mission Indian Water	1,880	3,210	160	1,110	3,780
Surplus at Intake to Escondido Canal	3,120	11,730	0	0	103,600
Delivery to Lake Wohlford	15,100	16,350	13,930	13,970	23,870
Total Outflow:	**28,860**	**45,080**	**22,650**	**21,620**	**143,480**
System Change in Storage	**-720**	**+710**	**-17,370**	**-14,630**	**+29,300**
Groundwater Pumped	**10,760**	**0**	**20,040**	**17,450**	**0**

[a]Hydrologic conditions represented by 41 historic years when the wells were pumped.
[b]Hydrologic conditions represented by 30 historic years when the wells were not pumped.
[c]Hydrologic conditions represented by year 1961, when the maximum amount of groundwater is pumped; the driest year.
[d]Hydrologic conditions presented by year 1977, when maximum pumping power costs would be incurred; the year of lowest aquifer level.
[e]Hydrologic conditions represented by year 1980, when the maximum delivery to Lake Wohlford would be made.

It is roughly estimated that in five out of 71 years, the system could capture more water if the canal had greater capacity; in six of the 71 years, the system could capture more water if Lake Henshaw had more capacity. Although increasing canal and reservoir capacity would allow occasional recovery of surplus, benefits would be realized only in roughly 15 percent of the years. A more detailed analysis, such as running the operational model at varying canal and reservoir capacities, is needed to better determine the benefits of enlarging system capacity.

During the driest year, the natural inflow is obtained almost equally from above and below Henshaw Dam, yet total natural inflow is insufficient to offset system losses. Surface storage has also been depleted and yield is entirely dependent on groundwater. Over 16,000 AF of groundwater storage is drawn upon; however, about 30 percent is lost to evaporation during conveyance or while it is stored in Lake Henshaw. Because the aquifer is not recharging, groundwater levels decline dramatically.

Yield is not directly proportional to hydrologic system inputs. During the wettest year, the system has significantly more inflow; however, yield does not proportionately increase because the facilities have capacity constraints and peak flows cannot be stored or diverted. Although approximately 35,000 AF could be delivered through the canal if the runoff were uniform throughout the year, about 24,000 AF is the maximum annual yield, due to system constraints and daily hydrologic variability.

Almost all yield during droughts is obtained by pumping groundwater; therefore, aquifer constraints (remaining storage in the aquifer, the recharge rate, and the accepted risk of shortages) determine the yield during droughts.

Figure 3-7 shows the aquifer response at operational yield. During depletion from full aquifer conditions (estimated at 400,000 AF) to 250,000 AF, pumping is feasible and costs are primarily a function of pumping lifts. As pumping continues, the storage drops into the safety zone, where the feasibility of pumping contains a high degree of uncertainty. Below 200,000 AF of storage, water levels are estimated to drop below well perforations as the saturated zone required for pumping is quickly depleted. Any water extracted under these conditions would be at an extremely low rate and at an extremely high cost, if feasible at all.

At the end of droughts, wells that historically have been not utilized because of high costs or low production would be pumped. Although the aquifer levels at operational yield remain in the 100 percent reliability range, there would be risk of shortage if the well field is not in optimum operating condition. From 70 to 90 percent of the yield during drought cycles would rely on groundwater for up to six consecutive years; during this time period, any well field breakdown would result in a temporary shortage.

HISTORIC WATER USAGE FROM 1980 TO 1995

Operational yield, as discussed above, was estimated from the results of the operational model and is an estimate of the long-term yield over a 71-year period. Table 3-2 shows the historic yield from fiscal year 1980 to 1995, a period of above average watershed inflows, during which an average of 17,530 AF per year was diverted at the intake to the Escondido Canal and 18,170 AF per year of local water was released from the treatment plant. Note that Table 3-2 is based on the fiscal year (July to June) whereas the previous discussion of operational yield was based on the water year (October to September).

From July 1980 to June 1996, the City diverted an annual average of about 5,960 AF of water stored in Lake Henshaw and was able to capture an additional 2,230 AF of runoff on the San Luis Rey River below Lake Henshaw Dam. About 8,880 AF of local water was treated and delivered to the City's distribution system. The difference between delivery at the intake and delivery to the City's distribution system is the net result of conveyance and storage. On the average, about 680 AF of additional local water was netted after the City's share of system losses were applied. Differences for any given year also include the City's end-of-year change in storage at Lake Wohlford. Expressed as percentages, the City holds rights or has contracts for approximately 39 percent of the water released from Lake Henshaw and 49 percent of the total local water supply, including downstream net gains.

For the same period, VID diverted approximately 9,340 AF of Lake Henshaw water. VID holds no rights to downstream gains, and although canal losses are shared and storage in Lake Wohlford is short, a net loss of about 40 AF was incurred. For any given year, the difference in delivery from treatment and diversion at the intake also included the change in VID's storage account in Lake Wohlford. At delivery from treatment, VID's portion of the local water supply was 51 percent.

The operations model estimates that for hydrologic conditions similar those occurring from July 1980 to June 1996, about 16,500 AF of local water (excluding Indian water) should be diverted to achieve long-term operational yield. About 17,500 AF was actually diverted. Whereas the operations model is configured to conservatively deliver water at 100 percent reliability without, over the long term, depleting water storage in Lake Henshaw or the Warner Basin Aquifer, historically more variation in supply was tolerated. For example, diversions have been as little as 8,800 AF in the fiscal year ending 1989 and as much as 25,350 AF in the fiscal year ending 1984.

Production from 1980 to 1995 stressed the system more than the operations model recommends for the long-term yield. The wells may have been operated at aquifer levels that have uncertain consequences or high costs, some shortages may have been tolerated, the canal may have been run year-round instead of using two months for canal maintenance, and more than 55 cfs may have been diverted during high river flows. None of these practices, in the short term, may harm the ability of the system to deliver the yield, but in the long term, could risk system failure.

Table 3-2. Local Water Production from 1980 to 1995 in AF

Fiscal Year Ending June	City's Local Water				VID's Local Water			Total Local Water		
	Diverted Henshaw Releases	Diverted San Luis Rey Gains	Net Impact of Storage Below the Intake*	Delivery from Treatment Plant	Diverted Henshaw Releases	Net Impact of Storage Below the Intake*	Delivery from Treatment Plant	Diverted at Intake	Net Impact of Storage Below the Intake*	Delivery from Treatment Plant
1981	5,010	4,930	1,870	11,810	7,220	0	7,220	17,160	1,870	19,030
1982	4,800	1,700	6,420	12,920	10,870	530	11,400	17,370	6,950	24,320
1983	7,760	2,650	-4,160	6,250	5,760	420	6,180	16,170	-3,740	12,430
1984	6,780	6,600	-1,630	11,750	11,970	150	12,120	25,350	-1,480	23,870
1985	5,090	2,570	3,030	10,690	14,850	-10	14,840	22,510	3,020	25,530
1985	7,710	1,340	1,220	10,270	11,110	0	11,110	20,160	1,220	21,380
1987	8,820	2,070	-970	9,920	13,120	-2,510	10,610	24,010	-3,480	20,530
1988	6,410	480	1,940	8,830	12,810	700	13,510	19,700	2,640	22,340
1989	5,140	190	250	5,580	3,480	10	3,490	8,810	260	9,070
1990	5,940	80	480	6,500	10,960	-80	10,880	16,980	400	17,380
1991	5,460	50	-1,420	4,090	3,340	0	3,340	8,850	-1,420	7,430
1992	5,040	790	-1,860	3,970	4,750	0	4,750	10,580	-1,860	8,720
1993	5,290	910	1,320	7,520	4,060	0	4,060	10,260	1,320	11,580
1994	4,840	7,510	1,690	14,040	11,390	-1,160	10,230	23,740	530	24,270
1995	5,000	370	3,280	8,650	12,200	1,360	13,560	17,570	4,640	22,210
1996	6,330	3,390	-510	9,210	11,470	-60	11,410	21,190	-570	20,620
Annual Average	**5,964**	**2,227**	**681**	**8,875**	**9,335**	**-41**	**9,294**	**17,526**	**644**	**18,169**

*Includes runoff gain and system losses below the intake to the Escondido Canal and holdover storage or draws on storage for the fiscal year.
Source: *The City of Escondido Water Production Summary*.

APPENDIX C
TABLE C-1 - WATER SYSTEM DESIGN CRITERIA COMPARISON

Criteria	Agency, Year of Master Plan											
	Escondido, '00	**San Diego '04**	**Rincon, 05**	**Vallecitos '10**	**Olivenhain, '00**	**Carlsbad, '11**	**Otay WD, '10**	**So Coast WD, 08**	**San Dieguito, '10**	**Valley Center, '94**	**Vista ID, '00**	**AWWA M32**
Demands - Residential (gpd)												
Residential per capita (EDU)	**2117-4046 gpd/ac**	525 (150 gpc * 3.5)	1700-2200 gpd/ac	1000-7000 gpd/ac		550/DU	425-850 gpd/DU	400-450 gpd/DU	1775-2100 gpd/ac		1020 gpd/ac	
Multifamily	**5630 gpd/ac**	225-480	2500-3500 gpd/ac	3300-9000 gpd/ac		250/DU	255 gpd/DU	300 gpd/DU	2425-4300 gpd/ac		4100 gpd/ac	
Estate	**648-1440 gpd/ac**	-	1000-1600 gpd/ac	600 gpd/ac		-	1050 gpd/DU		400-1275 gpd/ac		650 gpd/ac	
Demands - Other		-				2300 gpd/10k ft bldg						
Central Business District		6000 (gpd/net acre)		-		-						
Commercial	**1757 gpd/ac**	5000 (gpd/net acre)	1400 gpd/ac	1500 gpd/ac		-	1607 gpd/ac	2500 gpd/ac	2600 gpd/ac		2020 gpd/ac	
Park/Landscape	**1250 gpd/ac**	4000 (gpd/net acre)		1700 gpd/ac		-	2155 gpd/ac	2500 gpd/ac	1175 gpd/ac		1250 gpd/ac	
Hospital		22500 (gpd/net acre)		-		-	2428 gpd/ac	4200 gpd/ac				
Hotels		6555 (gpd/net acre)		125 gpd/room		-		95 gpd/room	145 gpd/room			
Industrial	**1757 gpd/ac**	6250 (gpd/net acre)	1400 gpd/ac	1000 gpd/ac		-	848 gpd/ac		1725 gpd/ac		2020 gpd/ac	
Office	**1757 gpd/ac**	5730 (gpd/net acre)	1400 gpd/ac	1500 gpd/ac		-	1620 gpd/ac	2500 gpd/ac	1375 gpd/ac		2020 gpd/ac	
School		4680 (gpd/net acre)	1500 gpd/ac	1400 gpd/ac		-	1428 gpd/ac	2500 gpd/ac			2020 gpd/ac	
Pipelines:												
PH Max Vel. (ft/s)	**7**		7	7	7	8	6	5	7		8	7
MD Max Vel. (ft/s)	**7**			-	7	-	6				8	
MD+Fire Max Vel. (ft/s)			10	7	none	10	10	12	15		16	10
Max Headloss (ft/1000 ft)	**10**		15	15	10	5-10	10	10	10	10	10	
Hazen Williams C	**Varies w/ age & material**		130	130	130	Varies w/ age & material (graph)	130, >12" pipe 120, 12" & smaller	120		130	130	
Minimum pipe size		8-inch	8-inch	-	8-inch		8	8	8			
Max EDUs on dead-end		30 (or 2 hydrants)				18						
Pressure (psi)												
Max Static	**150**	120	150	150	-	150	200 (no demand)		150		150	110
Min Static		65		65	-	60	65	65			40	
Max Desireable	**110**	120		-	120	125	120	120	120	150-200	150	90
PH Min	**40**	40	40	40	40	40	40	40	40	25	30	40-50
MD+Fire Min	**20**	20	20	20	20	20	20	20	20	20	20	20
Max drop from Static		25				25		30%				
Fire Flow (gpm)/duration												
Residential 1	**1500/2 hours**	2000/5 hours	1500/2 hours	1500/2 hours	1500/3 hours	1500/2 hours	1500/2 hours	1500/2 hours	1500/2 hours		1000/2 hours	
Residential 2		-		-	2500/3 hours (RSF)	-	-				1500/2 hours	
Multifamily (duplex)	**2000/2 hours**	2500/5 hours	2000/2 hours	2500/2 hours	-	3000/2 hours					2000/2 hours	
Multifamily (condos)	**2500/2 hours**	3000/5 hours	2500/2 hours	2500/2 hours	-	3000/2 hours	2500/2 hours	2500/2 hours	2500/2 hours		2000/2 hours	
Commercial	**2500/2 hours**	4000/5 hours	2500/2 hours	2500/2 hours	3500/3 hours	4000/4 hours	3500/3 hours	3000/3 hours	3500/3 hours		3000/3 hours	
Industrial	**2500/2 hours**	6000/5 hours	2500/2 hours	3500/4 hours	3500/3 hours	4000/4 hours	3500/4 hours	4000/4 hours			3500/3.5 hours	
Urban/Wildland				2500/2 hours		-						
Pumps												
Min Capacity[1]	**MD+3 Days Fire Recharge**		Max Day + Fire	MDD + 150 gpm Fire Recharge	Max Day + Fire Recharge	MDD	MD+3 Days Fire Recharge	MD+3 Days Fire Recharge		MD+ Fire Recharge		
Min # of Pumps				3 w/storage, 4 w/o		3			3			
Standby	**= Largest Pump**		= Largest Pump	1	= Largest Pump	1	= Largest Pump	= Largest Pump	= Largest Pump	= Largest Pump		
Max Suction Vel.				-	-							
Max Discharge Vel.				-	-							
Standby Power	**yes if no reservoir**			Permanent	-	Geneerator	Permanent/Portable	Permanent/ Portable				
Off-Peak Pumping			-	-	-	no	Desireable					
Reservoir												
Operational	**15% MDD**		33%-40% ADD	150% ADD	150% ADD	15% MDD	30% MDD	25% MDD	35% ADD	25% MDD	20% ADD	
Pumped Zone				-	-	-						
Non-Pumped Zone				-	-	-						
Emergency	**100% ADD**		300% ADD	300% ADD	50% to 100% ADD[2]	100% MDD	100% MDD	50% ADD	100% ADD	100% ADD	200% ADD	
Forebay				-	100% ADD	-						
Fire	**Largest Fire Flow Duration**		Largest Fire Flow Duration	Largest Fire Flow Duration	Largest Fire Flow Duration (3 hr)	Largest Fire Flow Duration	Largest Fire Flow Duration	Largest Fire Flow Duration	Largest Fire Flow Duration	Largest Fire Flow Duration	Largest Fire Flow Duration	
Terminal						10 days (Maerkle)	500% ADD		10 days/Lake Hodges			

1) Assumes Open System
2) Depends on proximity to Gaty, Denk, Peay, Miller Reservoirs. More remote areas require 100% ADD.

A-11 Reservoir Hydraulic Study
January 2012

Purpose

This A-11 Reservoir hydraulic study is provided in response to a recent inspection report that identified the need to rehabilitate the operating bay of the A-11 Reservoir. The study evaluates the operational performance and hydraulic limitations of the reservoir and the advantages/ disadvantages of operating the system with both bays, one bay, or abandoning the reservoir. This will provide the City with options when considering reservoir rehabilitation costs.

Background

The combined A-11/Lindley Zone is the City's largest pressure zone, and approximately half of the total Escondido water demand is supplied from this zone. The 8.0 MG A-11 Reservoir was constructed in 1984 to operate hydraulically with the 2.0 MG Lindley Reservoir, which was constructed in 1950, in an expanded zone service area. The Lindley Reservoir is located at the far northern end of the zone, and the A-11 Reservoir is located along the southern and westerly edge, as shown on Figure 1. The physical dimensions of both reservoirs and SCADA water level settings are provided in Table 1.

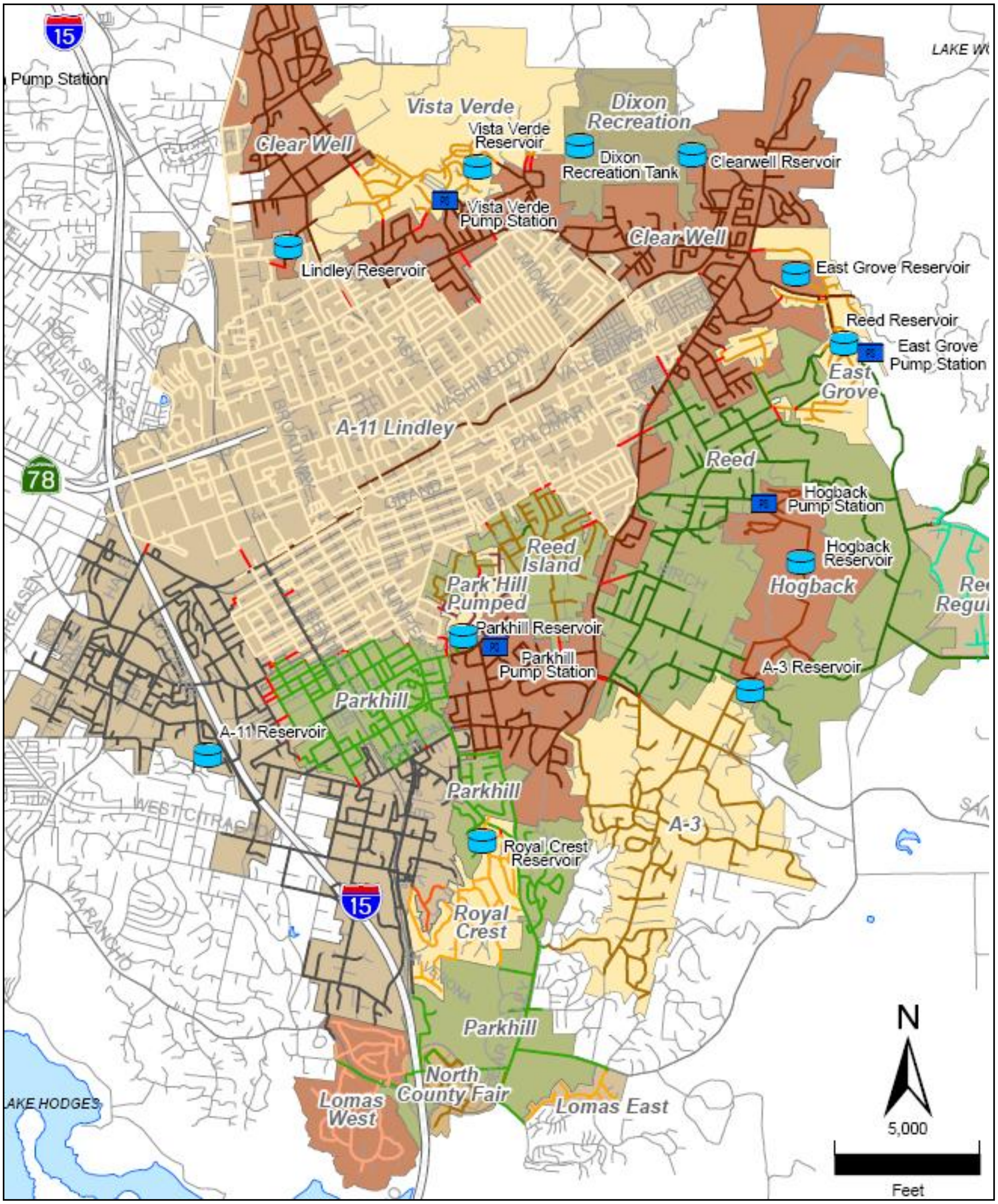
Table 1 – A-11/Lindley Zone Reservoirs

Reservoir Name	Reservoir Type	Year Constructed	Capacity (MG)	Bott. Elev. (ft)	HWL Elev. (ft)	Interior Dimensions (ft)	Level Settings L-L (ft)	Low (ft)	High (ft)	H-H (ft)
Lindley	- circular steel	1950	2.0	905	928	120' diam.	6.0	8.0	18.0	20.5
A-11	- rectangular concrete - hopper bottom - east & west basins	1984	8.0	904	930	single bay: 170' x 147' top 138' x 84.5' bottom	6.5	8.5	19.5	23.5

The A-11 Reservoir is a rectangular partitioned reservoir with two identical bays, only one of which has been in service for at least the past 15 years. The bottom twelve vertical feet of each bay is sloped inward to created a hopper-type bottom. The reservoir is connected to the distribution system by approximately 1,550 feet of a common 30-inch diameter inlet/outlet pipeline.

Despite the two reservoirs having approximately the same bottom and high water elevations, the reservoirs have never operated well together hydraulically. The main reasons for this are the lack of transmission mains connecting the two reservoirs and the method in which each reservoir is filled. Water levels in both reservoirs are controlled through automated valves that are set to a specific position (percent open) through SCADA by water system operators at the treatment plant. The Lindley Reservoir can be supplied directly from the Clearwell Zone through the Lindley Reservoir valve, which is located adjacent to the tank. The main source of supply to the A-11 Reservoir is the automated valve at Valley Parkway and Orange, which supplies an A-11/Lindley Zone transmission main.

Figure 1 Water System Facility Map



To fill the A-11 Reservoir from the regulating valve, water must flow though nearly two miles of a dedicated 24-inch diameter transmission main and then another two miles in a transmission main in a looped distribution system before reaching the 30-inch diameter A-11 inlet/outlet pipe. Furthermore, there are few pipelines with diameters larger than 8-inches extending south from the Lindley Reservoir service area to the A-11 distribution system, which limits the hydraulic interaction between the two reservoirs. When the reservoirs were operated together in a combined A-11/Lindley Zone the A-11 Reservoir floated several feet lower than the Lindley Reservoir, and there was little flow in or out of the A-11 Reservoir, resulting in poor water turnover.

To better regulate the fill and drain of each reservoir, the A-11/Lindley Zone has been operated as two separate zones by closing key valves in the distribution system. The A-11 Zone, which is much smaller than the Lindley Zone, is generally located south of Valley Parkway and west of approximately Tulip Street. Supply to the A-11 Zone is through the Clearwell "Channel Line" from the automated regulating station at Valley Parkway and Orange, and a backup supply is provided through the Clearwell Bear Valley Parkway transmission main from the regulating station at El Dorado/Juniper. The A-11 Zone in turn provides the primary supply to the Lomas West Zone through the Via Rancho/Quiet Hills regulating station and supplemental supply on a daily basis to a portion of the Park Hill Zone through the Frontage Road/El Ku regulator. The Lindley Zone is supplied from automated regulating stations at the Lindley Reservoir and Ash/Channel, and from seven additional regulators, most of which are backup regulators. It is noted that many closed valves are required to separate the Lindley and A-11 Zones, and the location of all closed valves on smaller diameter pipelines has not been documented. Furthermore, if the A-11 Zone is not fully isolated this could be impacting the system hydraulics and filling and draining of the A-11 Reservoir. It is important the City document the extent of the closed valves and understand the exact location of the zone boundary to improve overall operations.

Operational Challenges

Even with the A-11 and Lindley Zones operated separately, there are challenges to maintaining water quality in the A-11 Reservoir due to its volume, location at the edge of the zone, and the long length of the single inlet/outlet pipeline. Most of the water supplied to the A-11 Zone bypasses the reservoir, and water levels in the A-11 Reservoir will fluctuate by less than 3 feet even during peak demand periods if the supply rate into the zone is kept constant. Water levels in the single operating bay of the A-11 Reservoir are kept low to maintain water quality, and system operators at the treatment plant will attempt to cycle the reservoir by drawing down water levels and then refilling through the automated Valley/Orange regulating station on a daily basis. However, supply rates to the tank are limited by hydraulic constraints. The Valley/Orange regulation station is a 12-inch diameter globe valve that supplies a 24-inch diameter A-11 Zone transmission main from a 24-inch diameter Clearwell main. The maximum flow rate through a fully open globe valve is dependent on the pressure differential, and there is only 45 feet difference between the high water elevation of the Clearwell and the A-11 Reservoir. Due to high velocities and the resulting headloss in the 12-inch diameter sections of pipe the 12-inch diameter globe valve, and other unknown minor losses, flow through the regulating station with the valve wide open is barely adequate to maintain water levels in the A-11 Reservoir during summer periods. This flow restriction limits the ability to cycle water in the tank, which is why the tank is kept low. Upgrade of this control valve is a high priority to improve A-11 Reservoir operations.

Figure 2 illustrates water elevations in the Lindley and A-11 Reservoirs during the last week in October 2011, which was a typical week with average demands. It is noted that while the A-11 and Lindley Zones are reported to be separated with closed valves, tank water levels for both tanks exhibit similar patterns, which could indicate the two zones are not completely separated. The amount of water stored at each reservoir was approximately the same during this period, and averaged 1.1 MG. Lindley Reservoir averaged approximately 51 percent full, and the single operating bay of the A-11 Reservoir was approximately 28 percent full by volume. The A-11 Reservoir is operating primarily over the bottom 12 feet of the tank that is sloped inward, and therefore has approximately 25 percent less water stored in the bottom 12 feet of the tank than in 12 feet of the upper straight-sided section. It is noted that the volume of water for the A-11 Reservoir reported through the SCADA system does not appear to take into account the reduced cross-sectional area in the bottom sloped portion of the tank, and water volumes at lower water levels are therefore overstated.

Figure 2

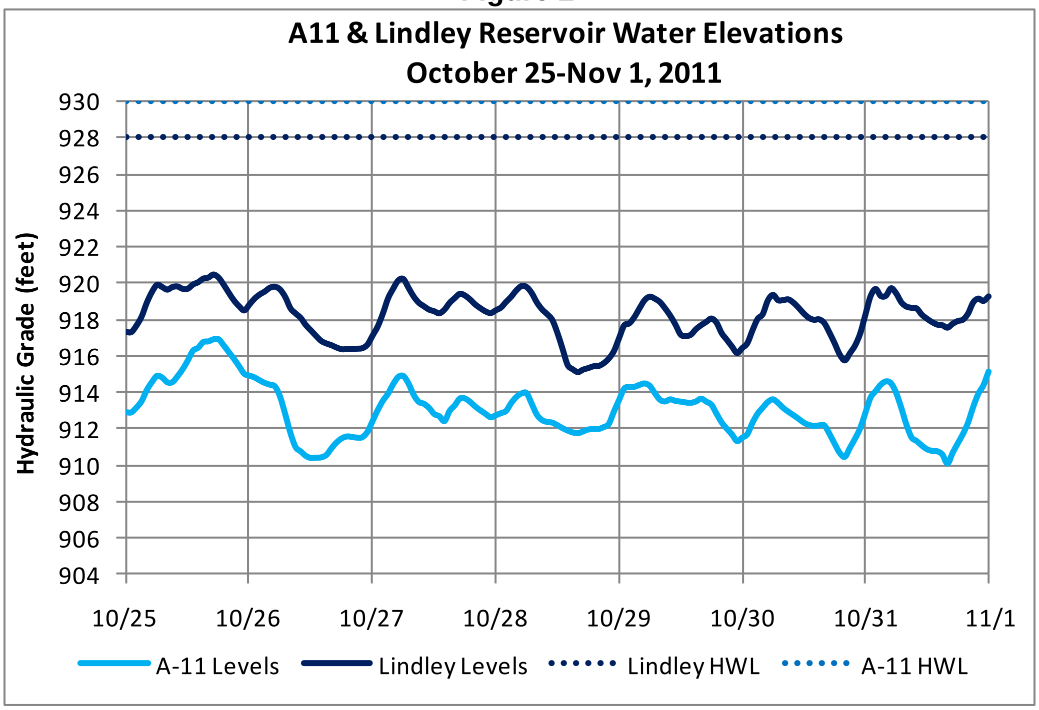
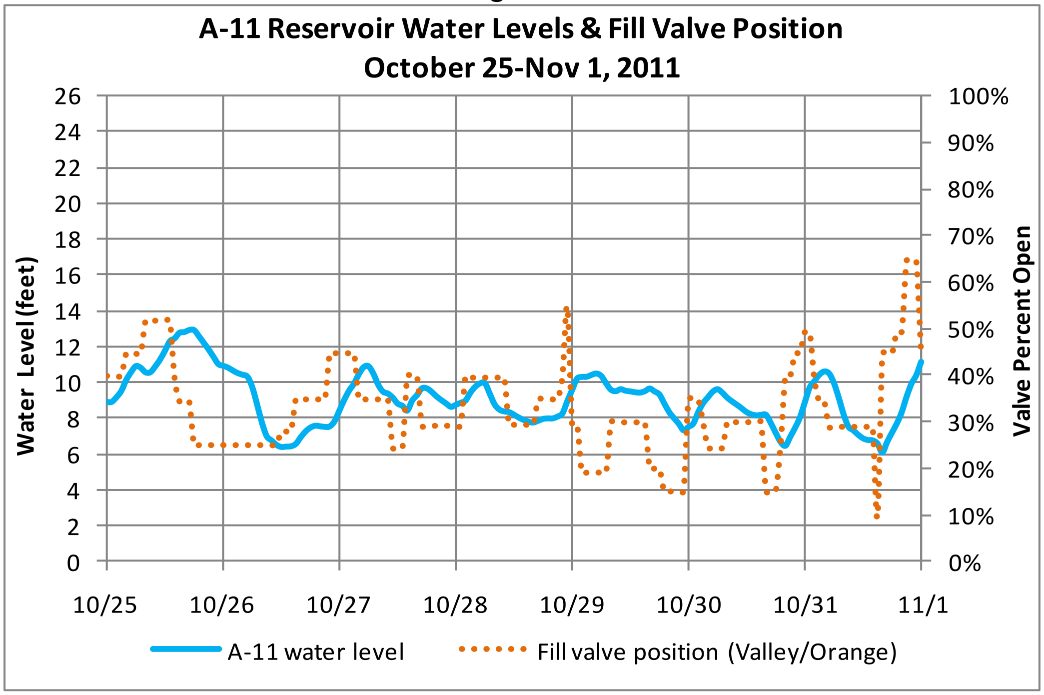


Figure 3 illustrates water levels in the A-11 Reservoir and the positioning of the automated Orange/Valley fill valve. During the last week in October 2011, water levels ranged from 6.1 to 12.9 feet, with corresponding storage volumes of approximately 0.7 MG to 1.8 MG, and averaging 1.1 MG. The automated fill valve position ranged from approximately 10 to 65 percent open. Due to hydraulic constraints and water quality concerns, it can be concluded that approximately 15 percent of the full 8.0 MG storage capacity of the A-11 Reservoir is currently being utilized under an average day demand operating scenario.

Figure 3



Condition Assessment

Due to water quality concerns and the operational limitations summarized above, only a single bay of the A-11 Reservoir is currently in operation, and the second bay has remained empty for many years. A wet inspection of the active bay of the reservoir was performed on January 12-13, 2010 by Aquatic Inspections, Inc. As summarized in the inspection report, the majority of the exterior and the bulk of the interior of the reservoir appear to be in good condition, with only hairline cracks and minor areas of spalling or cracked caulking. However, there is tie wire and rebar corrosion on the interior of the reservoir and extensive coating failure on the outside of the common inlet/outlet, overflow and drain lines that has lead to corrosion. The recommendations for rehabilitation of the active bay of the A-11 Reservoir proposed in the 2010 inspection report include recoating the steel lines, replacing the heavily corroded hardware and supports, and installing sacrificial anodes to prevent further corrosion when the reservoir is dewatered. It was also recommended that the A-11 Reservoir be placed on a regular inspection and maintenance schedule.

The dry side of the A-11 Reservoir is reported to be unusable in its current condition and will require extensive cleaning and some repairs to be put back in service.

Storage Assessment

It is desirable that all major pressure zones have in-zone storage to provide peak flows for daily operations (operational storage), fire flows (fire storage), and emergency storage for short-term local outages or supply disruptions (emergency storage). The recommended storage for the A-11 and Lindley Zones based on adjusted 2010 water billing data and system storage criteria defined in the 2000 Master Plan is summarized in Table 2. The required storage capacity is calculated for both a combined A-11/Lindley Zone and separate zones, both with and without providing water supply to the Lomas West Zone.

Table 2 – Required A-11/Lindley Zone Storage Based on Adjusted 2010 Billing Date

Zone Configuration	Reservoir/Zone *and Sub-Zones*	Average Annual Demand[1] gpm	MGD	Required Storage - MG Operational 15% of max day	+ Fire 2 hours	or Emergency 1 avg day	= TOTAL	Existing Storage MG	Surplus/ Deficit MG
Combined	**A-11/Lindley** *Lomas West*	8,383	12.07	3.08	0.30	12.07	15.15	10.0	(5.15)
Separate	**Lindley**	6,035	8.69	2.22	0.30	8.69	10.91	2.0	(8.91)
	A-11 *Lomas West*	2,348	3.38	0.86	0.30	3.38	4.24	8.0	3.76
Separate w/o supply to Lomas West	**Lindley**	6,035	8.69	2.22	0.30	8.69	10.91	2.0	(8.91)
	A-11	1,923	2.77	0.71	0.30	2.77	3.47	8.0	4.53

1) Excludes special rate agriculture demands. FY2010 water use is increased by 20% to account for temporary reductions in water use due to Level 2 water use restrictions, economic conditions, and lower than average summer temperatures.

As can be seen in Table 2, there is a large storage capacity deficit both in the combined A-11/Lindley Zone and in a separate Lindley Zone, mostly due to the emergency storage requirements. At a minimum, in-zone storage needs to be provided for operational conditions and fire flows. While not ideal, emergency storage can be provided by a higher pressure zone if there is storage surplus and direct gravity supply from that zone, and a well looped or redundant transmission system. It is also worth noting that some water agencies have reduced emergency storage requirements for specific zones if there are multiple supply locations and back-up sources of water.

There are nine pressure regulators supplying the Lindley Zone from three separate transmission mains. In addition, the Lindley Zone is in close proximity to an emergency interconnect with Rincon that can provide most, if not all, of the zone demands in an emergency. A reduction of the required emergency storage capacity may be justified in conjunction with facility improvements and will be considered in the update to the water master plan, which is currently in progress. In addition, the City is planning to replace the Lindley Reservoir with two new reservoirs. The new reservoirs, which have each been sized at 1.5 MG due to site limitations, will have the capacity to provide operational and fire flow storage to the Lindley Zone

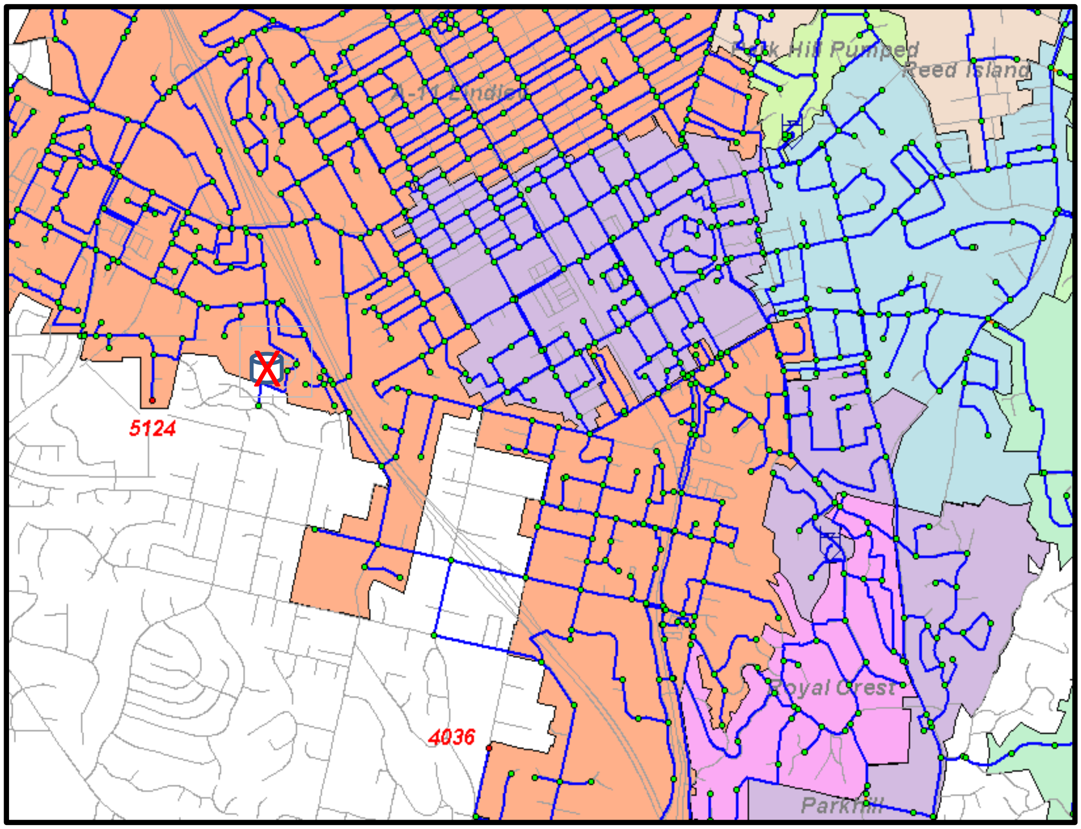
When the system is operated as two separate zones, there is surplus storage capacity in the A-11 Zone. Since only one bay is currently in operation, however, the additional 4.0 MG of storage capacity could only be accessed in the event of a planned water shortage by first filling up both bays several days in advance. With only one 4.0 MG bay in operation, there is a slight storage deficit in the A-11 Zone when demands of the Lomas West Zone are included. Operators now supply the Lomas West Zone from the A-11 Zone in an attempt to circulate more water through the A-11 Reservoir. However, Lomas West can also be supplied from the Park Hill Zone, and there is surplus storage capacity in the Park Hill Reservoir. If supply to Lomas West is switched from the A-11 to the Park Hill Zone, a single bay of the A-11 Reservoir has 0.53 MG of surplus in-zone storage capacity based on existing A-11 Zone demands.

Fire Flow Analysis with and without the A-11 Reservoir

Both bays of the A-11 Reservoir require rehabilitation, and it will be cost effective for the City to repair both bays simultaneously. As part of this hydraulic study, the ability to provide fire flows without the A-11 Reservoir in service was investigated. Fire flows were simulated in the hydraulic model at the two locations shown in Figure 4. These locations (Nodes 4036 and

5124) were selected because they are in close proximity and downstream of the A-11 Reservoir, where the largest impacts would be observed with the reservoir removed from service. Both these locations are at the end of 8-inch diameter pipelines. Fire flow simulations were first run with the A-11 Reservoir at a water level of 11 feet. Model results indicate that pressures with maximum day demands are 65 psi at Node 5124 and 128 psi at Node 4036. With 1,500 gpm fire flow, pressures drop to 38.5 psi and 100 psi, respectively.

Figure 4 – Location of Fire Flow Nodes



If the A-11 Reservoir were to be removed from service, valves now separating the A-11/Lindley Zone would be opened and controls for the regulating valves at Valley/Orange and Ash/Channel would be set to provide a constant downstream pressure. In addition, supply to the Lomas West Zone would be switched over to the Park Hill regulators, so that fire storage to this area would be provided from the Park Hill Reservoir. These changes were made to the hydraulic model and the Valley/Orange regulator was set to approximate the grade of the A-11 Reservoir when approximately half full. Fire flow simulations were then rerun. With the A-11 Reservoir removed from service, residual pressures with a 1,500 gpm fire flow dropped by less than 2 psi as compared to when the A-11 Reservoir was in service. Without the A-11 Reservoir, additional flows are provided by the Orange/Valley regulator, which opens wider. When higher fire flows were simulated, the backup regulator at El Dorado/Juniper also opened to deliver the required flow. Because the transmission mains to the A-11 Reservoir are so large, there is very little pressure drop up to the reservoir site, and it can be concluded that there will be a negligible difference in available fire flows throughout the A-11 Zone when the A-11 Reservoir is removed from service.

Hydraulic Investigation – Channel Line out of Service

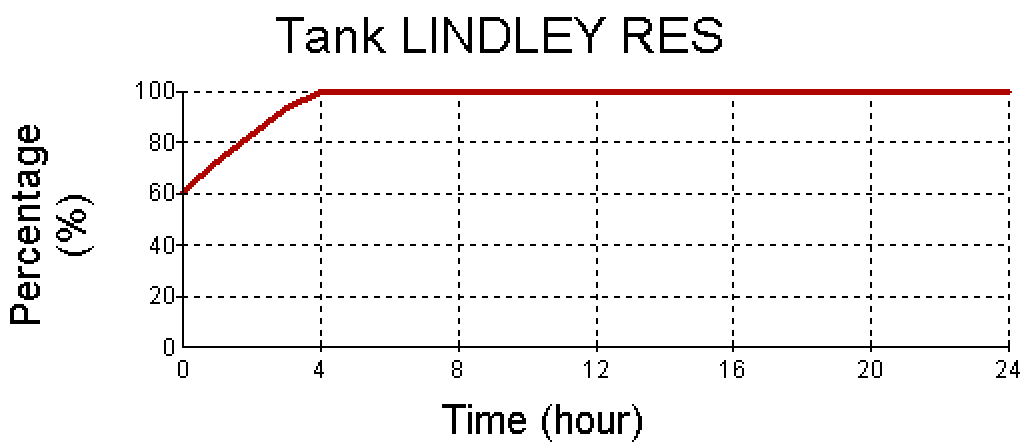
An analysis was conducted to evaluate the impact to the A-11/Lindley Zone with the Clearwell "Channel Line" out of service. Five pressure regulating stations supplying the A-11/Lindley Zone are located on the Channel Line, including the automated stations at Ash/Channel and Valley/Orange. The upstream section of the 36-inch diameter Channel Line, which was constructed in 1976-77, extends for approximately three miles along the southern border of the City's main drainage channel, and is therefore susceptible to a potential washout. Under normal operating conditions, the Channel Line supplies nearly half of the Lindley Zone demand and most of the A-11 Zone demand through the two automated stations. The remaining manual valves on the Channel Line provide a backup supply to the Lindley Zone.

A 24-hour extended period simulation was performed with the hydraulic model with the Channel Line removed from service at the upstream end, average 2010 demands, a single operating bay at the A-11 Reservoir, and separate A-11 and Lindley Zones, which is the way the system currently operates. Valve settings were not changed, with the exception of the Lindley automated valve, which was opened wider to pass more flow. Without the Channel Line, supply to the Lindley Zone is from the Lindley Reservoir and two regulating stations on the northern El Norte transmission main, plus a third valve on the Bear Valley main. Supply to the A-11 Zone is from the A-11 Reservoir (single bay) and the El Dorado/Juniper regulating valve on the Bear Valley main.

Model results indicate that sufficient flow can be provided from the remaining regulating stations, and there were only minor pressure drops in the distribution system with average demands, even during the peak morning demand (1.45 times average demands). The Lindley regulating valve was set at 50 percent open during entire simulation. It is noted that two 8-inch diameter pipelines extending south from the reservoir were modeled based on information in the water atlas/GIS, but at a subsequent meeting with City staff it was reported that the 8-inch diameter pipeline in Broadway had been replaced with an 18-inch diameter pipeline several years ago. Therefore the maximum flow supplied from the Lindley Reservoir will be higher and water levels will be lower than indicated by the model and will be documented in the final Water Master Plan report. In the A-11 Zone, the single bay of the A-11 Reservoir that was initially set with a water level at 11 feet drained down over the first 10 hours of the simulation and then leveled out at around five feet, which is when the El Dorado/Juniper regulating valve opened. The El Dorado/Juniper valve supplies a 21-inch diameter transmission main and can make up for the loss of the Valley/Orange automated valve under the average demand scenario. Model results showing water volumes in the Lindley and A-11 Reservoir (single bay) with the Channel Line out of service are shown in Figure 5.

An additional simulation with the Channel Line out of service was made with 2010 maximum day demands, which are the average demands peaked by a factor of 1.7. With higher demands on the system, the remaining valves could not supply the required flow and the A-11 Reservoir drained completely during the 24-hour simulation. The model was then rerun with the supply to Lomas West transferred from the A-11 Zone to the Park Hill Zone. With this modification, the A-11 Reservoir drained to nearly empty by the end of the 24-hour simulation, the manual regulating valves opened fully and pressures dropped during peak demand periods in the morning and late evening hours. The Lindley Reservoir remained full after about the sixth hour in the simulation, although higher flows were provided from the reservoir during peak demands when pressures in the distribution system dropped. Figure 6 illustrates flow through the Washington/Citrus valve and pressures directly downstream of the valve (Junction 200), which drop by approximately 20 psi when the valve opens wide during the two peak demand periods.

Figure 5 – Simulated Reservoir Volumes with the Channel Line Out of Service – Average 2010 Demands



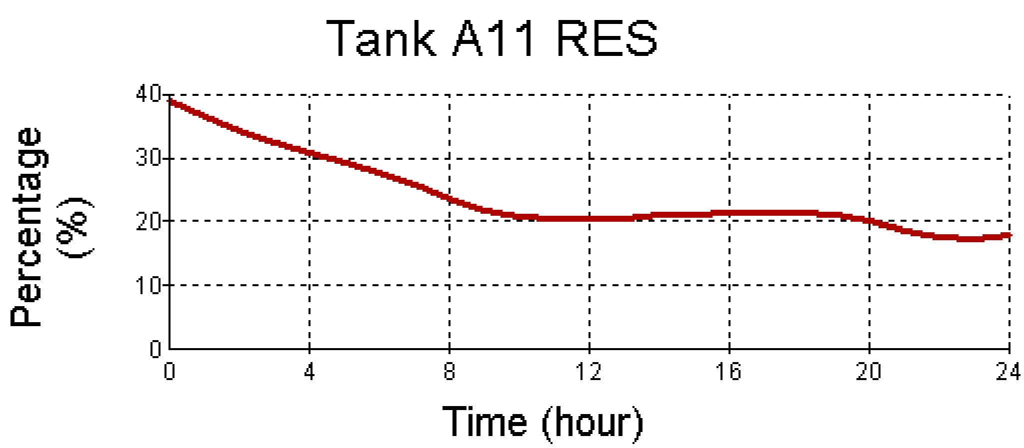
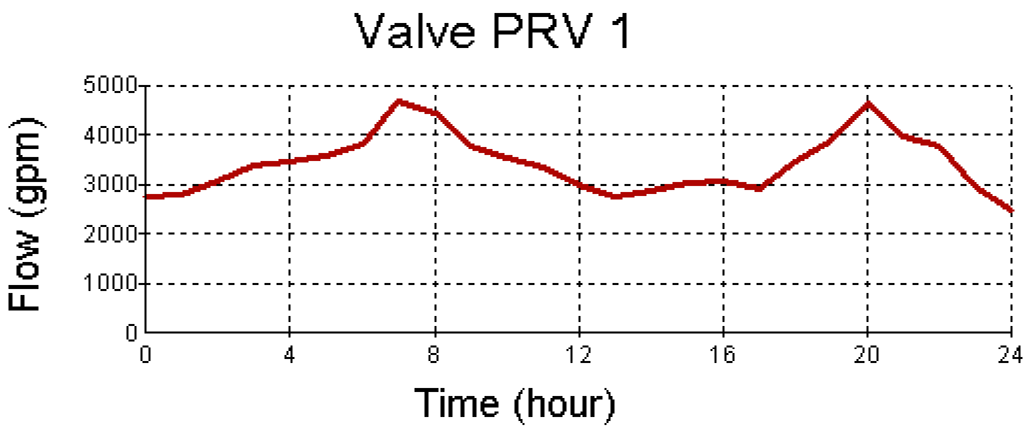
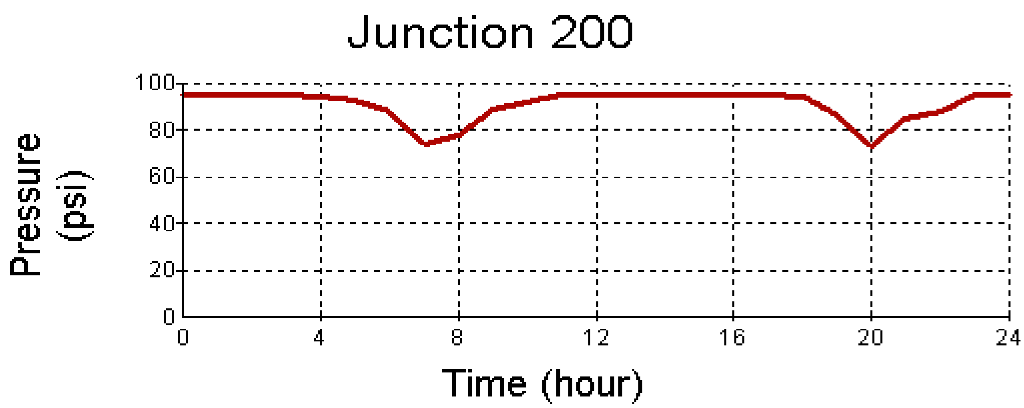


Figure 6 – Analysis Results with the Channel Line Out of Service and Maximum Day 2010 Demands: Washington/Citrus PRS (PRV 1) Simulated Flows and Downstream Pressures





Water volumes in the A-11 Reservoir are provided in Figure 7, and Figure 8 illustrates flow through the El Dorado/Juniper PRS. The El Dorado/Juniper PRS was able to provide higher flows and maintain its setting throughout the simulation, even when the A-11 Reservoir emptied. However, higher flows in the downstream A-11 Zone transmission mains resulted in A-11 Zone pressures dropping down to 30 psi along the ridge east of Interstate 15. Reduced pressures in the Bear Valley Pipeline caused water levels in other reservoirs filled from this line to drop slightly as well.

Figure 7 – Simulated A-11 Reservoir Volumes (single bay) with the Channel Line Out of Service – Max Day 2010 Demands

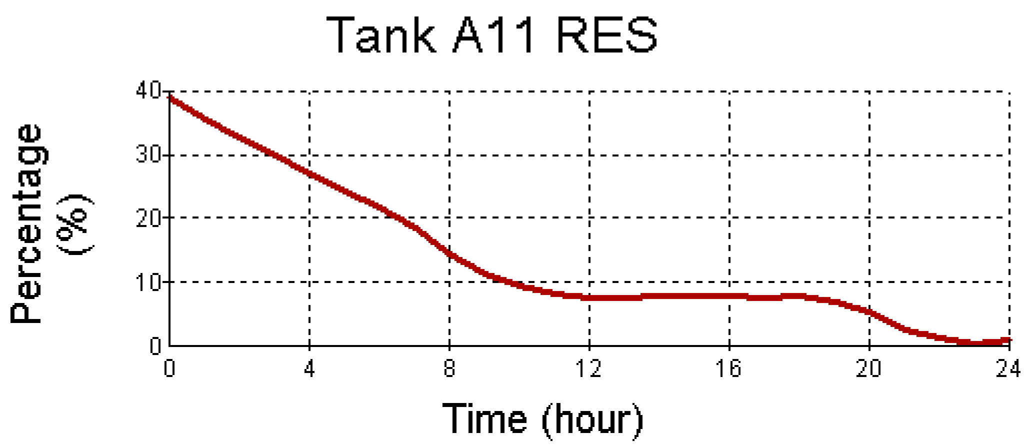
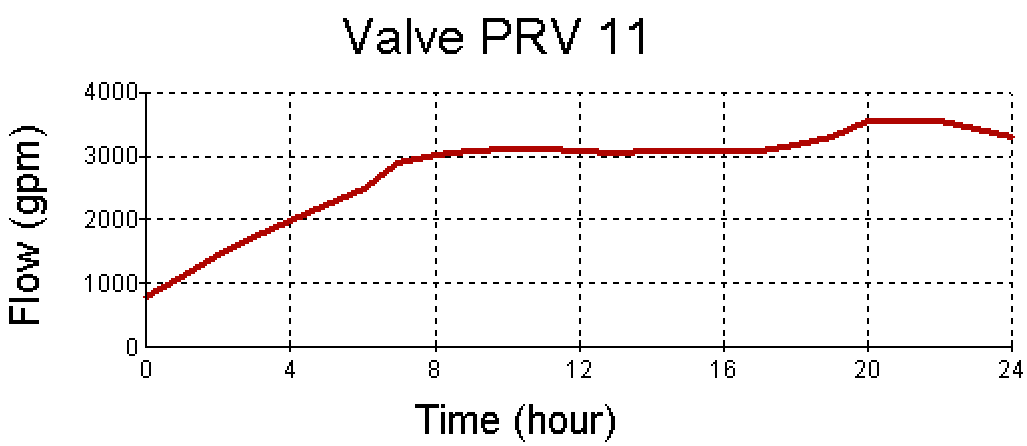
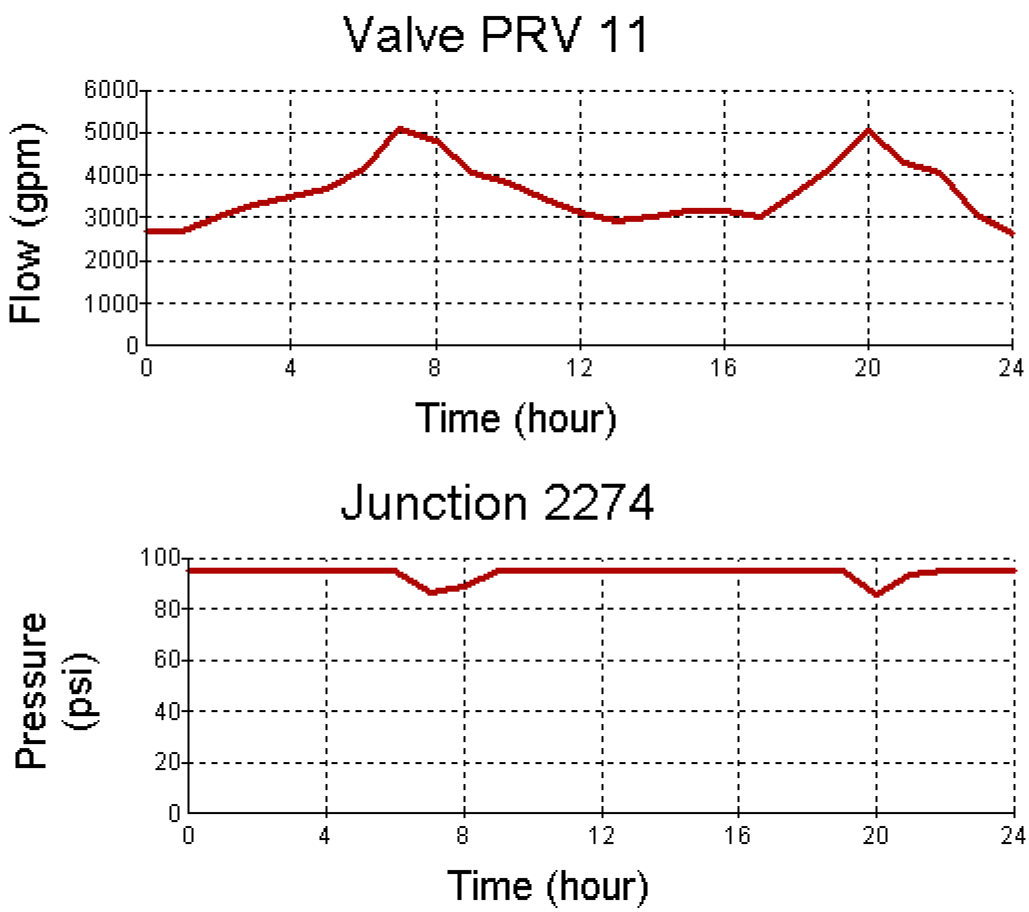


Figure 8 – Analysis Results with the Channel Line Out of Service and Maximum Day 2010 Demands: El Dorado/Juniper PRS Simulated Flows



A third and final simulation was made with both the Channel Line and the A-11 Reservoir out of service, and 2010 maximum day demands. During this simulation the El Dorado/Juniper regulating valve makes up for the A-11 Reservoir, but opens wide and cannot maintain its downstream setting during the two peak demand periods in the 24-hour simulation, as illustrated in Figure 9. Furthermore, upstream pressures in the Clearwell Zone drop by 15-20 psi.

Figure 9 – Analysis Results with the Channel Line & A-11 Reservoir Out of Service and Maximum Day 2010 Demands: El Dorado/Juniper PRS (PRV 11) Simulated Flows and Downstream Pressures



In conclusion, model results indicate:

- The A-11 and Lindley Zones can operate adequately and maintain system pressures with average 2010 demands indefinitely if the Channel Line is out of service. However, there will be very little turnover of water in the A-11 Reservoir, resulting in water quality problems.
- If the Channel Line were out of service during summer demand periods, the two reservoirs and remaining pressure regulators cannot adequately supply peak flows. Pressures will drop during the mid-morning and late evening hours, and the A-11 Reservoir (single bay) will drain within a day.
- With both the A-11 Reservoir and the Channel Line out of service, model results indicate that average day demands can still be supplied to the A-11 Zone with only a small

pressure drop. With maximum day demands under these conditions, however, adequate service cannot be provided.

The following operational changes and system improvements will mitigate the effects of a planned shutdown or break of the Channel Line:

- Change supply to the Lomas West Zone from the A-11 Zone to the Park Hill Zone and limit supply from the A-11 Zone to the Park Hill Zone (modify settings for pressure reducing valves).
- Raise the pressure setting on the El Dorado/Juniper Valve to maintain higher water levels at the A-11 Reservoir and reduce the drain rate during peak demand periods.
- Construct a new PRS (Clearwell to Lindley Zone) at Sheridan/Rincon Villa Drive and approximately 1,500 feet of 16-diameter pipeline in Rincon Villa Drive south to El Norte Parkway to connect with the existing 18-inch diameter pipeline in North Ash Street. This will allow for higher flow rates into the Lindley Zone and the ability to use any serviceable downstream portions of the Channel line to increase supply to the A-11 Zone.
- Fill the Lindley Reservoir and one or both bays of the A-11 Reservoir prior to a planned shutdown.

Conclusions

As water system operators have discovered over the years, the location of the A-11 Reservoir at the remote southwest end of the distribution system and hydraulic constraints prohibit the full capacity of the reservoir to be utilized effectively in the distribution system. Per our observations, during the first week in April and the last week in October of 2011 only about 15% of the full 8.0 MG reservoir capacity was actively used. Although operations staff can effectively utilize more of the storage capacity by filling one bay of the reservoir in advance of a planned facility shutdown, both bays have never been actively used under normal operations in the distribution system.

The results of this A-11 Reservoir hydraulic study are summarized in Table 3, which defines alternative A-11 Reservoir configurations (dual bay, single bay or no reservoir) and implementation options, including the advantages and disadvantages of each proposed operational configuration. Recommended mitigation measures to offset the disadvantages of each option are also proposed. As documented in the table, several of the reservoir options are not recommended.

Preliminary results from this study and a draft version of Table 3 were discussed with City Staff at a master plan project review meeting on January 12, 2012. The option to permanently remove the A-11 Reservoir from the distribution system was eliminated due to concerns with localized pressure swings and surges, and the ability of the A-11 Reservoir to stabilize pressures under existing demand conditions. At this meeting a decision was made to recommend, as a minimum, rehabilitation of a single bay of the A-11 Reservoir for continued operation in a separate A-11 Zone as a 4.0 MG Reservoir. Facility improvements to increase reservoir supply rates and improve water circulation within the tank to allow the reservoir to operate at higher water levels are also recommended. Although a 4.0 MG A-11 Reservoir will satisfy storage requirements for the A-11 Zone, the Lindley Zone will have a large storage deficit based on 2000 Master Plan storage criteria. In lieu of constructing additional storage in higher zones (Reed or Clearwell), there was consensus to construct water supply improvements for alternate emergency supplies to the A-11/Lindley Zone. With multiple sources of supply and numerous supply locations along three separate Clearwell transmission mains, there is justification to revise the storage criteria in the master plan update to reduce the required emergency storage in the A-11/Lindley Zone. This cost-effective option will also increase the reliability and operational flexibility of entire water system.

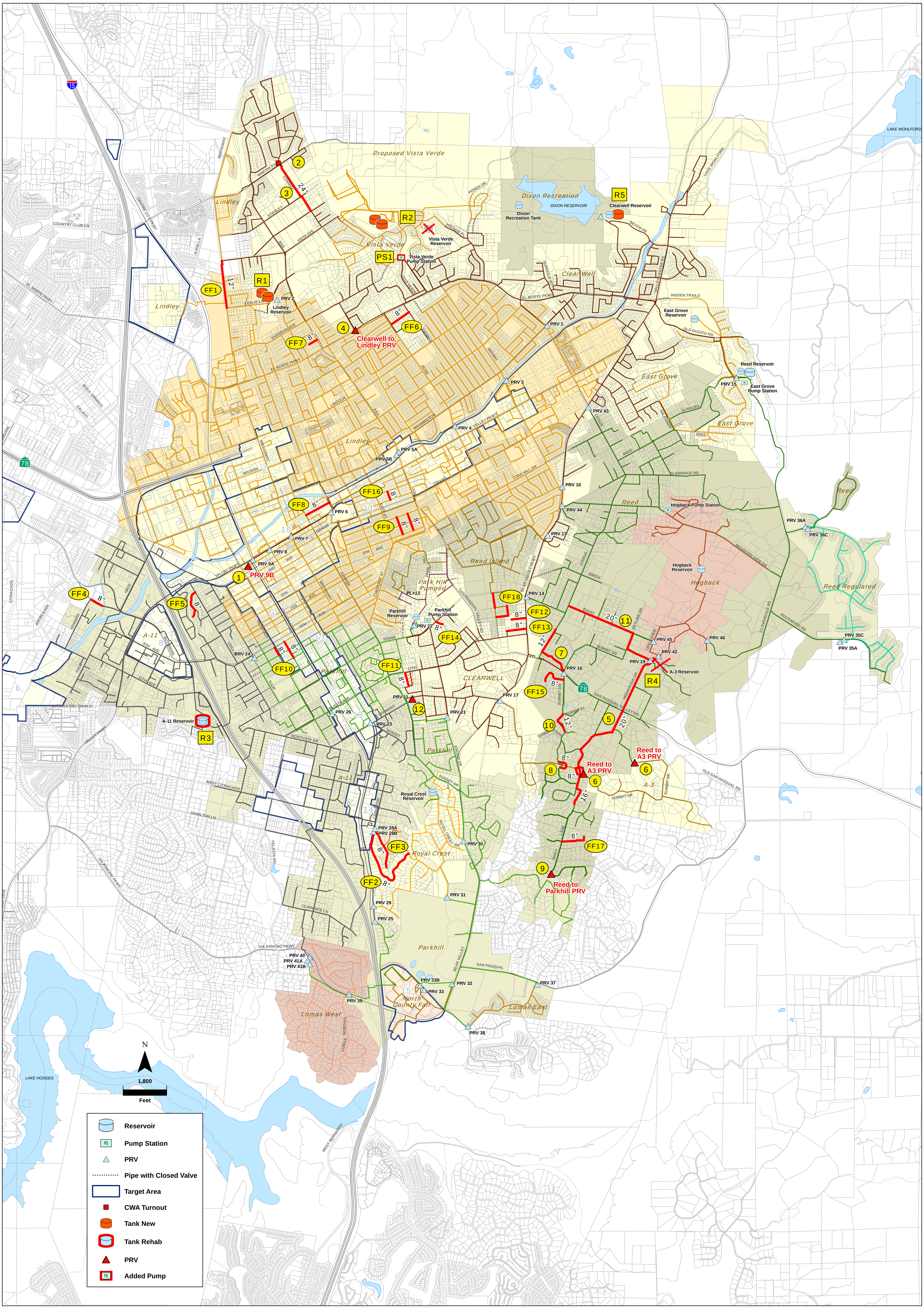
The following prioritized list of improvement projects are recommended to implement the 4.0 MG A-11 Reservoir option described above.

1. Increase flow rates through the Valley Parkway/Orange regulating station by upsizing the 12-inch diameter regulator and associated piping to 16-inch, or adding a parallel 12-inch regulator. *Note – this was a high priority project in the 2000 Master Plan*
2. Rehabilitate a single 4.0 MG bay of the A-11 Reservoir based on recommendations provided in the 2010 inspection report prepared by Aquatic Inspections, Inc. In addition, construct facilities to improve reservoir mixing and turnover rates. New facilities may include the addition of a circulating pump and/or revisions to the inlet/outlet piping.
3. Replace the existing Lindley Reservoir with a larger capacity tank of at least 3.0 MG to meet Lindley Zone fire flow and operational storage requirements. *Note – two 1.5 MG Reservoirs are currently planned.*
4. Construct facilities to supply water from the CWA treated water turnout on Pipeline 2 (ESC 2) near Rincon Avenue/Conway Drive to the Clearwell Zone. New facilities will include a modulating flow control valve and upsizing or replacing approximately 2,400 feet of 12-inch and 8-inch diameter Clearwell Zone pipelines with 24-inch diameter or larger pipeline.
5. Construct a new pressure regulating station (Clearwell to Lindley Zone) at Sheridan Avenue/Rincon Village Drive and approximately 1,400 feet of 18-inch diameter pipeline in Rincon Village Drive south to El Norte Parkway to connect with the existing 18-inch diameter pipeline in Ash Street. These facilities will provide an emergency water supply to the A-11/Lindley Zone from the proposed CWA treated water turnout described above or from the existing emergency supply turnouts with Rincon MWD.

The above projects will be included with the capital improvement projects in the 2012 Master Plan Update. The master plan update will also document the revised emergency storage criteria for the A-11/Lindley Zone. It is noted that the preferred option for a 4.0 MG A-11 Reservoir assumes the second bay is abandoned. As a final note, the hydraulic simulations performed for this analysis were made with the existing system computer model and 2010 demands imported directly from water billing data. Additional analyses will be performed with ultimate system demands for the master plan update once demand projections based on the General Plan Update have been completed. The projects as described above may therefore be revised based on the results of the ultimate system analysis.

Table 3 – A-11 Reservoir Options

Reservoir Options	Zone Configuration	Advantages	Disadvantages	Mitigation Measures
8.0 MG A-11 Reservoir (both bays)	Combined A-11/ Lindley Zone	• Provides in-zone operational & fire flow storage, plus 60% of emergency storage for planned emergencies • Total storage capacity in the system meets 2000 design requirements based on existing demands • Maximizes storage on west side of City	• Hydraulic limitations due to operation w/ Lindley Res – A-11 water levels will be several feet lower than Lindley • Very limited ability to cycle A-11 and control water levels • Poor circulation and water quality problems	Option not recommended
	Separate A-11 Zone	• Surplus in-zone storage – could provide emergency storage for Lindley and Royal Crest Zone (zones with storage deficits) • Total storage capacity in the system meets 2000 design requirements based on existing demands • Maximizes storage on west side of City	• Demands of existing A-11 Zone do not justify storage volume, resulting in low water turnover rates • Very limited ability to cycle A-11 and control water levels • Poor circulation and water quality problems • Attempting to cycle 8.0 MG tank may cause large Clearwell level fluctuations and reduced flows to other tanks	• Expand A-11 /reduce Lindely Zone service areas by closing valves and constructing new pipelines, as necessary – requires additional study • Automate PRS at El Dorado/Juniper to & install larger valve at Ash/Channel to help cycle A-11 Reservoir • Install circulating pump at reservoir • Add remote chlorination facilities • Construct separate tank inlet/outlet
4.0 MG A-11 Reservoir (single bay)	Combined A-11/ Lindley Zone	• Provides in-zone operational & fire flow storage, plus 25% of emergency storage for planned emergencies • A-11 Res rehabilitation only required for a single bay • Half of A-11 Reservoir becomes a standard asset	• Hydraulic limitations due to operation w/ Lindley Res – A-11 water levels will be several feet lower than Lindley • Limited ability to cycle A-11 and control water levels • Poor circulation and water quality problems • Elimination of 2nd bay creates an emergency storage deficit of 9 MG in-zone, and 3 MG deficit City-wide	Option not recommended
	Separate A-11 Zone	• Provides in-zone operational & fire flow storage, plus nearly all in-zone emergency storage for the A-11 Zone • A-11 Res rehabilitation only required for a single bay • Maintains storage on west side of City and buffer for surges • Half of A-11 Reservoir becomes a standard asset	• Limited ability to cycle A-11 Reservoir • Poor circulation and water quality problems • Elimination of 2nd bay with separate zones creates an emergency storage in-zone deficit of 9 MG in the Lindley Zone, and 3 MG deficit City-wide	• Install larger valve at Ash/Channel and automate PRS at El Dorado/Juniper to help cycle A-11 tank • Install circulating pump at the A-11 tank or revise inlet/outlet to improve mixing • Construct 3MG Lindley Res and additional storage at Reed Reservoir site • Construct pipelines for a direct Reed=>Lindley Zone emergency supply • Construct CWA treated water turnout and related facilities, Clearwell=> A-11/ Lindley PRS at Ash/Rincon Villa Dr, & 16" pipe in Ash south to El Norte for emergency supply • Revise 2000 design criteria to reduce emergency storage capacity for Lindley Zone based on access to multiple emergency supply sources
No A-11 Reservoir	Combined A-11/ Lindley Zone	• Rehabilitation of A-11 Reservoir not required • Lindely Reservoir provides most of the in-zone operational & fire flow storage for combined zone demands • Full control over Lindley Res levels - eliminates water quality problems in zone	• No in-zone emergency storage • Slight reduction in residual fire flow pressures near the A-11 Reservoir site • Increased pressure swings/surges in south end of distribution system • Elimination of A-11 Res creates an in-zone emergency storage deficit of 13 MG, and 7 MG deficit City-wide	• Set automated control valves supplied from Channel Line to pressure control • Switch Lomas West Zone supply from A-11/Lindley Zone to Park Hill Zone • Construct 3MG Lindley Res and additional storage at Reed Reservoir site • Construct pipelines for a direct Reed=>Lindley/A-11 Zone emergency supply • Construct CWA treated water turnout and related facilities, Clearwell=> A-11/ Lindley PRS at Ash/Rincon Villa Dr, & 16" pipe in Ash south to El Norte for emergency supply • Revise 2000 design criteria to reduce emergency storage capacity for Lindley/A-11 Zone based on access to multiple emergency supply sources
	Separate A-11 Zone	• Rehabilitation of A-11 Reservoir not required	• No operational or emergency storage provided in A-11 zone • Slight reduction in residual fire flow pressures near the A-11 Res • Supply of higher peak flows from Bear Valley Line will reduce Clearwell Zone pressures and supply rates to PH & A-3 Reservoirs Elimination of A-11 Res creates an in-zone emergency storage deficit of 9 MG for Lindley, 4 MG for A-11, & 7 MG deficit City-wide	Option not recommended



POTABLE WATER SYSTEM
RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

FIGURE 8-1

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ATKINS

ESCONDIDO WATER MASTER PLAN

MAY 2012