City of Davis 2010 Urban Water Management Plan

Prepared for

City of Davis

July 2011

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May 31, 2011

Jacques De Bra
Utilities Manager
Public Works Department
City of Davis
1717 Fifth Street
Davis, California 95616 140569

Subject: City of Davis 2010 Urban Water Management Plan

Dear Mr. De Bra:

This Urban Water Management Plan (Plan) addresses the City of Davis's (City's) projected water use and water supplies. This Plan has been prepared in accordance with the Urban Water Management Act (Act) that requires urban water suppliers to adopt and submit a plan every five years to the California Department of Water Resources.

The Act was most recently amended in November 2009 with the adoption of Senate Bill (SB) X7-7, which includes the requirement for establishing a gallons per capita per day (gpcd) water use targets for 2020 using one of four methods. The City has selected Method 3 for establishing its 2020 water use target of 167 gpcd.

The City's per capita water use has been declining since 2007, similar to water use trends experienced in other communities throughout California, to the level where it is approximately at the 2020 gpcd target. It is likely that the City's per capita water use will continue to decline as customers replace old plumbing fixtures, new homes are constructed with low flow plumbing devices, retrofit on resale requirements become effective in 2016 and 2017, the City removes park irrigation from the potable water supply and possibly expands its existing conservation program, and higher water pricing impacts water use. Focusing the City's water conservation program on reducing peak demands would provide the best benefits by reducing summer water supply capacity needs and the use of higher cost peak period energy.

Please do not hesitate to contact me at 916-444-0123 if you have any questions or comments.

Sincerely,

BROWN AND CALDWELL

Paul Selsky, PE
Project Manager

PS:ds

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2010 Urban Water Management Plan

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List of Abbreviations

AB	Assembly Bill
Act	Urban Water Management Act
ac-ft	acre-feet
ac-ft/yr	acre-feet per year
AWWA	American Water Works Association
BMP	Best Management Practice
CCF	hundred cubic feet
cfs	cubic feet per second
CII	commercial, industrial, and institutional
City	City of Davis
CTD	Conaway Toe Drain
CUWCC	California Urban Water Conservation Council
DMM	Demand Management Measure
DPH	California Department of Public Health
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment Plan
EAT	East Area Tank
EPA	United States Environmental Protection Agency
ET_o	evapotranspiration
gpcd	gallons per capita day
GPHD	gallons per home per day
gpf	gallons per flush
gpl	gallons per load
gpm	gallons per minute
GWMP	groundwater management plan
in	inches
MFR	multi-family residential
MG	million gallons
mgd	million gallons per day
mg/L	milligrams per liter
Mn	manganese
MOU	Memorandum of Understanding
MPN	most probable number
NPDES	National Pollutant Discharge Elimination System
PCA	possible contaminating activity
PG&E	Pacific Gas and Electric
Plan	Urban Water Management Plan
PS	pump station
SB	Senate Bill
SFR	single family residential
SWRCB	State Water Resources Control Board
TBD	to be determined
TDS	Total Dissolved Solids
TM	technical memorandum
UC	University of California
Plan	Urban Water Management Plan
WAT	West Area Tank
WDCWA	Woodland Davis Clean Water Agency
WPCP	Water Pollution Control Plant
WRA	Water Resources Association of Yolo County

Section 1

Introduction

This Urban Water Management Plan (Plan) addresses the City of Davis (City) water system and includes a description of the water supply sources, historical and projected water use, water supplies, and water conservation activities.

The remainder of this section provides an overview of the Plan, resources maximization and import minimization, public participation, details on Plan adoption, agency coordination, and Plan organization.

1.1 Urban Water Management Planning Act

The Plan has been prepared in accordance with the Urban Water Management Act (Act). The Act is defined by the California Water Code, Division 6, Part 2.6, and Sections 10610 through 10657. The Act became part of the California Water Code with the passage of Assemble Bill 797 during the 1983-1984 regular session of the California legislature. The Act requires every urban water supplier providing water for municipal purposes to more than 3,000 connections or supplying more than 3,000 acre-feet (ac-ft) of water annually to adopt and submit a plan every five years to the California Department of Water Resources (DWR). Subsequent assembly bills have amended the Act. The Act was most recently amended in November 2009 with the adoption of Senate Bill (SB) X7-7. The most significant revision is the requirement for establishing gallons per capita per day (gpcd) water use targets and the delay of the Plan adoption to July 1, 2011.

1.2 Resources Maximization and Import Minimization

Water management tools have been used by the City to maximize water resources. The City uses local water supplies and does not use any imported water. The City has developed several reports to help maximize water resources that address water supply and demand for the City. This section provides a list of these planning reports.

- Future Water Supply Study (Montgomery Watson/West Yost Associates, 1996)
- Deep Aquifer Study (West Yost Associates, 1998)
- Water System Audit (Brown and Caldwell, 1999)
- Water Rate Study Update (Brown and Caldwell, 2000/2001)
- City of Davis and UC Davis Joint Water Supply Feasibility Study (West Yost Associates, Sept 2002)
- Status Report on Municipal Wastewater Treatment Facilities (City of Davis Department of Public Works, March 2003)
- Final Environmental Impact Report: Davis Well Capacity Replacement (Winzler & Kelly Consulting Engineers, July 2005)
- Hydrogeologic Conceptualization of the Deep Aquifer. Prepared for the University of California, Davis (Luhdorff and Scalmanini Consulting Engineers, May 2003)
- Phase II Deep Aquifer Study (Brown and Caldwell, 2005)
- Water Supply Optimization Plan (Brown and Caldwell, 2011)

1.3 Public Participation

The Act requires the encouragement of public participation and a public hearing as part of the Plan development and approval process. As required by the Act, prior to adopting this Plan, the City made the Plan available for public inspection and held a public hearing. The City notified cities and counties within the service area 60 days before the public hearing. Appendix B provides documentation that the cities and county within which the City provides water supplies were notified at least 60 days prior to the Plan public hearing. As required by the Act, prior to adopting this Plan, the City made the Plan available for public review and comment and held a public hearing. Notices of the public meeting were published in the local newspaper and posted on the City's web site. The draft Plan was made available for public inspection at the City's administration building and the City's web site two weeks before the public hearing. The public hearing notice is included in Appendix A. Public meetings included a review of the Plan at the June 27, 2011 Natural Resources Commission meeting and a public hearing held at the City Council meeting held on July 19, 2011. The public hearing included a general discussion of the City's implementation plan for complying with the SBX7-7. The City Council adopted the Plan following the public meeting. A copy of the resolution adopting the Plan is included in Appendix C.

The City has encouraged the active involvement of diverse social, cultural, and economic elements of the population within its service area prior to and during the preparation of this Plan through its outreach efforts for the regional surface water supply project with the Woodland Davis Clean Water Agency (WDCWA). As part of these outreach efforts, there have been a variety of materials including information flyers and pamphlets, workshops, and a website developed to both educate and communicate with the diverse elements of the population.

Following City Council adoption, this Plan will be submitted to the DWR, the State Library, and the cities and county within which the City provides water supplies. The adopted Plan will be available in the local library publications section, as well as on the City's website.

1.4 Coordination

The City is a member agency of the Water Resources Association of Yolo County (WRA). The City regularly coordinates with WRA member agencies (both urban and agricultural) on projects of mutual interest and communicates City water-related actions both during and between regular WRA Board meetings. WRA members were encouraged to review and comment on the City's 2010 Urban Water Management Plan Update.

Table 1-1 summarizes the efforts the City has taken to include additional agencies and citizens in its planning and preparation process.

Table 1-1. Coordination with Appropriate Agencies (DWR Table 1)

Check at least one box on each row	Provided 60-day notice of public hearing	Commented on the draft	Attended public meetings	Was contacted for assistance	Was sent a copy of the draft Plan
Yolo County	X				X
City of Woodland	X				X
University of California (UC) at Davis	X				X
Water Resources Association of Yolo County (WRA)	X				X
Woodland Davis Clean Water Agency	X				X
Members of the public	X		X		X

1.5 Plan Implementation

The City will implement this 2010 Plan by taking steps to meet the SBX7-7 gpcd target. The City will continue implementation of their water conservation program as well as continue to track the groundwater quality. The City implemented the 2005 Plan in close accordance with the information that was presented in that Plan.

1.6 Plan Organization

This section provides a summary of the sections in the Plan.

- Section 2 – Description of the service area, climate, and water system
- Section 3 – Historical and projected water use
- Section 4 – Surface and groundwater supplies
- Section 5 –Recycled water use
- Section 6 –Water conservation program
- Section 7 –Comparison of future water supply to demand
- Section 8 –City's water shortage conditions and policies
- Appendices A through L – Supporting information

DWR provides a checklist of the items that must be addressed in the Plan based upon the Act. This checklist makes it simple to identify where in the Plan each item is addressed. The completed checklist is provided in Appendix D. It references the sections and page numbers where specific items can be found.

Section 2

Description of Existing Water System

This section describes the City's water system. It contains a description of the service area and the water supply facilities, including groundwater wells, storage reservoirs, and the piping system.

2.1 Description of Service Area

The City is located in the Central Valley in the southeastern corner of Yolo County and to the east of the coastal mountain range and San Francisco Bay Area, and 12 miles west of the state capital of Sacramento. It occupies an area of about 9.8 square miles (6,281 acres). Incorporation of the City occurred in 1917, and water service is provided to all residential (single and multi-family), commercial, industrial, and irrigation customers, and for open space and fire protection uses.

Local development began in the 1860's around the California Pacific Railroad depot, in use today as a multimodal transportation hub. Agriculture, the City's initial primary industry, led to the location of the University of California (UC) at Davis. The State Agricultural Experiment Station at Davis was established by the UC in 1906 with degree programs to follow in the 1920's. The community soon became the economic center of the region.

The downtown core is the oldest portion of the City. Residential expansion was first to the north and west of the core. The City expanded south of I-80 and west of Highway 113 in the 1960's. Growth in the 1970's expanded the urban area in all directions, and additions in the last twenty years have built out major areas of the incorporated area and added land to the City's service area. The City faces both negative and positive growth pressures from a variety of forces outside its control as follows: (1) steady growth of the UC Davis campus to meet growing state-wide education needs, (2) depressed regional economy, particularly in both Solano and Sacramento counties, (3) proximity to the Intertate 80 corridor, and (4) long term challenges for agriculture (international competition, high energy prices, and urban encroachment).

As shown on Figure 2-1, the City's service area, bordered by UC Davis campus, includes the City, El Macero (located south of Interstate 80), and additional areas to the north, south, east, and west of the City.

2.2 Climate

Summers in the City are warm and dry, and winters are cool and mild. The region is subject to wide variations in annual precipitation, and also experiences periodic dry periods and wild fires in the regional watershed and surrounding areas with chaparral and oak lands. Summers can be hot at times with weekly periods of 100 degree Fahrenheit temperatures, greatly increasing summer irrigation requirements.

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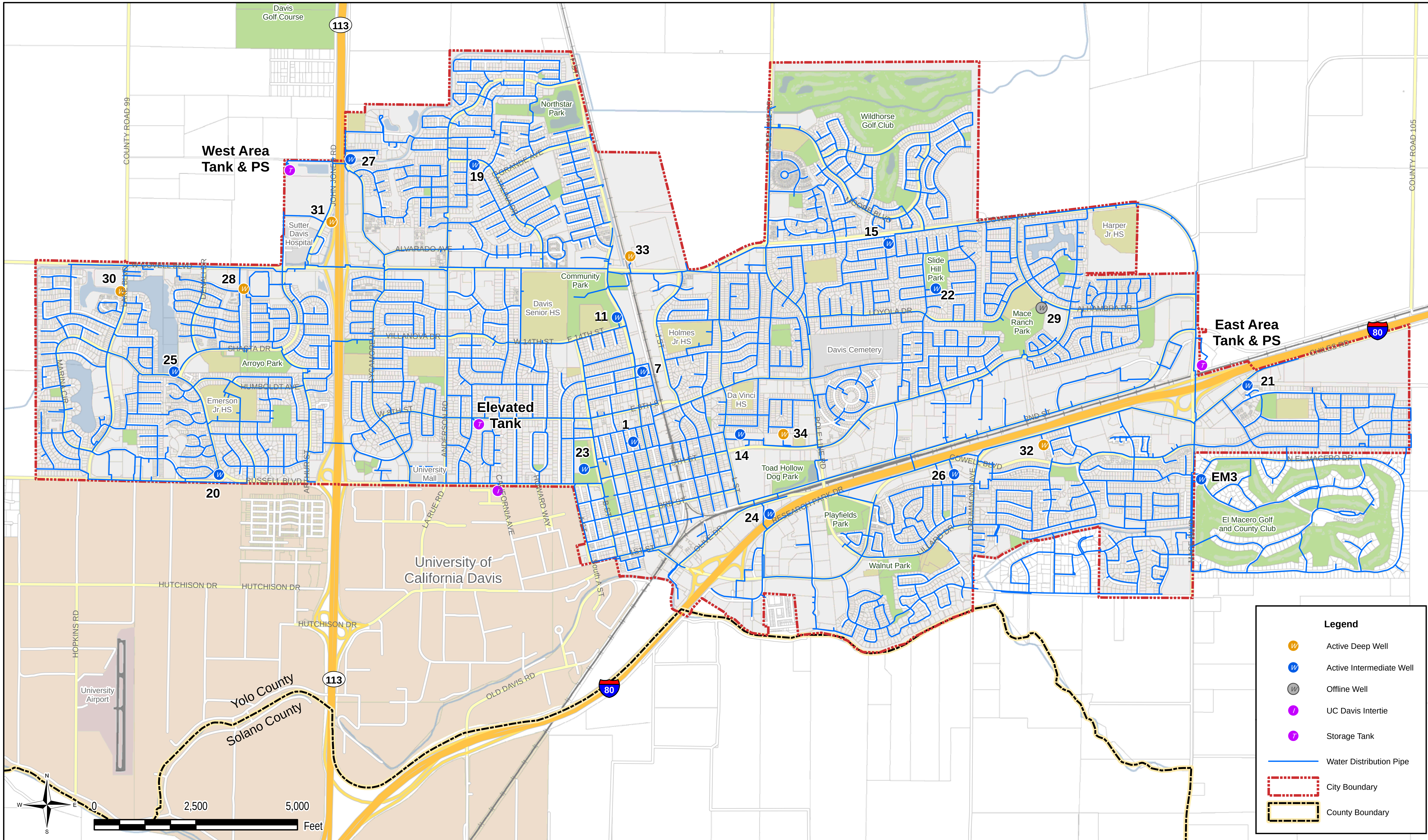

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Engineers & Scientists

Davis California

DRAFT

Figure 2-1. Water Distribution System

Based on the historical data obtained from the Western Regional Climate Center, the City's average monthly temperature ranges from 45 to 75 degrees Fahrenheit, but the extreme low and high daily temperatures have been 12 and 116 degrees Fahrenheit, respectively. The historical annual average precipitation is approximately 19 inches. The rainy season normally begins in November and ends in March. Evapotranspiration (ETo) records, which measure the loss of water from the soil both by evaporation and by transpiration from the plants growing thereon, indicate average monthly values ranging from 1.2 inches in the City's wet January to 8.3 inches in much drier June and July. Low humidity usually occurs in the summer months, from May through September. The combination of hot and dry weather results in high water demands during the summer. Table 2-1 summarizes the City's average climate conditions. Figure 2-2 illustrates the City's average monthly ETo versus the average monthly and annual rainfall. The difference between these values represents the potential irrigation needs within the City.

Table 2-1. Climate

Month	Standard Average ET_0 (in.)	Average Rainfall (in.)	Average Temperature (°F)
January	1.2	3.4	45
February	1.9	4.0	49
March	3.7	2.6	54
April	5.4	1.1	58
May	7.2	0.6	65
June	8.3	0.2	71
July	8.3	0.1	73
August	7.6	0.1	72
September	5.9	0.3	69
October	4.2	1.5	62
November	2.1	2.1	52
December	1.2	3.2	45
Annual	56.9	19.3	--

Source: Data recorded July 1982 to January 2011 from Sacramento Valley, Davis Station 6, CIMIS www.cimis.water.ca.gov.

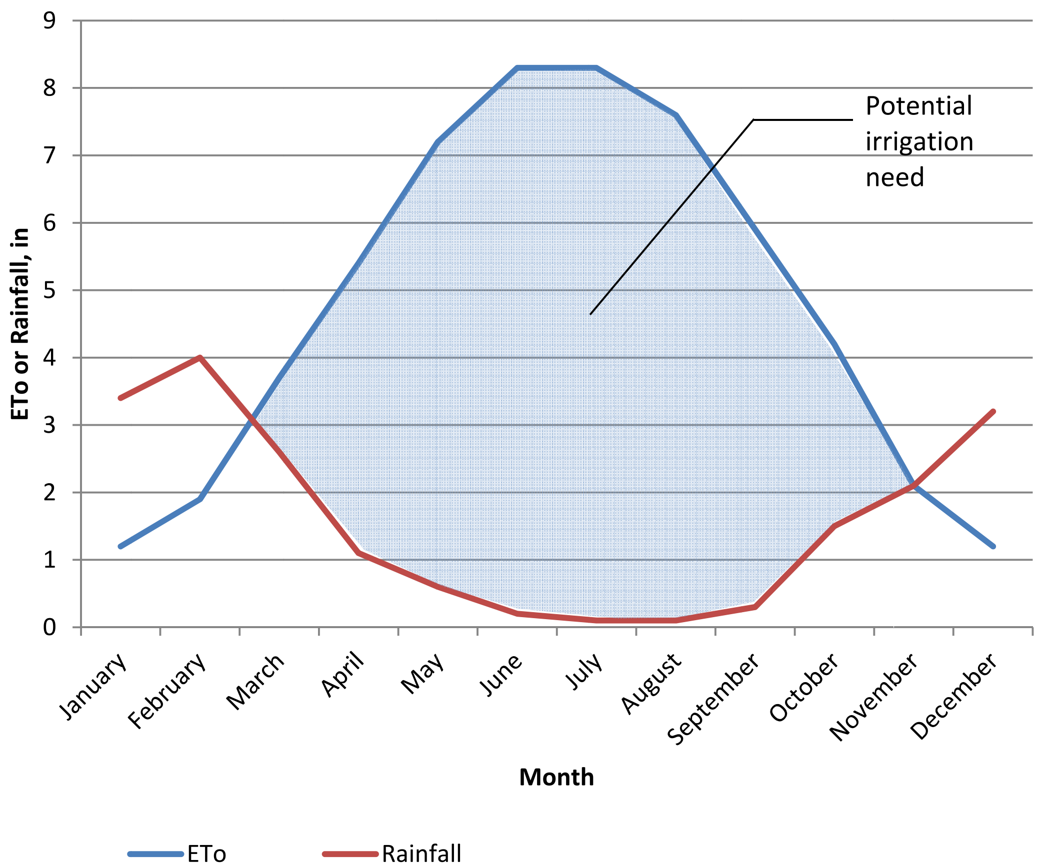


Figure 2-2. Potential Irrigation Need

2.3 Water Supply Facilities

The City currently relies solely on groundwater to meets its entire potable water demand. The City's groundwater supply infrastructure has a total groundwater pumping capacity of 32,250 gallons per minute (gpm) from 21 active wells. This includes wells 32 and 34 which are currently offline but scheduled to be placed into operation following the addition of treatment facilities. All of the wells pump directly into the distribution system. Some of the wells pump from the intermediate depth aquifer, and the newer wells pump from the better quality deep aquifer. The wells are listed in Table 2-2.

Table 2-2. Groundwater Wells			
Well No.	Well depth classification	Capacity, gpm	Status
1	Intermediate	1,040	Active
EM3	Intermediate	1,165	Active
7	Intermediate	946	Active
11	Intermediate	1,360	Active
14	Intermediate		Active
15	Intermediate	1,178	Active
19	Intermediate	1,200	Active
20	Intermediate	1,108	Active
21	Intermediate	1,120	Active
22	Intermediate	1,183	Active
23	Intermediate	1,700	Active
24	Intermediate	1,855	Active
25	Intermediate	1,035	Active
26	Intermediate	1,591	Active
27	Intermediate	1,058	Active
28	Deep	591	Active
29	Deep	1,221	Standby - Inactive due to water quality concerns
30	Deep	1,712	Active
31	Deep	2,759	Active
32	Deep	2,339	Offline, treatment being added for Manganese (Mn)
33	Deep	1,750	Active
34	Deep	2,348	Offline, treatment being added for Mn
Total capacity	--	32,259	Includes capacity from Wells 32 and 34. Does not include capacity from Well 29.
Reliable capacity	--	27,500	Assumes largest well, Well 31 is offline

2.4 Water Distribution System

The City's water distribution system operates as one pressure zone with one elevated tank and two ground level storage tanks with booster pump stations. The hydraulic grade in the system is based on the level in the elevated tank. The wells are controlled by a Supervisory Control and Data Acquisition (SCADA) system based on the level in the elevated tank.

2.4.1 Pipelines

The City's water system consists of piping ranging from 2 to 14-inches (in). Almost 90 percent of the distribution system consists of 6 to 10-in diameter pipelines. The City's pipeline system was constructed to support localized supply, with wells spread throughout the City. This type of localized supply does not require large diameter transmission mains.

2.4.2 Storage Facilities/Booster Pump Stations

There are three storage tanks in the City's water system, the existing Elevated Tank and West Area Tank (WAT) and the new East Area Tank (EAT), which will be online soon. The three tanks have a combined storage of 8.5 million gallons (MG). The WAT has a booster pumping capacity of 4,200 gpm and the EAT will have a total pumping capacity of 8,000 gpm. The WAT fills during off-peak demand periods and then the booster station pumps stored water back into the system during peak periods based on time and system pressure. The new EAT has just been constructed and is expected to operate like the WAT.

2.4.3 Interties

The only water system to which the City's is connected to is the UC Davis water system via two interties. UC Davis retains ownership of the interties. UC Davis entered into a water supply agreement with the City on July 9, 2010, and it is in affect through June 30, 2016. The water supply agreement limits the City from receiving water supply in excess of 300,000 hundred cubic feet (CCF) per year with a flow rate not to exceed 1,500 gpm from UC Davis.

Section 3

Historical and Projected Water Use

This section describes the City's demographics, water use data, customer connections, per capita water use target, and the projections for future water needs.

3.1 Demographics

The City's population has been increasing since the 1960's. Population increases were above normal for the 1996-2000 period as strong regional economic forces and UC Davis campus growth exerted pressure on urban land development needs. Population has and is expected to continue to grow more gradually in accordance with the recently adopted update of the City's General Plan. Most of the City's growth has been in the residential and open space land categories, with a relatively small spurt of commercial development. Significant multifamily residential development occurred to meet increasing student population housing needs. In the commercial sector, there was some growth in high technology and tourist related businesses.

The City continues to primarily be a residential community, with modest but growing commercial and industrial sectors. The City has a mix of commercial customers, ranging from restaurants, markets, retail stores, insurance offices, beauty shops, gas stations, office buildings, and some retail providing services in support of local resident and visitor populations. The City draws visitors from its close affiliation with UC Davis, proximity to the Interstate 80 corridor, and annual special events drawing visitors from the entire region.

The City has a very small industrial sector, primarily centered on technology and light manufacturing. The industrial sector has not grown relative to other sectors in the last decade. The City has a stable institutional/governmental sector, consisting primarily of local government, schools, public facilities, and hospitals.

Since 2005, population, housing and employment have increased but not as significantly as previously projected because of the economic recession. However, the University increased annual enrollment targets, resulting in additional growth in the region. Table 3-1 provides the 2010 and projected future population.

Table 3-1. Population – Current and Projected (DWR Table 2)

	2010	2015	2020	2025	2030	2035
Total	68,289	69,996	73,496	77,171	81,029	85,081

3.2 Historical Water Use

Water production is the volume of water measured at the source, which includes all water delivered to residential, commercial, and public authority customers, as well as unaccounted-for water.

Historical annual treated groundwater production for the City's water system is shown in Table 3-2. This is the total water use by the City.

Table 3-2. Groundwater – Volume Pumped (DWR Table 18)

Year	Groundwater, ac-ft/yr
1995	12,494
1996	12,995
1997	13,857
1998	11,908
1999	13,740
2000	14,099
2001	15,072
2002	15,112
2003	14,551
2004	15,100
2005	14,452
2006	14,333
2007	14,762
2008	14,219
2009	12,835
2010	11,955

3.3 Per Capita Water Use Targets

With the goal of reducing California's urban water use by twenty percent by year 2020, recently passed SBX7-7 requires water providers to establish per capita water use targets following one of four methods.

- **Method 1:** Eighty percent of the urban retail water supplier's baseline per capita daily water use using a 10-year average,
- **Method 2:** The per capita daily water use that is defined using the sum of several defined performance standards. This method requires quantifying the landscaped area and the baseline commercial, industrial, and institutional use. This method has not yet been evaluated by the City due to the difficulty in accurately measuring the City's landscape area.
- **Method 3:** Ninety-five percent of the applicable state hydrologic region target The City, located in DWR's Sacramento River Hydrologic Region 5 as shown on Figure 3-1, has a year 2020 target of 167 gpcd.
- **Method 4:** Calculated water savings based on indoor residential water savings, metering savings, commercial, industrial, and institutional (CII) savings, and landscape and water loss savings, as set forth in DWR's Provisional Final Method 4 for Calculating Urban Water Use Targets, released February 2011.

A technical memorandum (TM) regarding the City's water use characteristics, gpcd targets by each method, and demand projections is provided in Appendix E. This TM describes the City's water use characteristics and describes an approach for the City to meet the water use target.

Table 3-3 provides information related to the base period ranges. Data used to calculate the City's 10 and 5-year baseline water use are presented in Tables 3-4 and 3-5, respectively.

The City has selected Method 3 for establishing the 2020 water use target.

Table 3-3. Base Period Ranges (DWR Table 13)			
Base	Base Period Ranges		
	Parameter	Value	Units
10- to 15-year Base Period	2008 total water deliveries	4,216	million gallons
	2008 total volume of delivered recycled water	0	--
	2008 recycled water as a percent of total deliveries	0	--
	Number of years in base period	10	years
	Year beginning base period range	1995	
	Year ending base period range	2004	
5-year Base Period	Number of years in base period	5	years
	Year beginning base period range	2000	
	Year ending base period range	2004	

Table 3-4. Base Daily per Capita Water Use - 10- to 15-year Range (DWR Table 14)

Base Period Year		Distribution System Population	Daily System Gross Water Use (MG/yr)	Annual Daily Per Capita Water Use (gpcd)
Sequence Year	Calendar Year Ending			
Year 1	December 1995	54,926	4,071	203
Year 2	December 1996	55,834	4,234	208
Year 3	December 1997	57,303	4,515	216
Year 4	December 1998	58,639	3,880	181
Year 5	December 1999	61,691	4,477	199
Year 6	December 2000	63,324	4,594	199
Year 7	December 2001	64,877	4,911	207
Year 8	December 2002	65,415	4,924	206
Year 9	December 2003	66,136	4,741	196
Year 10	December 2004	65,942	4,920	204
Year 11	--	--	--	
Year 12	--	--	--	
Year 13	--	--	--	
Year 14	--	--	--	
Year 15	--	--	--	
Base Daily Per Capita Water Use				202

Table 3-5. Base Daily per Capita Water Use - 5-year Range (DWR Table 15)

Base Period Year		Distribution System Population	Daily System Gross Water Use (MG/yr)	Annual Daily Per Capita Water Use (gpcd)
Sequence Year	Calendar Year Ending			
Year 1	December 2000	63,324	4,594	199
Year 2	December 2001	64,877	4,911	207
Year 3	December 2002	65,415	4,924	206
Year 4	December 2003	66,136	4,741	196
Year 5	December 2004	65,942	4,920	204
Base Daily Per Capita Water Use				203

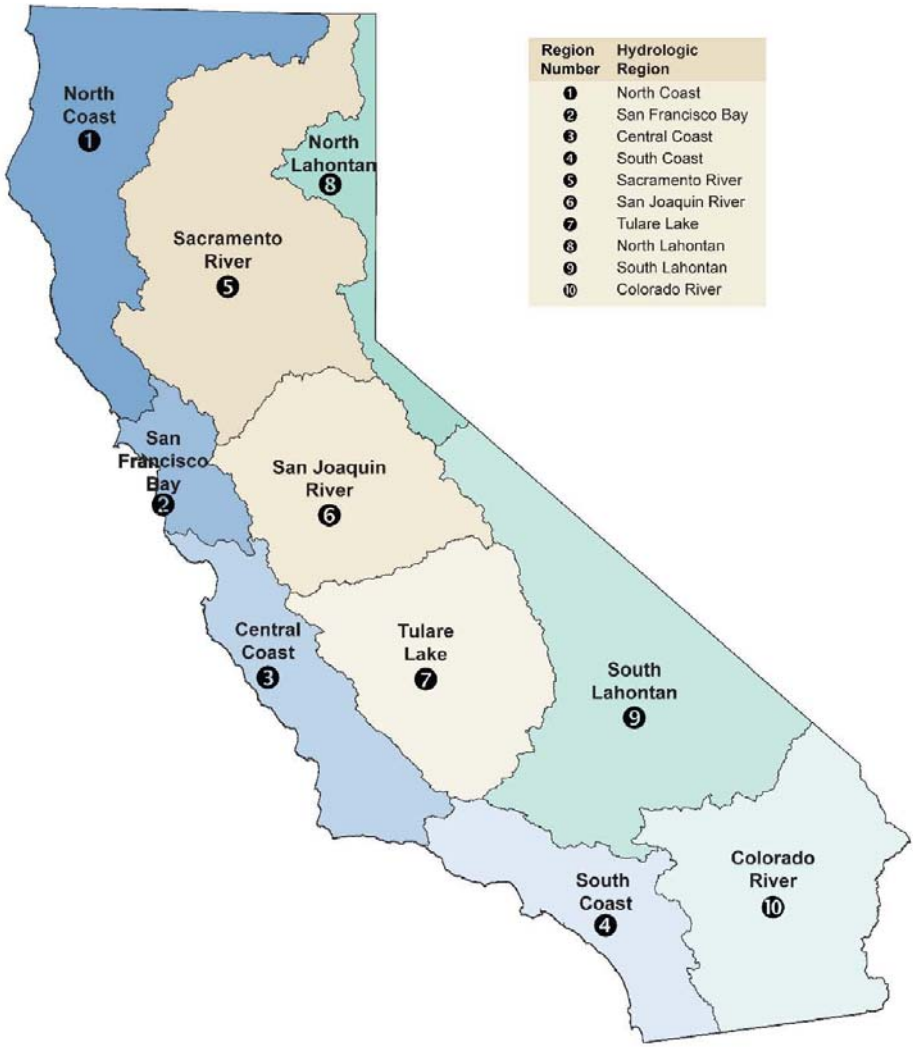


Figure 3-1. California Hydrologic Regions for SBX7-7 Analysis

3.4 Water Use

This section discusses the City's water use by customer type and projected water use.

3.4.1 Water Use by Customer Type

Table 3-6 and Table 3-7 show the past water use and the number of connections for each customer category. Projected water use by water use sector are presented for 2015 in Table 3-8, 2020 in Table 3-9, and 2025, 2030, and 2035 in Table 3-10.

Table 3-6. Water Deliveries, Actual 2005 (DWR Table 3)

Water Use Sector	2005				
	Metered		Unmetered		Total Volume (ac-ft/yr)
	# Accounts	Volume (ac-ft/yr)	# Accounts	Volume (ac-ft/yr)	
Single family	14,264	6,475	0	0	6,475
Multi-family	530	2,817	0	0	2,817
Commercial/ Institutional/ Industrial	671	1,605	0	0	1,605
Governmental	0	0	0	0	0
Landscape Irrigation	531	331	0	0	331
Agriculture	0	0	0	0	0
Other	233	997	0	0	997
Total	16,229	12,497	0	0	12,497

Table 3-7. Water Deliveries, Actual 2010 (DWR Table 4)

Water Use Sector	2010				
	Metered		Unmetered		Total Volume (ac-ft/yr)
	# Accounts	Volume (ac-ft/yr)	# Accounts	Volume (ac-ft/yr)	
Single family	14,436	5,914	0	0	5,914
Multi-family	541	2,478	0	0	2,478
Commercial/ Institutional/ Industrial	728	1,481	0	0	1,481
Governmental	-	-	0	0	-
Landscape Irrigation	550	300	0	0	300
Agriculture	-	-	0	0	-
Other	265	560	0	0	560
Total	16,519	10,734	0	0	10,734

Table 3-8. Water Deliveries, Projected 2015 (DWR Table 5)					
Water Use Sector	2015				
	Metered		Unmetered		Total Volume (ac-ft/yr)
	# Accounts	Volume (ac-ft/yr)	# Accounts	Volume (ac-ft/yr)	
Single family	14,797	6,826	0	0	6,826
Multi-family	554	2,715	0	0	2,715
Commercial/ Institutional/ Industrial	746	1,622	0	0	1,622
Governmental	-	-	0	0	-
Landscape Irrigation	563	329	0	0	329
Agriculture	-	-	0	0	-
Other	272	614	0	0	614
Total	16,932	12,105	0	0	12,105

Table 3-9. Water Deliveries, Projected 2020 (DWR Table 6)					
Water Use Sector	2020				
	Metered		Unmetered		Total Volume (ac-ft/yr)
	# Accounts	Volume (ac-ft/yr)	# Accounts	Volume (ac-ft/yr)	
Single family	15,537	7,166	0	0	7,166
Multi-family	582	2,850	0	0	2,850
Commercial/ Institutional/ Industrial	753	1,253	0	0	1,253
Governmental	-	-	0	0	-
Landscape Irrigation	592	345	0	0	345
Agriculture	-	-	0	0	-
Other	286	644	0	0	644
Total	17,749	12,259	0	0	12,259

Table 3-10. Water Deliveries, Projected 2025, 2030, and 2035 (DWR Table 7)						
Water Use Sector	2025		2030		2035	
	Metered		Metered		Metered	
	# Accounts	Volume (ac-ft/yr)	# Accounts	Volume (ac-ft/yr)	# Accounts [a]	Volume (ac-ft/yr)
Single family	16,314	7,525	17,129	7,901	17,986	8,296
Multi-family	611	2,993	642	3,143	674	3,300
Commercial/ Institutional/ Industrial	792	1,338	833	1,428	876	1,522
Governmental	-	-	-	-	-	-
Landscape irrigation	621	362	652	381	685	400
Agriculture	-	-	-	-	-	-
Other	300	677	315	710	331	746
Total	18,638	12,895	19,571	13,562	20,551	14,263

3.4.2 Projected Low Income Water Demands

One new requirement of the Act is presenting projected water demands for low income residential water uses. To fulfill this new requirement, the threshold for annual income was first determined based on documentation from the U.S. Department of Housing and Urban Development. For Davis (in Yolo County), the limit for "low income" is $26,000. Then, the proportion of population considered "low income" was determined using 2005-2009 census data for household income. The total percentage of low income population is 26.6 percent.

The percentage of low income population was then applied to the residential water demand projections to estimate the low income water demand, as summarized in Table 3-11.

Table 3-11. Low Income Projected Water Demands (DWR Table 8)					
Water Use Sector	Low Income Water Demands (ac-ft/yr)				
	2015	2020	2025	2030	2035
Single family	1,723	1,809	1,900	1,995	2,095
Multi-family	722	758	796	836	878
Total	2,445	2,567	2,696	2,831	2,973

Note: These demands are included in the demands in Tables 3-6 through 3-10.

3.4.3 Water Sales to Other Agencies

The City does not currently sell water to any other agency, and, as shown in Table 3-12, does not plan to sell water to any other agency.

Table 3-12. Sales to Other Agencies (DWR Table 9)							
Water Distributed	Sales to Other Agencies (ac-ft/yr)						
	2005	2010	2015	2020	2025	2030	2035
None	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0

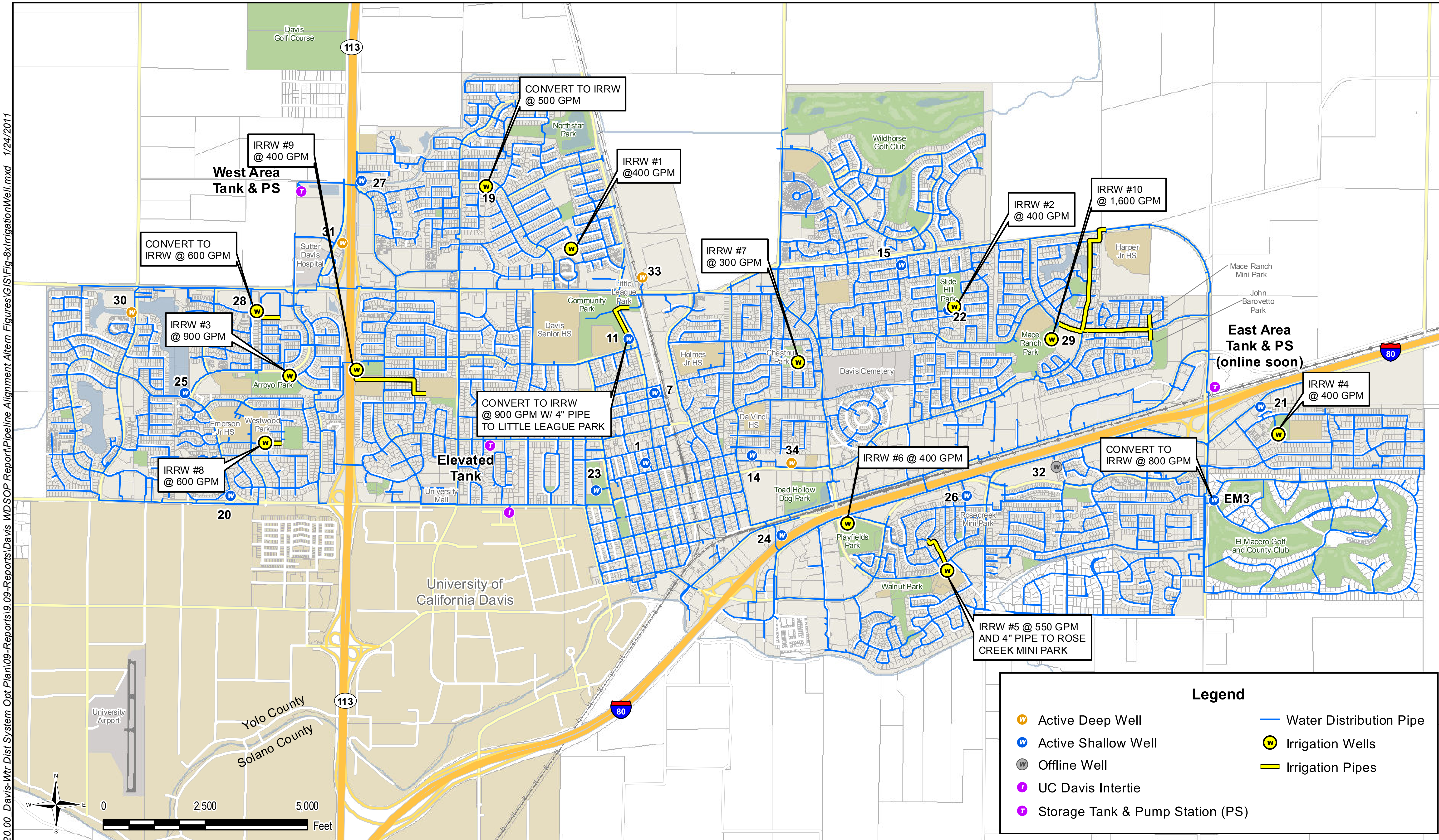
3.4.4 Non-Revenue Water and Additional Water Uses

Unaccounted-for water use is unmetered water use such as for fire protection and training, system and street flushing, sewer cleaning, construction, system leaks, and unauthorized connections. Unaccounted-for water can also result from meter inaccuracies. Table 3-13 shows additional water uses and losses. The City is planning to have the irrigation supply for some of the parks shifted from the potable water system to dedicated irrigation wells. This future additional use is shown in Table 3-13. Figure 3-2 depicts the proposed park irrigation project. Appendix F contains a water loss audit conducted for the City water system using the new American Water Works Association based spreadsheet.

Table 3-13. Additional Water Uses and Losses (DWR Table 10)							
Water use	Additional Water Uses and Losses (ac-ft/yr)						
	2005	2010	2015	2020	2025	2030	2035
Saline barriers	0	0	0	0	0	0	0
Groundwater recharge	0	0	0	0	0	0	0
Conjunctive use	0	0	0	0	0	0	0
Raw water	0	0	0	0	0	0	0
Park Irrigation	0	0	0	450	450	450	450
Recycled water[(a)]	0	0	0	0	0	0	0
System losses[(b)]	1,310	1,221	990	1,040	1,092	1,146	1,204
Total	1,310	1,221	990	1,490	1,542	1,596	1,654

(a) *Recycled water shown as zero because it is used for wetlands and agriculture, and its use does not offset potable water use.*

(b) *System losses are assumed for this Plan to be reduced by approximately 20 percent from a 9.5 percent of total production for system losses on average from 2007 through 2009 to a 7.6 percent of total projection for system losses for 2015 through 2035.*



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Brown AND Caldwell

Kennedy/Jenks Consultants
Engineers & Scientists

Davis California

WATER DISTRIBUTION SYSTEM OPTIMIZATION PLAN

Figure 3-2. Irrigation Well Improvement Project Recommendations

3.4.5 Total Water Use

The total past and future water use for the system is shown in Table 3-14. Historical and projected water demands are shown on Figure 3-3 with the upper range representing the City's per capita water use target and lower range representing additional potential water conservation that could be realized in the future. The recent decline in the City's annual water use shown on Figure 3-3 is similar to recent demand decreases experienced by other water agencies in the region as shown on Figure 3-4.

Table 3-14. Total Water Use (DWR Table 11)

Water Distributed	Total Water Use (ac-ft/yr)						
	2005	2010	2015	2020	2025	2030	2035
Total Water Deliveries (from DWR Tables 3 through 7)	12,497	10,734	12,105	12,259	12,895	13,562	14,263
Sales to Other Water Agencies (from DWR Table 9)	-	-	-	-	-	-	-
Additional Water Uses and Losses (from DWR Table 10)	1,310	1,221	990	1,490	1,542	1,596	1,654
Total	13,807	11,955	13,095	13,749	14,437	15,158	15,917

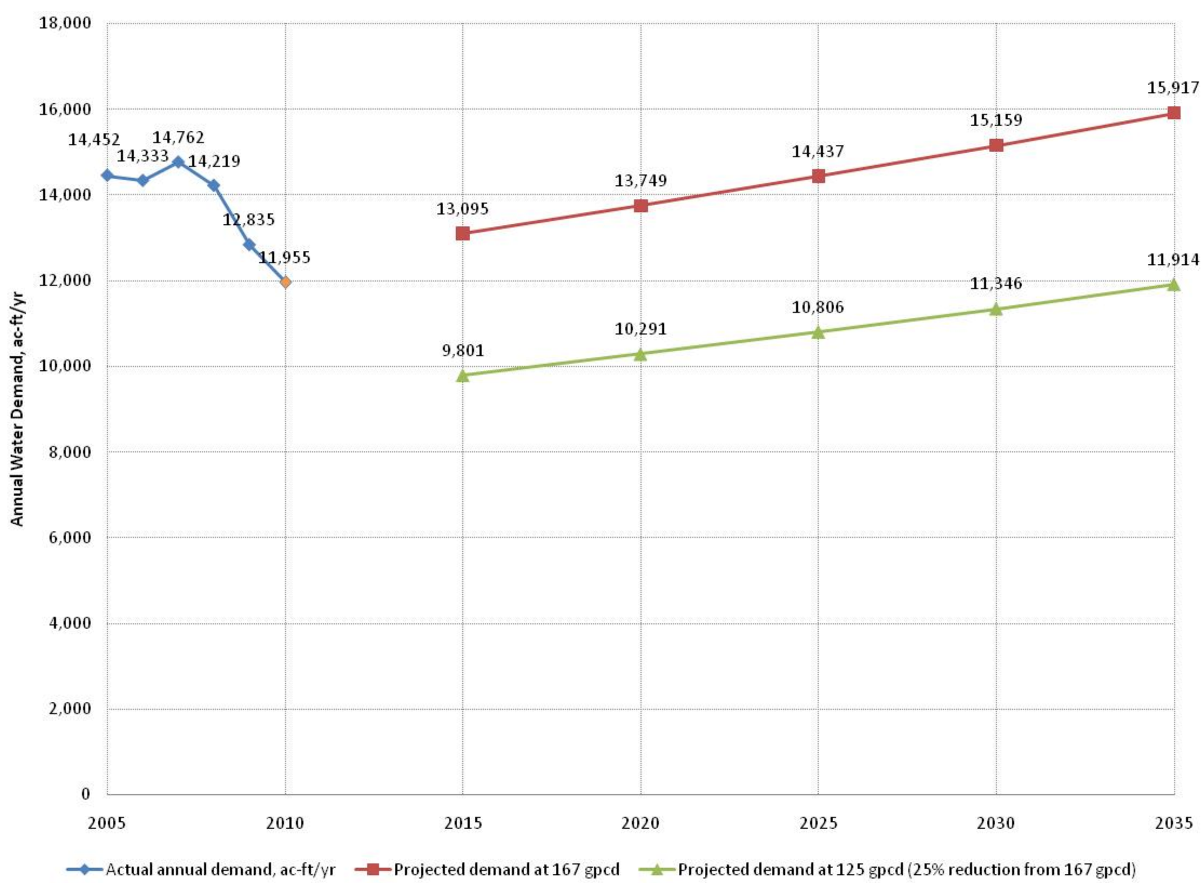


Figure 3-3. Historical and Projected Water Demands

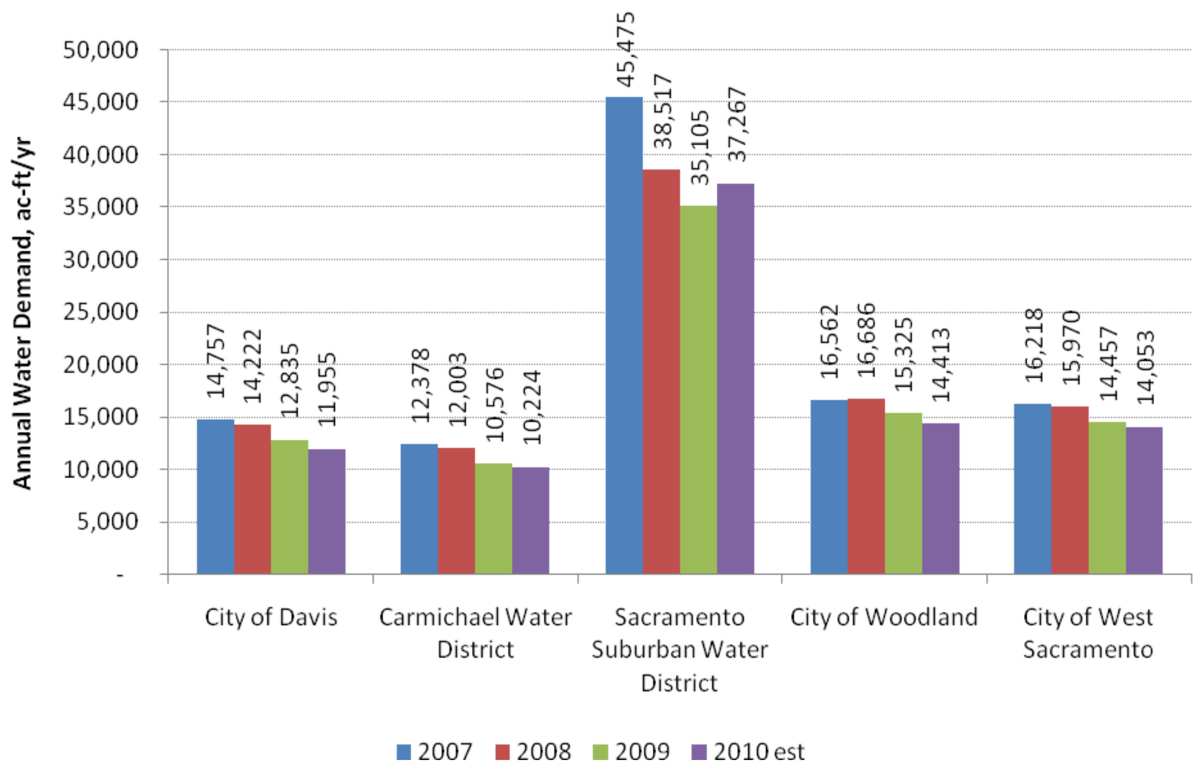


Figure 3-4. Comparison of Recent Demands from Other Agencies

3.5 Demand on Wholesale Supply

The City is expecting to receive wholesale water from the WDCWA starting in 2016. Table 3-15 shows the City's projection for wholesale water. The actual demands for wholesale water may vary depending on the amount of groundwater supply the City chooses to use in any given year.

Table 3-15. Retail Agency Demand Projections Provided to Wholesale Suppliers (DWR Table 12)

Wholesaler	Retail Agency Demand Projections Provided to Wholesale Suppliers (ac-ft/yr)						
	Contracted Volume	2010	2015	2020	2025	2030	2035
WDCWA[(a)]	17,000	0	0	13,000	13,000	13,000	17,000
Total	17,000	0	0	13,000	13,000	13,000	17,000

[(a)] *Assumes 40 mgd regional water treatment facility capacity from 2016 to 2035, then full capacity of 52 mgd by 2035.*

Section 4

Water Supply

This section describes the City's current and projected water supplies and water supply reliability. Recycled water supplies are discussed in Section 5 of this Plan.

4.1 Groundwater

The City currently uses groundwater as its sole potable water supply source. This section provides a description of the City's groundwater supply as well as the physical and legal constraints of this supply.

The City pumps from the Sacramento Valley groundwater basin, Yolo subbasin, 5-21.67. The Yolo subbasin is not adjudicated and there are no legal restrictions to groundwater pumping. DWR Bulletin 118 does not consider the basin to be in overdraft. In 2006, the City and UC Davis developed a groundwater management plan (GWMP) that focuses on the sustainability of the yield and water quality of the groundwater basin. Appendix G contains a CD of the GWMP. The amount of groundwater pumped in the last five years is shown in Table 3-2.

The amount of groundwater projected to be pumped in the next 25 years is shown in Table 4-1. The City plans to supplement the future surface water supply with groundwater from the deep aquifer to meet peak summer demands. The amounts of groundwater pumped by the City will vary from the amounts shown on Table 4-1 based on operational considerations. The City's wells will continue to have a groundwater pumping capacity greater than the amounts projected to be pumped shown on Table 4-1.

Table 4-1. Groundwater – Volume Projected to be Pumped by City (ac-ft/yr) (DWR Table 19)

Basin Name(s)	Volume Projected to be Pumped				
	2015	2020	2025	2030	2035
Sacramento Valley Groundwater Basin	13,100	1,000	1,500	2,000	2,000
Total	13,100	1,000	1,500	2,000	2,000

The City's deep aquifer zone exists throughout the service area, and is more predominant to the north and west. The deep aquifer zone slopes downward from the Plainfield Ridge, 3.5 miles west of the service area, with gradual flattening towards the east.

The productive aquifers in the Davis area of Yolo County occur in the Tehama and younger formations. In most areas of Yolo County, the sands and gravel of the Tehama Formation are thin, discontinuous layers between silt and clay deposits. In much of the eastern portion of Yolo County, productive aquifers are found up to 700 feet below ground surface with few productive aquifers in the 700-foot to 1,000-foot depth range. In the area (especially to the west), good quality water is also found in the Tehama Formation at depths of approximately 1,200 feet to 1,500 feet.

Aquifers in the Davis area are recharged by a number of sources. Deep percolation of rainfall and to a lesser extent irrigation water, are major components of groundwater recharge. Other significant sources include infiltration in streambeds, channels, and the Yolo Bypass. Relatively course-grained deposits line both Putah and Cache Creeks, allowing substantial infiltration.

Water moves very slowly between aquifers at different depths. In some places, water moves between aquifers through wells that have been screened at a number of different depths to enhance production. This causes the well columns to act as open pipes to equalize the water pressure of aquifers at different depths. The deep aquifer has a much longer recharge period as compared to the intermediate depth aquifer, on the order of thousands of years versus hundreds of years, respectively. Both the City and UC Davis are increasingly reliant on the deep aquifer due to its superior quality to water produced from the intermediate depth aquifer.

The City has few physical constraints on its groundwater supply other than the pumping capacities of existing wells. The Plainfield Ridge creates a minor restriction to east-west groundwater flow just west of the City. There are no other major restrictions to horizontal groundwater flow in the area (DWR "Bulletin 118", 2004).

4.2 Surface Water

The City currently utilizes no surface water, relying solely on local groundwater resources for its entire community water supply. The City is planning on purchasing wholesale surface water from the WDCWA use management with groundwater from deep wells. The City estimates the wholesale surface water supply to become available by 2016, after which some of the City's intermediate aquifer wells would be kept for emergency supply and the deep aquifer wells would remain online to help supply maximum day and peak hour demands.

4.3 Desalination

The City has no sources of ocean water or brackish water that provide opportunities for development of desalinated water as a water supply.

4.4 Transfer and Exchange Opportunities

Water transfer guidelines were developed in Yolo County in the early 1990s through the WRA. The goal of the guidelines is to discourage out-of-county water transfers without due process and to ensure environmental review, including mitigation of potentially significant impacts. The other facet of the guidelines is to allow flexibility for intra-county transfers which could be particularly beneficial to water users in Yolo County during a severe water shortage condition.

With regards to water transfers, the City will continue to support such guidelines and work with other agencies to facilitate intra-county transfers while making sure due process occurs in regard to any out-of-county water transfers. The City is not planning any water supply transfer and exchanges as presented in Table 4-2.

Table 4-2. Transfer or Exchange Opportunities, (ac-ft/yr) (DWR Table 20)

Transfer Agency	Transfer or Exchange	Short Term or Long Term	Proposed Quantities
None	0	0	0
Total	0	0	0

4.5 Water Quality

This section describes the water quality of the existing water supply sources within the City and the manner in which water quality affects water management strategies.

The quality of the existing groundwater supply sources and planned surface water supply sources over the next 25 years is expected to be adequate. In recent years a number of City intermediate-depth wells have been removed from service due to water quality problems, including high concentrations of nitrates, iron, manganese, and selenium. The City has constructed wells in the deep aquifer to obtain water with higher overall quality versus the current quality of water from the intermediate depth aquifer. Groundwater will continue to be disinfected, and treated as necessary to meet drinking water standards. Table 4-3 presents a comparison of the City's water supply services for several parameters that indicates the relative water quality of the different sources.

Table 4-3. Water Quality Comparison

	Hardness (CaC03)	Total Dissolved Solids
Water quality objective	110 mg/L	300 mg/L
Surface water quality (Sacramento River)	85 mg/L	100 mg/L
Groundwater Quality		
Intermediate depth wells	300 – 590 mg/L	480 - 1,000 mg/L
Deep aquifer wells	71 - 180 mg/L	270 – 340 mg/L

The challenges related to groundwater quality is one of the reasons the City is pursuing a surface water supply. There are no projected water supply changes due to water quality, as shown in Table 4-4.

Table 4-4. Water Quality – Current and Projected Water Supply Impacts (DWR Table 30)

Water source	Description of Condition	Current and Projected Water Supply Impacts (ac-ft/yr)					
		2010	2015	2020	2025	2030	2035
Surface water	Best. Will be treated to drinking water standards by WDCWA.	0	0	0	0	0	0
Supplier produced groundwater	Good. Deep aquifer good quality water. Intermediate depth aquifer has high hardness levels. Groundwater treatment necessary on some wells.	0	0	9,000[a]	9,000[a]	9,000[a]	9,000[a]
Recycled water	Treated to meet standards.	0	0	0	0	0	0
Total		0	0	0	0	0	0

[a] *Intermediate depth wells will not be used and some wells will become emergency supply only once the wholesale surface water supply becomes available.*

Water quality affects the City's water management strategies through efforts to comply with Federal and State drinking water regulations. These regulations require rigorous water quality testing, source assessments, and treatment in some cases. Drinking water quality also impacts wastewater quality and affects the City's National Pollutant Discharge Elimination System (NPDES) permit requirements regulating discharges to the environment.

4.6 Current and Projected Normal Water Year Supplies

The City's current and projected supplies are summarized in Table 4-5. These values represent the available supply, not the projected amounts to be used.

Table 4-5. Water Supplies – Current and Projected (DWR Table 16)

Water supply sources		Current and Projected Water Supplies (ac-ft/yr)					
		2010 (actual)	2015	2020	2025	2030	2035
Water purchased from:	Wholesale supplied volume (yes/no)						
Wholesaler – WDCWA	Yes	-	-	13,000	13,000	13,000	17,000
Supplier produced groundwater [(a)]		15,000	15,000	6,000	6,000	6,000	6,000
Park irrigation wells		0	0	450	450	450	450
Recycled water [(b)]		0	0	0	0	0	0
Total		15,000	15,000	19,450	19,450	23,450	23,450

(a) *Groundwater supply capacity of all wells in 2010 and 2015 to supply annual demand and deep aquifer wells only for 2020 through 2035.*

(b) *Recycled water supply is discussed in Section 5 of this Plan. Recycled water is not currently or planned to be used to replace potable water supplies. Recycled water used for wetlands and agricultural uses not shown. See Section 5 for values.*

As summarized in Table 4-6, the City's future surface water supply will include a wholesale water supply source. The wholesale water use projection has been provided to WDCWA.

Table 4-6. Wholesale Supplies – Existing and Planned Sources of Water (DWR Table 17)

Wholesaler sources	Contracted Volume (ac-ft/yr)	Projected Volume (ac-ft/yr)				
		2015	2020	2025	2030	2035
WDCWA	17,000	-	13,000	13,000	13,000	17,000
Total	17,000	-	13,000	13,000	13,000	17,000

Note: Balance of City water supplies shown in Table 4-5.

4.6.1 City's Changing Water Supply Portfolio

Figure 4-1 indicates the historic, current, and future water supply portfolio for the City since 1990. Due to the need to improve drinking water and wastewater discharge water quality, the future sources the City would plan to rely on have better water quality and results in a more diversified water supply portfolio to be better prepared to comply with water quality regulations and address climate change issues.

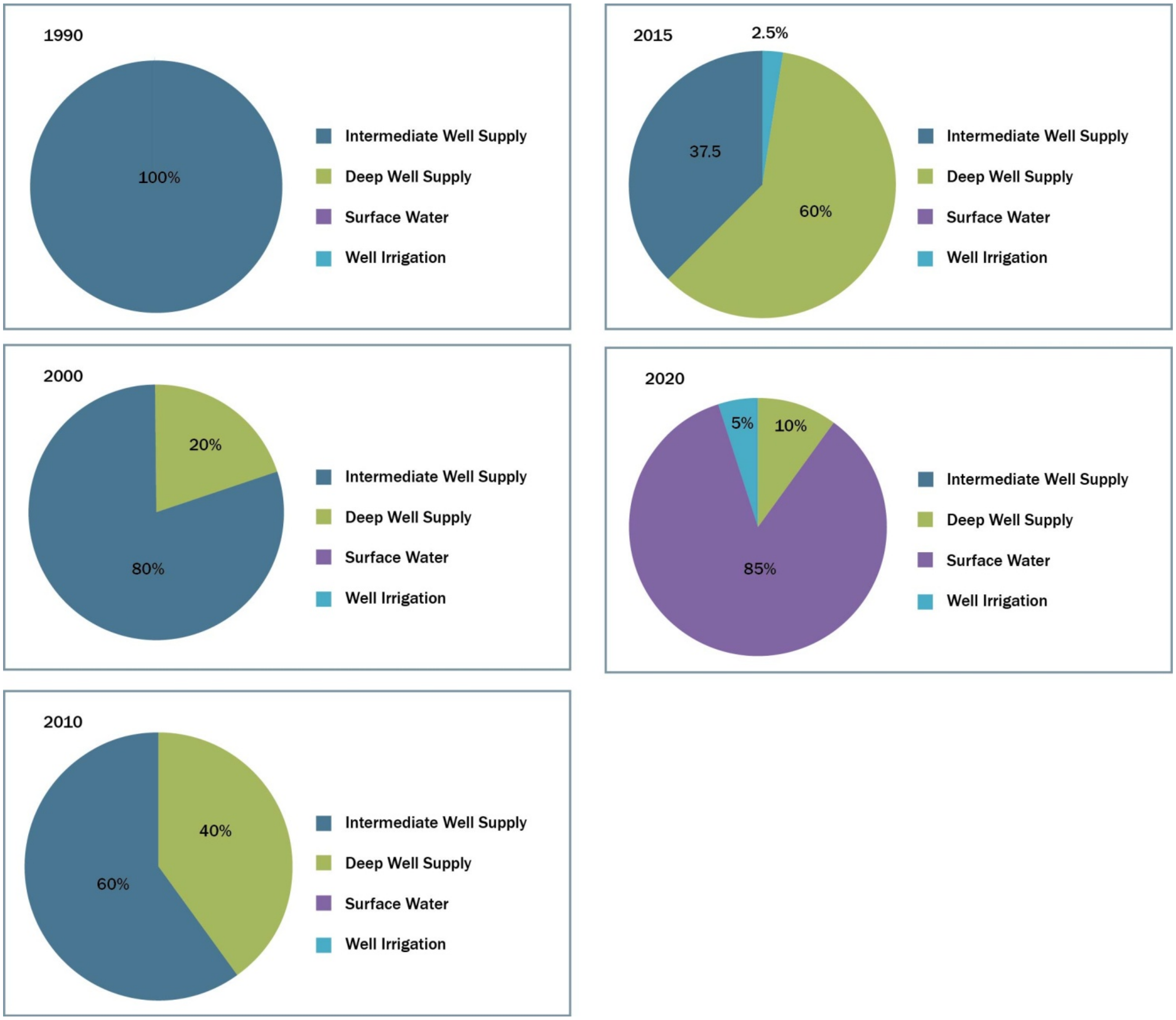


Figure 4-1. Water Supply Portfolio

4.7 Water Supply Projects

As shown in Table 4-7, the City is not planning to construct any projects that will increase water supply. The City will continue to construct wells as necessary to replace old wells and to add groundwater treatment as needed to meet drinking water standards. However, none of these projects will increase water supply.

The planned surface water project by the WDCWA will provide the City wholesale surface water in the future. The WDCWA was created in 2009 to undertake and implement a project to divert water from the Sacramento River, transmit the water for treatment to a new water treatment facility, and deliver wholesale treated surface water to the City, the City of Woodland, and UC Davis for use in their respective service areas. The City projects to receive wholesale surface water supply from the WDCWA by 2016.

Table 4-7. Future Water Supply Projects (DWR Table 26)

Project Name(a)	Projected Start Date	Projected Completion Date	Potential Project Constraints	Normal-Year Supply	Single-Dry Supply	Multiple-Dry Year First Year Supply	Multiple-Dry Year Second Year Supply	Multiple-Dry Year Third Year Supply
None, see text.								

(a)This table does not include replacement well projects to maintain existing groundwater supply capacity.

4.8 Water Supply Reliability

This section describes the reliability of the City's water supply and its variability. Climate variability as well as other factors such as earthquakes, chemical spills, and energy outages at treatment and pumping facilities can cause water supply shortages. Section 8 presents the City's water shortage contingency plan.

4.8.1 Reliability Comparison

The City's water supply quantity available from groundwater is not impacted by dry, average, or wet years. In dry years the groundwater levels may decline, but this does not reduce the pumping capacity of the City's wells. Groundwater levels have not declined in past dry years to the level that the wells do not have adequate submergence. Therefore, as shown in Table 4-8, the basis of the water year data to develop the water supply reliability is not applicable to the City's groundwater supply. As shown in Tables 4-9 and 4-10, the City's current groundwater supply is the same for average, single dry,and multiple dry water years.

Table 4-8. Basis of Water Year Data (DWR Table 27)

Water Year Type	Base Year(s)
Average Water Year	Not applicable
Single-Dry Water Year	Not applicable
Multiple-Dry Water Years	Not applicable

Table 4-9. Supply Reliability – Historic Conditions (DWR Table 28)					
Average/ Normal Water Year (ac-ft/yr)	Single Dry Year (ac-ft/yr)	Multiple Dry Years (ac-ft/yr)			
		Year 1	Year 2	Year 3	Year 4
15,000	15,000	15,000	15,000	15,000	15,000
Percent of Average Year	100%	100%	100%	100%	100%

Table 4-10. Supply Reliability – Current 2011 Water Sources (DWR Table 31)						
Water supply sources	Average/normal water year supply	Single Dry Year (ac-ft/yr)	Multiple Dry Years (ac-ft/yr)			
			Year 1	Year 2	Year 3	Year 4
Wholesaler - WDCWA	0	0	0	0	0	-
Supplier produced groundwater	15,000	15,000	15,000	15,000	15,000	15,000
Supplier produced surface water	0	0	0	0	0	-
Transfers in	0	0	0	0	0	-
Exchanges in	0	0	0	0	0	-
Recycled Water	0	0	0	0	0	-
Total	15,000	15,000	15,000	15,000	15,000	15,000
Percent of Average/Normal Year:	100%	100%	100%	100%	100%	100%

4.8.2 Factors Resulting in Inconsistency of Supply

A summary of the factors resulting in inconsistency of the groundwater supply is provided in Table 4-11. The future wholesale supply from WDCWA is also shown, although it will be WDCWA's responsibility to address these issues in their future Plan.

Table 4-11. Factors Resulting in Inconsistency of Supply (DWR Table 29)							
Water supply sources	Specific source name, if any	Limitation quantification	Legal	Environmental	Water quality	Climatic	Additional information
Wholesaler-WDCWA	Sacramento River		X	X		X	
Supplier produced groundwater	Yolo Subbasin 5-21.67	None			X		
Recycled Water		None					

Section 5

Recycled Water

The purpose of this section is to provide information on recycled wastewater and its potential for use as a water resource in the City.

5.1 Agency Coordination

The City's Department of Public Works in addition to being responsible for urban water supply, manages the wastewater collection and treatment for the domestic and industrial wastewater flows generated within the City.

5.2 Wastewater Quantity, Quality and Existing Uses

This section presents the amount of wastewater generated and disposed by the City and a description of the wastewater treatment process.

5.2.1 Wastewater Generation

Municipal wastewater in the City is generated from a combination of residential and commercial sources. The quantities of wastewater generated are proportional to the population and the water use in the service area. Estimates of the wastewater flows generated within the City for the present and future conditions are presented in Table 5-1. The source of the estimates is the population projection in Section 3 applied to historical WPCP inflow. The projected effluent that will meet reuse water quality standards for agricultural and landscape irrigation uses is also presented in Table 5-1.

Table 5-1. Recycled Water – Wastewater Collection and Treatment (DWR Table 21)

Type of wastewater	Wastewater Collection and Treatment (ac-ft/yr)						
	2005 (actual)	2010 (actual)	2015	2020	2025	2030	2035
Wastewater collected & treated in service area	6,420	5,415	5,600	5,600	5,800	6,100	6,400
Volume that meets recycled water standards	6,420	5,415	5,600	5,600	5,800	6,100	6,400

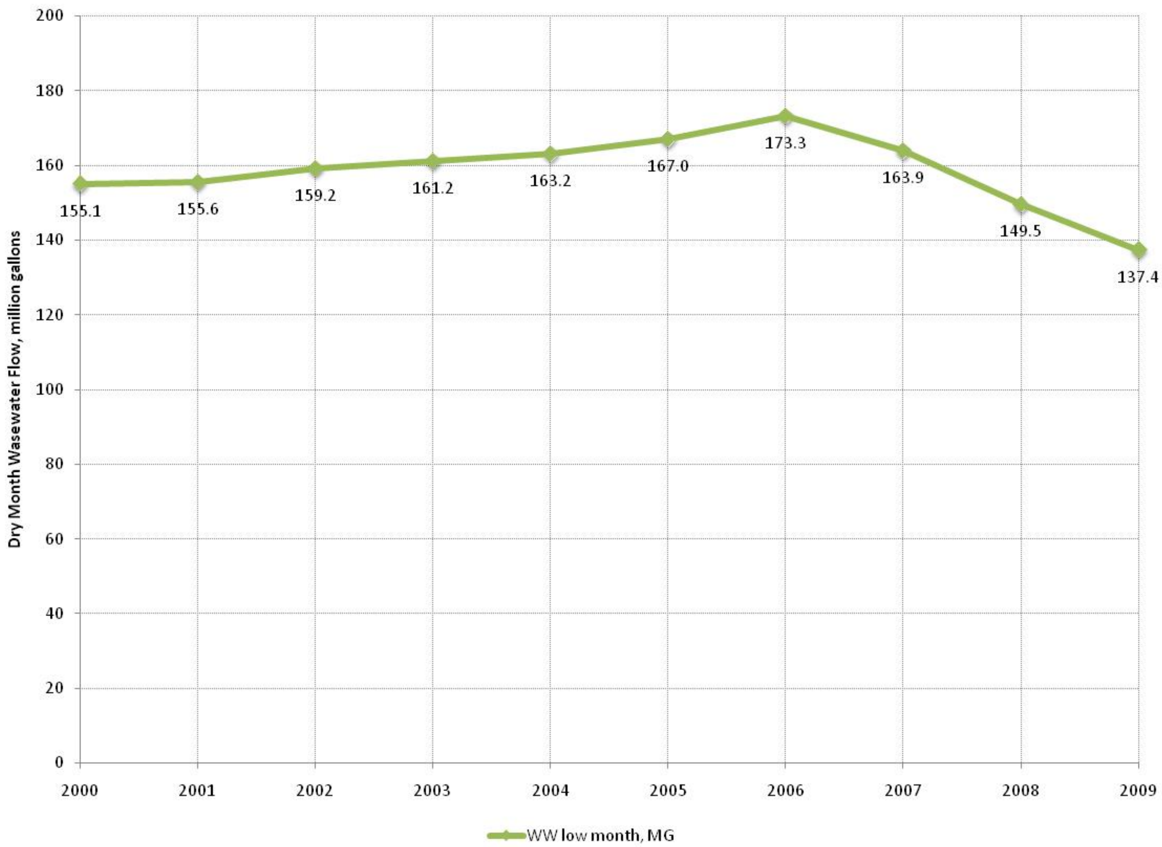


Figure 5-1. Annual Wastewater Flow

5.2.2 Wastewater Collection

The wastewater collection system in the City is a network of pipes, and lift stations that transport wastewater from its source to the treatment plant. Inflow and infiltration includes water that enters the sewer system through breaks, gaps, and joints during rain, flood, and high water table conditions. The inflow and infiltration quantities are estimated to be approximately 280 ac-ft/yr.

5.2.3 Wastewater Treatment

The City's WPCP uses a combination of both conventional and natural treatment processes to effectively meet discharge standards. The WPCP is rated at an operating capacity of 7.5 million gallons per day (mgd), with current average flows at approximately 5.3 mgd. The operations and maintenance manual recommends separate treatment trains for Spring/Summer (April through October) and Fall/Winter (November through March) operation. Current wastewater treatment at the WPCP includes the following processes:

1. Primary Sedimentation
2. Oxidation Ponds
3. Overland Flow System
4. Aerated Ponds
5. Lemna (Duckweed) Settling Pond
6. Chlorination/Dechlorination
7. Restoration Wetlands

8. Wastewater Disposal
9. Anaerobic Sludge Digestion and Drying Lagoons

Most of the current facilities at the WPCP were constructed in 1972. These facilities include a headworks, aerated grit chamber, two primary clarifiers, three oxidation ponds (120 acres total) with recirculation, gas chlorine disinfection facilities, one anaerobic digester and sludge drying lagoons. The design capacity of the original plant facilities was 5.0 mgd, but the headworks was sized large enough to allow conversion to a regional treatment plant at a later date.

In 1980, overland flow treatment facilities were constructed to provide additional suspended solids removal for oxidation pond effluent. In early 1993, the overland flow slopes were taken out of service for complete renovation in accordance with an Environmental Protection Agency (EPA) compliance order. Slopes were re-leveled, the soil was conditioned with gypsum, collection ditches were lined with cobbles, and new grass was planted. The renovated overland flow facilities started operation in the spring of 1995.

In 1988, new chlorine disinfection facilities were constructed with a capacity of 7.5 mgd, and new overland flow influent and effluent pumps were installed with a capacity of 6.3 mgd. A new transfer structure was also constructed to allow primary effluent to be blended with oxidation pond effluent.

In 1999, several improvements were made to achieve the performance needed to meet the discharge standards for an estimated capacity of 7.5 mgd, while continuing to meet the operational and reliability goals established for the plant. These improvements included:

1. Modifications to the influent pumping and preliminary treatment facilities;
2. Expansion of the primary treatment facilities;
3. Several modifications to the natural secondary wastewater treatment system, including the addition of new mechanically aerated ponds and a lemna clarification pond;
4. Changes in operational procedures for the secondary facilities in the late spring through early fall;
5. Modification to the disinfection facilities; and
6. Expansion of the solids treatment facilities.

In October 2007, the Central Valley Regional Water Quality Control Board issued a new discharge permit to the City that requires significant upgrades to effluent quality to produce treated wastewater that meets Title 22 reclamation requirements by October 2016. It is anticipated tat these upgrades will be constructed by October 7, 2016.

5.2.4 Wastewater Disposal

All effluent is either discharged to Willow Slough Bypass or is sent to 77 acres of constructed wetlands for additional treatment and potential discharge to Conaway Toe Drain (CTD) as shown in Table 5-2. The amount of treated effluent discharged to and from the constructed wetlands is metered, however effluent from Tract 7 can be recycled to supply the consumptive uses of the wildlife habitat area. The wetlands were intended to be operated by allowing effluent from the WPCP to flow through 180 acres of wetlands prior to discharge to the CTD. Excessive retention time within the wetland ponds, however, resulted in an elevated pH in the wetland effluent. As a result, five (5) wetlands tracts were converted to storm water use in order to decrease the detention time of the WPCP effluent in the constructed wetlands. If rainfall is sufficient, storm water from the wetlands storm water tracts is blended with the wetlands effluent prior to discharge to the CTD to assist with pH control. A pH adjustment facility was also constructed by City staff to maintain compliance with NPDES Permit conditions if rainfall is not sufficient to maintain the appropriate pH level.

Table 5-2. Recycled Water –Non-Recycled Wastewater Disposal (DWR Table 22)							
Method of Disposal	Treatment Level	Non-Recycled Wastewater Disposal (ac-ft/yr)					
		2010 (actual)	2015	2020	2025	2030	2035
Willow Slough Bypass	Secondary	2,322	3,480	0	0	0	0
	Tertiary by 2016	0	0	3,480	3,680	3,980	4,280
Total		2,322	3,480	3,480	3,680	3,980	4,280

5.3 Water Recycling Current Uses

Currently, the City does not use recycled water to mitigate urban demand. The City uses a portion of its secondary treated effluent as the primary source of water for approximately 77 acres of a 398-acre, City-owned reclamation wetland facility. The City continues to investigate the potential to expand its recycled water program to include irrigation on agricultural properties, application to a nearby wildlife habitat wetlands project, or possibly a combination of both alternatives.

The influent to, and effluent from, the wetlands varies by year but the estimated consumptive use by the wetlands is 340 ac-ft/yr. This consumptive use value is largely dependent on ETo, and in the summer months, would be much higher than the average, while in the winter months it is likely to be near zero.

5.4 Projected Recycled Water Use

The City has evaluated the current treatment processes at the WPCP and analyzed the economics and water quality requirements of potential recycled water projects. Preliminary analyses have shown that 100 percent reuse is an economically justifiable and environmentally beneficial solution for long term disposal. Although the proposed recycled water project is still in its planning stage, recycled water could potentially be used to offset surface water needs for both agricultural irrigation and the wildlife habitat wetlands project.

The City is in the process of developing a program to reuse a significant portion of its effluent from the WPCP. A major factor to determine which potential recycled water project becomes a projected construction project is the financial feasibility of connecting the user to the system. A recycled water distribution system will require pipelines, storage tanks, and pumps. This infrastructure is complex and costly to construct. In addition, the recycled water user must make their own investment in constructing and operating the on-site irrigation pipelines and sprinkler systems together with the necessary warning signs, backflow prevention, and associated health and safety requirements.

The volume of potential recycled water use is summarized in Table 5-3. This table estimates the use of recycled water for various uses at five-year intervals.

Table 5-3. Recycled Water – Potential Future Use (DWR Table 23)							
User type	Description	Feasibility	Potential Future Use (ac-ft/yr)				
			2015	2020	2025	2030	2035
Agricultural irrigation	Secondary		--	--	--	--	--
	Tertiary		1,050	1,050	1,050	1,050	1,050
Landscape irrigation			--	--	--	--	--
Commercial irrigation			--	--	--	--	--
Golf course irrigation [a]	Tertiary		--	--	--	--	--
Wildlife habitat			--	--	--	--	--
Wetlands	Secondary		1,070	1,070	1,070	1,070	1,070
Industrial reuse			--	--	--	--	--
Groundwater recharge			--	--	--	--	--
Reuse within plant			--	--	--	--	--
Total			2,120	2,120	2,120	2,120	2,120

[a] *Not considered economically viable, but potential use at Wild Horse golf course*

The City's 2005 Urban Water Management Plan made future projections for recycled water use. A comparison of this projection with the actual use in 2010 is shown in Table 5-6.

Table 5-4. Recycled Water – 2005 UWMP Use Projection Compared to 2010 Actual (DWR Table 24)		
User Type	2010 Actual Use (ac-ft/yr)	2005 Projection for 2010 (ac-ft/yr)
Agricultural Irrigation		1,050
Landscape Irrigation	61	
Commercial Irrigation		
Golf Course Irrigation		
Wildlife Habitat		
Wetlands	2,000	1,170
Industrial Reuse		
Groundwater Recharge		
Seawater Barrier		
Geothermal/ Energy		
Indirect Potable Reuse		
Total	2,061	2,220

5.5 Optimizing the Use of Reclaimed Water

This section discusses how the City promotes the use of recycled water and the optimization plan for recycled water use.

5.5.1 Promotion of Recycled Water Use

The City would provide recycled water to the preferred reclamation project alternatives, which would include Conaway Ranch, Swanston Ranch, or other agricultural users interested in pursuing a long term mutually beneficial arrangement. In return, the City would require a long term use agreement to assure that all recycled water produced in the future would be used by the chosen projects. Methods to encourage recycled water use are listed in Table 5-5.

Table 5-5. Methods to Encourage Recycled Water Use (DWR Table 25)

Actions	Projected Results (ac-ft/yr)				
	2015	2020	2025	2030	2035
Financial Incentives [a]	TBD	TBD	TBD	TBD	TBD
Public Outreach	0	0	0	0	0
Total [a]	TBD	TBD	TBD	TBD	TBD

[a] *TBD, to be determined. This matter is currently under investigation by the City.*

5.5.2 Optimization Plan for Recycled Water

To optimize the use of recycled water, cost/benefit analyses will be conducted for each project alternative. These alternatives will then be ranked from highest to lowest net benefit so that the most balanced option can be implemented. Once the preferred alternative has been chosen, the City will work closely with the landowner(s) to optimize the use of recycled water.

Section 6

Water Conservation

Water conservation is one available method to reduce water demands, thereby reducing water supply needs for the City. This section describes the City's water conservation efforts.

6.1 California Urban Water Conservation Council (CUWCC)

The unpredictable water supply and ever increasing demand on California's complex water resources have resulted in a coordinated effort by the DWR, water utilities, environmental organizations, and other interested groups to develop a list of urban Best Management Practices (BMPs) for conserving water. This consensus-building effort resulted in a Memorandum of Understanding Regarding Urban Water Conservation in California (MOU), which formalizes an agreement to implement these BMPs and makes a cooperative effort to reduce the consumption of California's water resources. The MOU is administered by the California Urban Water Conservation Council (CUWCC).

The City, a signatory to the California Urban Water Conservation Council's Memorandum of Understanding since August 1994, has submitted their demand management implementation progress to the BMP Reporting Database. BMP reports for reporting years 2009-2010 are included in Appendix H. Table 6-1 presents the water conservation BMPs as recently revised by the CUWCC. Foundational BMPs are required of all MOU signatories. Programmatic BMPs are optional depending on the selected implementation track.

6.2 Demand Reduction Strategies

The City will have to meet the 2020 gpcd target. A combination of the installation of low flow devices, reduction of distribution system and customer leaks, implementation of outdoor landscaping measures, and price elasticity impacts will reduce demands. The priority will be focused on measures that reduce long term maximum day and peak hour demands that would benefit cost-effective infrastructure planning efforts.

6.2.1 Water Rates and Price Elasticity

Price elasticity as it pertains to the water supply field refers to the reduction in water use that occurs as a result of an increase in the cost of water. As rates increase, water use is expected to decrease. Utility rates for water and wastewater can impact summer and winter water use, respectively. As Tier 2 water rates increase there would be an impact on summer water use because customers would be encouraged to reduce Tier 2 water use that typically occurs in the summer months. Wastewater rates that are based on winter water use would encourage customers to reduce winter water use. Figure 6-1 illustrates the potential impact that utility rates can have on both summer and winter water use.

6.2.2 Park Irrigation Improvements

The City is considering future improvements to its municipal parks that reduces long term water use and site maintenance requirements. This would include both re-designing existing sites with lower water using features and installing dedicated irrigation wells to serve the largest park sites with non-potable (untreated intermediate well) water sources.

The City is planning to convert the water supply for some of the City's parks from the potable water system to dedicated irrigation wells. This would be accomplished by either drilling new dedicated wells at specific sites or converting existing intermediate depth wells to solely supplying landscape irrigation water. This park irrigation project will reduce annual and maximum day demands on the potable water system, as shown on Figure 6-1. These improvements can be phased in over time or implemented as a single large project.

The City is planning future modifications to its existing parks that would include site improvements that reduce water and maintenance requirements such as use of drought tolerant plants, rainwater harvesting, reduction of turf areas, and audit of existing irrigation systems to identify water use targets and optimal irrigation schedules. Projects being considered include: Cedar Park which would eliminate all existing turf throughout park paths and play spaces and replace with no-mow, low maintenance grass and permeable, light colored paving; West Manor Park which would remove one-third of the existing lawn area and establish a 100 percent on-site water retention goal. Appendix M presents the conceptual designs that have been developed for the park improvements.

These proposed park projects require identification of funding sources and City Council approval before they are implemented. The park projects do not represent the complete list of possible projects that the City could implement to reduce the water demands of City facilities.

Table 6-1. Water Conservation Best Management Practices Listed in MOU					
Revised (Current) CUWCC BMP Category			Former CUWCC BMP Name		Implemented
Category	BMP No.	BMP Name	BMP No.	BMP Name	
Foundational BMPs	BMP 1	Utility Operations			
	BMP 1.1	Operations Practices			
	BMP 1.1.1	Conservation Coordinator	12	Conservation Coordinator	✓
	BMP 1.1.2	Water Waste Prevention	13	Water Waste Prohibition	✓
	BMP 1.1.3	Wholesale Agency Assistance	10	Wholesale Agency Assistance Programs	Not applicable
	BMP 1.2	Water Loss Control	3	System Water Audits, Leak Detection, and Repair	✓
	BMP 1.3	Metering with Commodity Rates	4	Metering with Commodity Rates for all New Connections and Retrofit of Existing Connections	✓
	BMP 1.4	Retail Conservation Pricing	11	Conservation Pricing	✓
	BMP 2	Educational			
	BMP 2.1	Public Information	7	Public Education Programs	✓
	BMP 2.2	School Education	8	School Education Programs	✓
Programmatic BMPs	BMP 3	Residential			
	BMP 3.1	Residential Assistance	1 & 2	Water Survey Programs for Single-Family and Multi-Family Residential Customer (Indoor) and Residential Plumbing Retrofit	✓
	BMP 3.2	Landscape Water Survey	1	Water Survey Programs for Single-Family and Multi-Family Residential Customer (Outdoor)	✓
	BMP 3.3	High-Efficiency Clothes Washers	6	High-Efficiency Washing Machine Rebate Programs	✓
	BMP 3.4	Water Sense Standard (WSS) Toilets	14	Residential ULFT Replacement Programs	✓
	BMP 3.5	Water Sense Standard (WSS) for New Residential Development	(new)		
	BMP 4	Commercial Industrial Institutional (CII)	9	Conservation Programs for Commercial, Industrial, and Institutional Accounts	✓
	BMP 5	Landscape	5	Large Landscape Conservation Programs and Incentives	✓

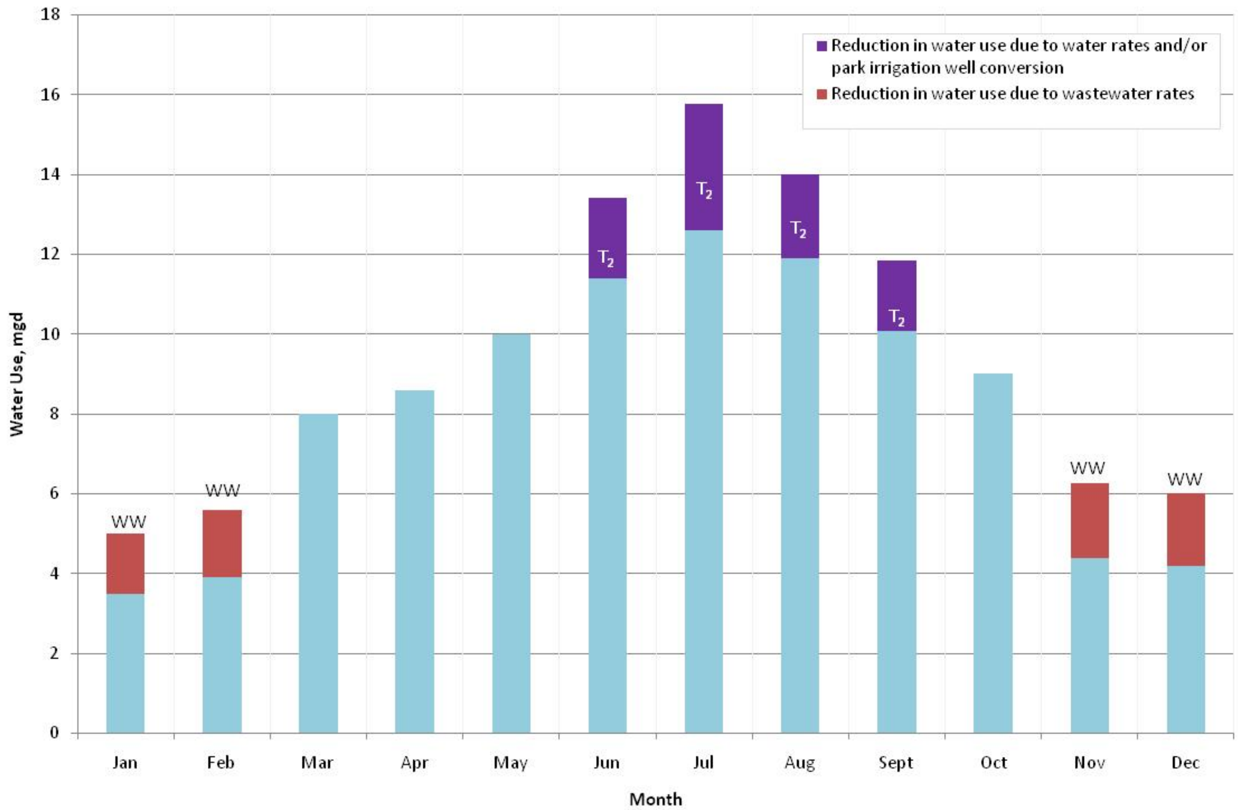


Figure 6-1. Impact of Utility Rates and Park Irrigation Conversion on Water Use

6.2.3 Landscape Ordinance

In November of 2010, the City adopted a local ordinance in compliance with the state requirements under the Water Conservation in Landscaping Act of 2006. The City's Water Efficient Landscape Ordinance is based on the model ordinance provided by the state and is consistent with state requirements. A copy of the City's ordinance is provided in Appendix I.

6.2.4 Plumbing Efficiency Standards

Over time, efficiency standards have increased the required efficiency of indoor appliances and facilities including dishwashers, clothes washers, showerheads, and toilets. Table 6-2 shows the requirements from before 1982 to projected to occur in the future. Currently there are two chaptered regulations (Assembly Bill (AB) 715(Laird 2007) and SB 407 (Padilla 2009)) as well as the CALGreen Building Standards that have impacts on efficiency standards. Between these three regulations there is some degree of confusion or uncertainty regarding what happens when, and how it happens. Specifically this relates to water efficiency measures, as altered by the regulations' effect on the plumbing code and building standards. Appendix J contains a writeup by the CUWCC that discusses these regulations and finds in conclusion that these laws are not found to be contrary, but simply "one-up" each other as dates pass and action is taken. The more stringent restrictions of AB 715 and the CALGreen Code will supersede the equipment flow standards included in SB 407. The most significant implementation challenge of these laws is enforcement.

Table 6-2. City of Davis Water Conservation Program - Efficiency Standards Over Time							
SFR Indoor Use	Unit	GPHD	% Use	Pre-1982	Pre-1992	Pre-2011	2011+
Toilets	gpf	39.1	22%	5	3.5	1.6	1.28
Showerheads	gpm	33	19%	3.5-5.0	3.5	2.5	2.5
Clothes Washers	gpl	26.9	16%	45	40	25	17-20
Dishwashers	gpl	1.9	1%	13+	10+	5.8	<5.0
Faucets	gpm	27.2	16%	3	3	2	2
Bath		2.8	2%				
Other		2.6	2%				
Leaks		37.4	22%				
Total		171	100%				

Notes:
Indoor Average Use: based on 2006 Davis SFR End Use Study results.
GPHD = gallons per home per day.
gpf = gallons per flush; gpm = gallons per minute; gpl = gallons per load

The End Use Study presented in Appendix K identifies low flow toilets and high efficiency clothes washers as opportunities where the penetration into the customer base still has significant room to grow. Table 6-3 presents an evaluation of indoor single family residential water savings that could be realized from increasing the saturation of some low flow devices to 75 percent and reducing customer leakage. Penetration or saturation refers to the extent or number of customers that have low flow devices installed. These measures would reduce water use by 7 gpcd. Additional water savings would be expected from applying the same measures to the other customer categories such as multifamily residential and commercial. Note that the penetration of low flow devices will naturally increase as customers replace old fixtures and new homes are constructed. Also, new retrofit on resale requirements will become effective in 2016 and 2017. Rebate programs serve to merely accelerate the conversion process.

Table 6-3. Evaluation of Indoor Water Savings per Single Family Connection from Increased Penetration of Low Flow Devices								
Fixture	Average SF indoor water use, End Use Study, gpd/SF con	Actual 3-yr aver SF indoor water use, gpd/SF con	Water use for SF with low flow devices, gpd/SF con	2006 Low flow device penetration, %	Water use for non-low flow SF, gpd/SF con	Average SF indoor water use at 75% penetration/25% leakage reduction, gpd/SF con	Reduction, gpd/SF con	Per capita water use reduction @ 3.0 people/SF con
Toilets	39.1	--	25.4	22%	43.0	29.8	9.3	3.1
Clothes washer	26.9	--	24.3	45%	29.0	25.5	1.4	0.5
Shower	33.0	--	44.1	87%	44.1	33.0	0.0	0.0
Leakage	37.4	--	37.4	--	37.4	28.1	9.4	3.1
Faucet	27.2	--	27.2	--	27.2	27.2	0.0	0.0
Bath	2.8	--	2.8	--	2.8	2.8	0.0	0.0
DW	1.9	--	1.9	--	1.9	1.9	0.0	0.0
Other	2.6	--	2.6	--	2.6	2.6	0.0	0.0
Total indoor use	170.9	193	165.7	--	188.0	150.8	20.1	6.7

Note: See Appendix K – SFR End Use Study

6.2.5 Water System Losses

Figure 6-2 illustrates the water system diurnal demand during winter and summer periods. On this figure the average diurnal demand curve for December and January is illustrated. In this region, due to winter precipitation, December and January use is typically considered 95 to 100 percent of indoor use. As shown on the diurnal curve for December and January, there is water use in the early morning time period from 2 to 4 am of 3,000 gpm which is equivalent to almost 5 mgd. It is assumed that at least 50 percent of the water use during this time period in winter months is attributed to system and customer leaks since there is typically very minimal outdoor water use this time of year. Reducing water system and customer leaks is a target for future outdoor water conservation efforts. The water system audit is presented in Appendix F. The audit should be updated with more accurate input data on a regular basis and it can be a good tool for assessing leak losses occurring at any given time.

The City's monthly water use by customer category over a three year period is shown in Figure 6-3. The difference between total water production and total water sales is shown as unaccounted-for water. As shown in Figure 6-3, the unaccounted-for water is higher in the summer months compared to the winter months.

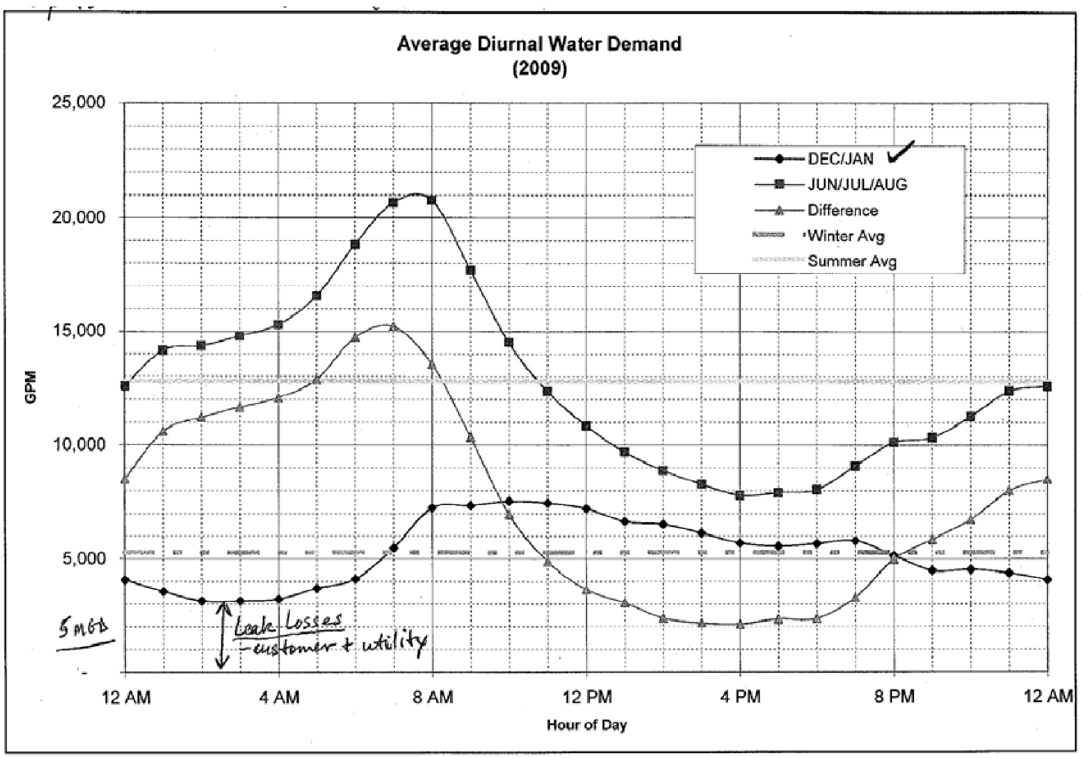


Figure 6-2. 2009 Diurnal Water Demand During Winter and Summer Periods

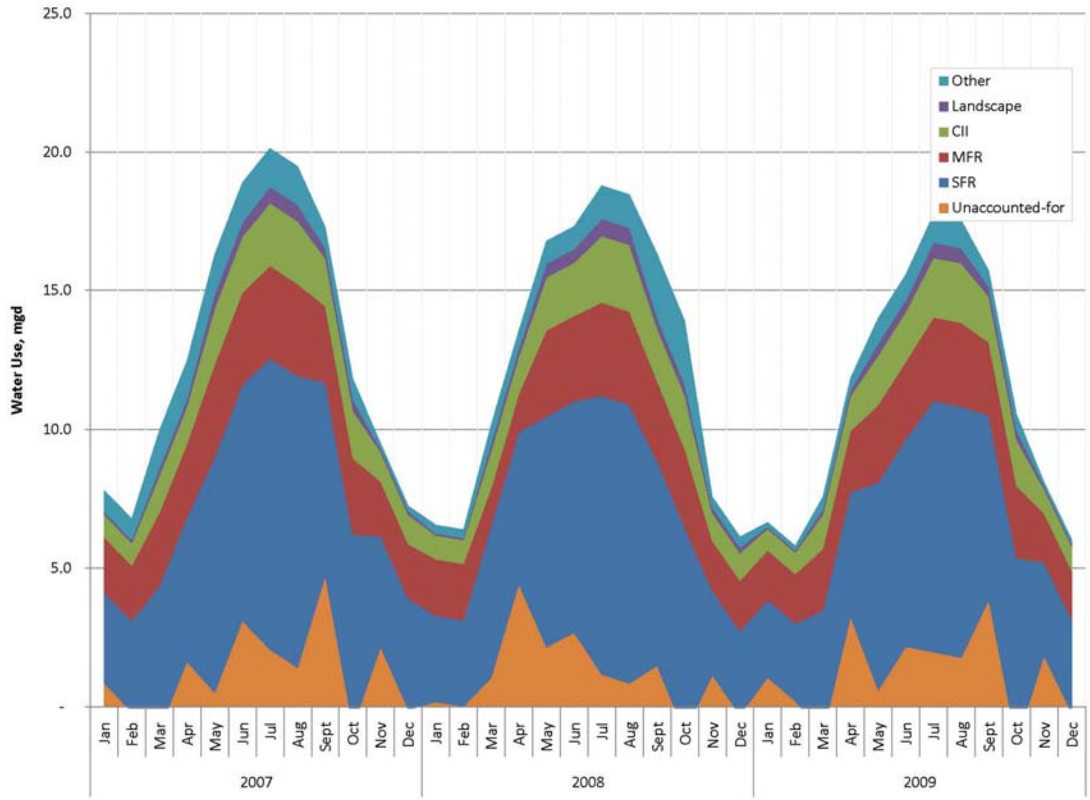


Figure 6-3. Monthly Water Use by Category

6.2.6 Possible Conservation Approach

Table 6-4 presents an approach to meeting the 2020 gpcd target through a combination of:

1. Increasing the penetration of low flow toilets and high efficiency clothes washers for single family residential customers to 75 percent and reducing single family residential customer leaks by 25 percent. This is 7 gpcd water savings calculation presented in Table 6-4. Reducing customer leakage would require an automatic meter reading system so that the City could rapidly identify customer leaks. The current method of reading a customer meter every two months cannot identify customer leaks.
2. Reducing outdoor residential water use by 15 percent.
3. Reducing CII indoor water use by 5 percent.
4. Reducing outdoor CII, landscape, and other water use by 10 percent.
5. Reducing unaccounted for water use by 25 percent.

This approach is an example of the possible water savings from a given combination of actions.

Table 6-4. Approach to Meeting the 2020 gpcd Target				
	3-yr aver, gpcd	Future, gpcd	Remarks	ac-ft/yr savings
Residential indoor	64	57	toilet and CW 75% penetration, 25% leakage reduction	539
Residential outdoor	64	55	15% reduction	789
CII indoor	11	10	5% reduction	45
CII outdoor	12	10	10% reduction	94
Landscape indoor	1	1	0% reduction	--
Landscape outdoor	4	3	10% reduction	29
Other indoor	3	2	0% reduction	22
Other outdoor	9	9	10% reduction	78
Unaccounted-for	17	13	25% reduction	356
Total	185	161	--	1,952

Figure 6-4 illustrates the City's 2007 through 2010 total single family residential water use. As seen on this figure, the single-family residential water use has been decreasing in recent years.

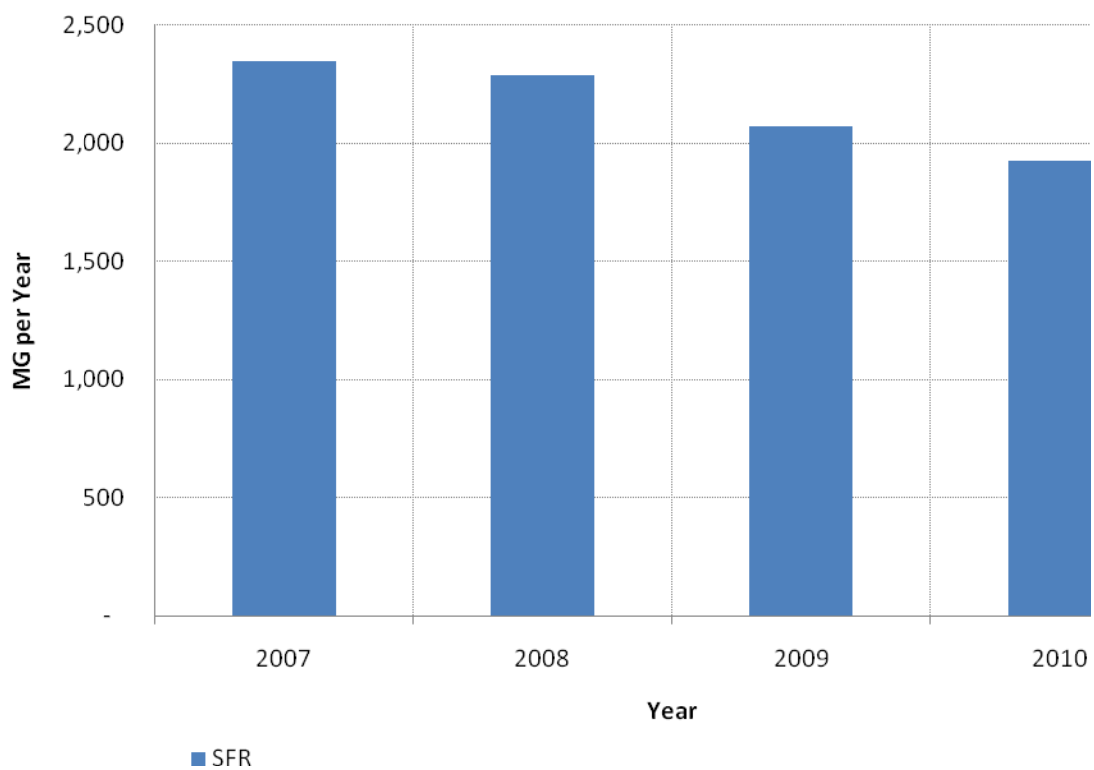


Figure 6-4. Single Family Residential Historical Water Use

Figure 6-5 compares the current gpcd breakdown to the gpcd breakdown that would result from the example approach to meeting the gpcd target.

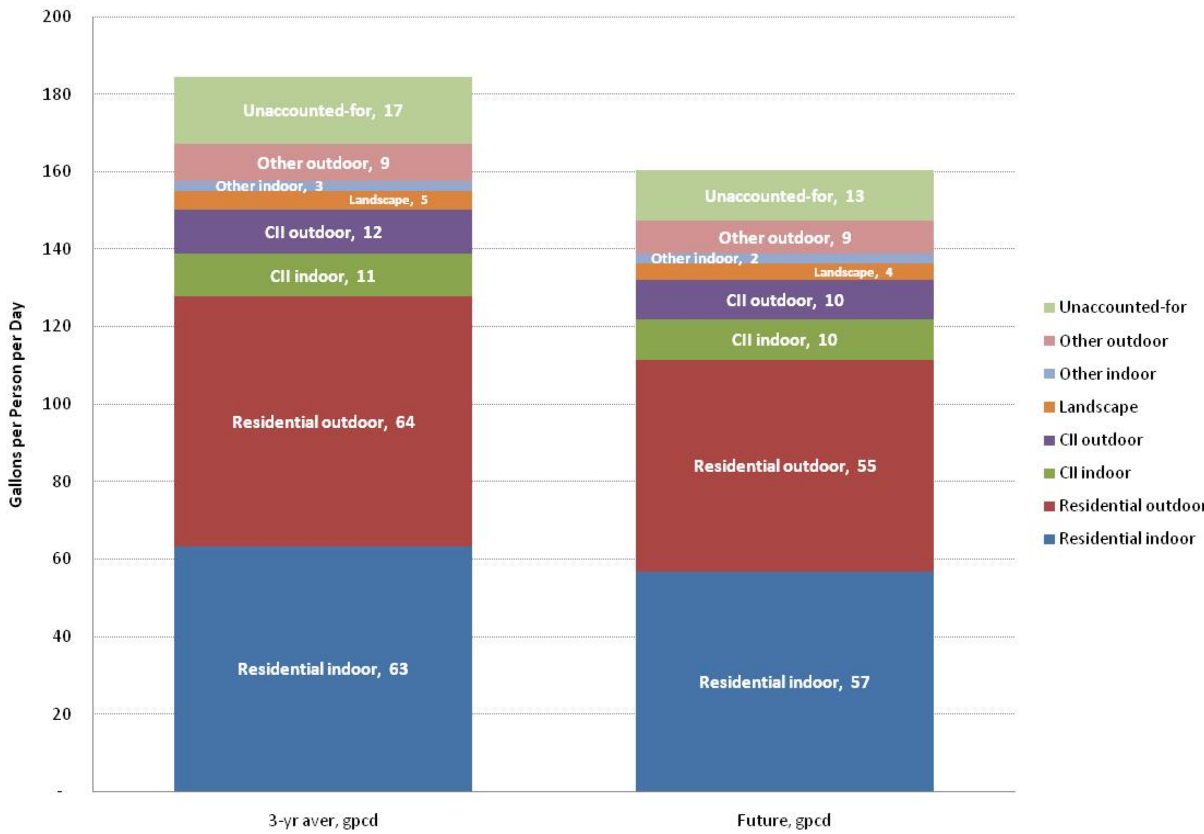


Figure 6-5. Current and Future gpcd Breakdown

6.2.7 Conservation Recommendations

The City will have to meet the gpcd water target mandate in the new legislation. The City has already made significant progress to improving water use efficiency. Further reductions in water use, particularly maximum day and peak hour demand, would provide the benefit of downsizing and/or delaying the construction of new water supply facilities. The City will have to conduct further planning to identify the best mix of conservation actions to implement. As conceptually depicted in Table 6-5 and Figure 6-6, increasing conservation efforts should result in lower per capita water use. Table 6-5 conceptually indicates the additional investments in water conservation that would be required to reliably further reduce per capita water demand.

Following are recommendations for the City to consider:

1. Refine the current water conservation program to focus on reducing peak demands so as to provide facility capacity size benefits, reduce use of higher cost peak period energy, minimize impacts on customers, and be cost effective. Define the optimal level of water conservation investment to maximize the cost savings from reduced sizes of facilities. The key elements of the program would include:

    a. Customer leak reduction after implementation of automatic meter reading.

   b. Distribution system leak reduction.
   c. Reduction of summer demands by focusing on outdoor water use measures.
   d. Monthly billing to send a quicker price signal to customers.

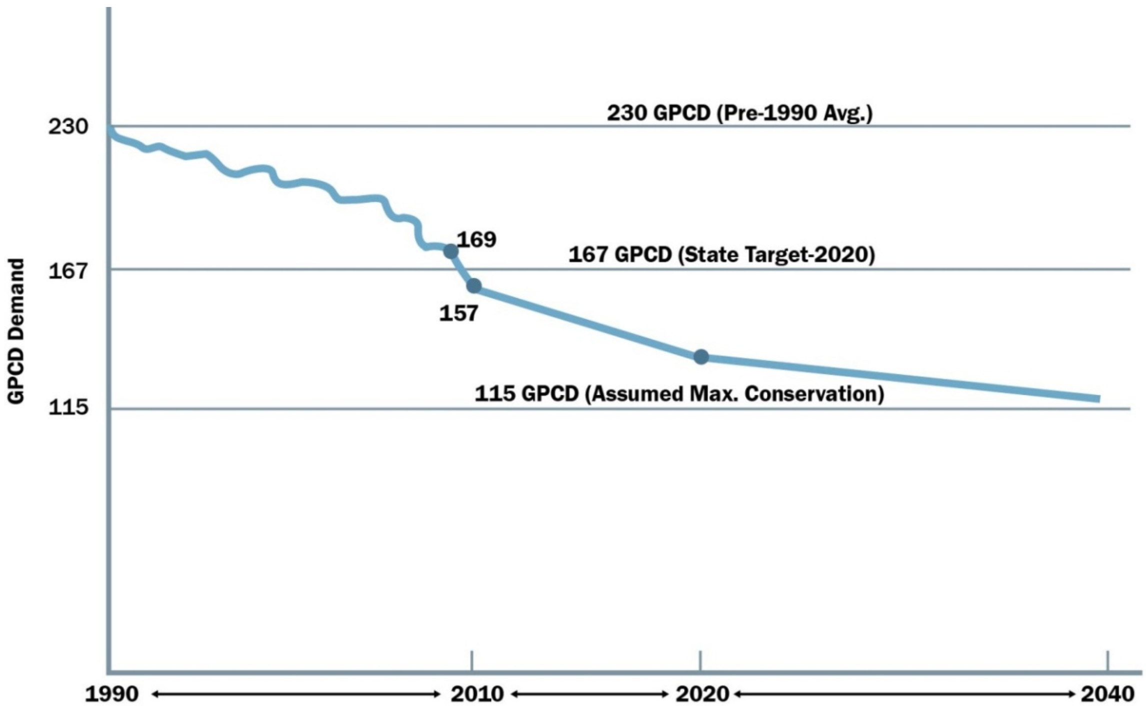
2. Develop a projection of the future peak hour demand that would result from meeting the 2020 gpcd target.
3. The City needs to collect adequate water revenues in an enviroment of declining per capita water use. The City's rate setting process needs to be based on a projection of the future water demands that incorporates the pricing effect on customer water use. Conduct an analysis of the likely impact on water use due to the price elasticity impacts of increased water rates. Consider the impact on water use due to water rate revisions that would occur from the implementation of the Davis Woodland Clean Water Project. Evaluate number of tiers, tiered water use levels, and price points.
4. Update the water system audit conducted in 1997, and use the new AWWA approach.
5. Improve the accuracy of measurements of the water used by City facilities.
6. Conduct a survey using a representative sample of customers to gauge the penetration of low flow devices with emphasis on multifamily residential customers.
7. Assess the extent of leaks being experienced by customers. Expand the work done in the End Use Study to also include other categories of customers.
8. Develop a "dashboard" approach to monitoring key water use indicators so that the City and its customers have real time knowledge regarding being on track to meet the gpcd goal.
9. Consider removing some landscaped areas from the potable water system by converting their supply to dedicated intermediate depth wells.
10. Develop a 10-year water conservation program and budget that meets new water use targets with the option to pursue the aggressive water conservation EIR targets if facility cost savings substantiate this approach.

Table 6-5. Water Conservation Actions and Demands

Water Conservation Actions	0% [a]	5% [a]	10% [a]	15% [a]	20% [a]	25% [a]
	167[b]	158.7[b]	150.3[b]	142.0[b]	133.6[b]	125.3[b]
Metered retrofit	X	X	X	X	X	X
Metered rates (water and sewer)	X	X	X	X	X	X
Some low flow fixture conversions	X	X	X	X	X	X
Minimal leak reductions	X	X	X	X	X	X
Initial water management improvements	X	X	X	X	X	X
$5M+ investment in water conservation		X	X	X	X	X
Increasing metered rates		X	X	X	X	X
Higher low flow fixture conversions		X	X	X	X	X
Higher leak reductions			X	X	X	X
Improving water management			X	X	X	X
Minimal landscape conversion (5-10%)			X	X	X	X
$7M+ investment in water conservation				X	X	X
Multiple tiered metered rates				X	X	X
Maximum low flow fixture conversions				X	X	X
Maximum leak reductions					X	X
Technology driven water management improvements					X	X
Some landscape conversion (>10%)					X	X
Maximum non-potable irrigation for City facility/institutional sites						X

[a] *Percent reduction from 167 gpcd*

[b] *Resulting gpcd*



1990-2010 (230 gpcd to 167)	2010-2020 (167 gpcd to 126)	2020-2040 (126 gpcd to 115)
- Metered retrofit - Metered rates (water and sewer) - Some Low Flow Fixture Conversions - Minimal leak reductions - Initial water management improvements - 5M+ investment in water conservation	- Increasing metered rates - Higher Low Flow Fixture Conversions - Higher leak reductions - Improving water management - Minimal landscape conversion (5-10%) - 7M+ investment in water conservation	- Metered rates leveling out - Maximum Low Flow Fixture Conversions - Maximum leak reductions - Technology-driven water management improvements - Some landscape conversion (>10%) - Maximum non-potable irrigation for City Facility/Institutional sites - Investment: highest (TBD)

Figure 6-6. Water Conservation Potential

Section 7

Water Supply Versus Demand Comparison

This section provides a comparison of projected water supplies to demands and identifies any water shortage expectations. The City does not experience any water shortages with exclusive groundwater supplies. Furthermore, once surface water supplies are available, water shortages are likewise not projected with the deep aquifer groundwater supply helping to supplement surface water supply reduction meet during those dry years when surface water is reduced.

7.1 Supply and Demand Comparisons

This section provides a comparison of normal, single dry, and multiple dry water year supply and demand for the City. Water demands are addressed in Section 3, water supply is addressed in Section 4, and recycled water supply is addressed in Section 5 of this Plan.

Normal Water Supply Years. Table 7-1 presents a comparison of the supply and demand during a normal precipitation year in five-year increments from 2010 to 2035. Figure 7-1 illustrates the comparison between the projected normal year supply and demand for the City.

Table 7-1. Supply and Demand Comparison – Normal Year (DWR Table 32)

	Supply and Demand Comparison – Normal Year (ac-ft/yr)					
	2010	2015	2020	2025	2030	2035
Supply totals	15,000	15,000	19,450	19,450	19,450	23,450
Demand totals	11,955	13,095	13,749	14,437	15,158	15,916
Difference	3,045	1,905	5,701	5,013	4,292	7,534
Difference as percent of supply	20%	13%	29%	26%	22%	32%
Difference as percent of demand	25%	15%	41%	35%	28%	47%

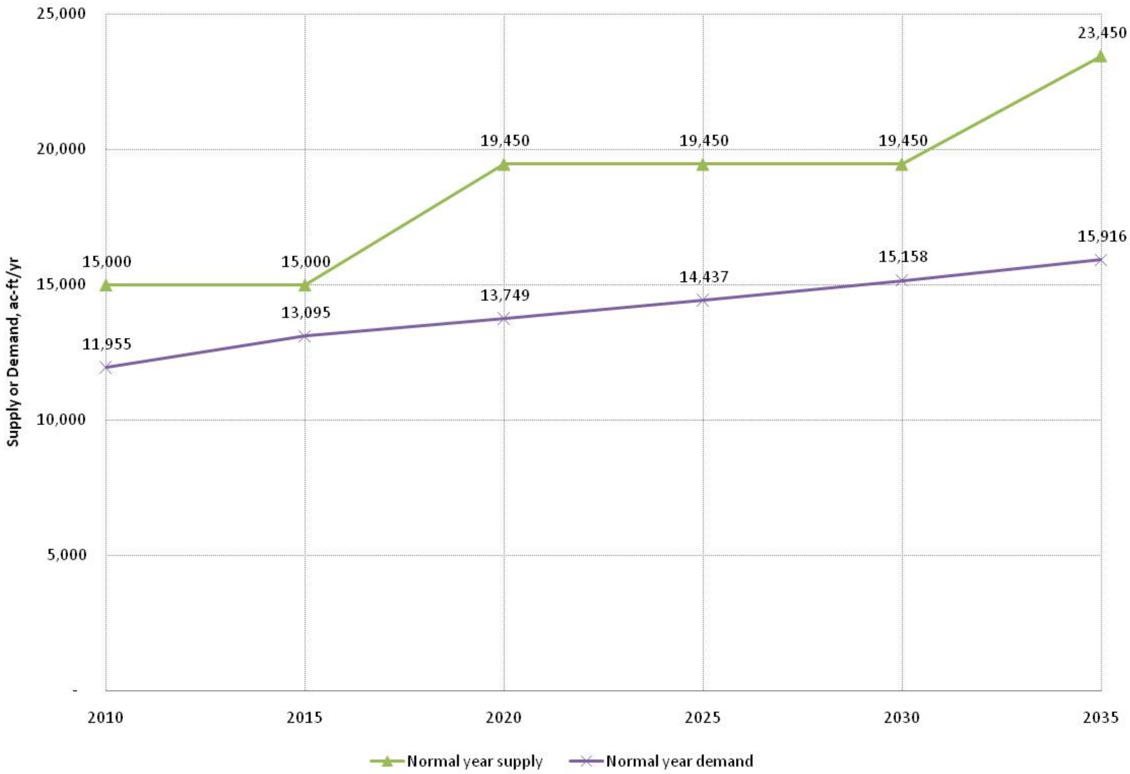


Figure 7-1. Comparison of Projected Normal Year Supply to Demand

Single and Multiple Dry Water Years. The projected water supplies are compared to the demands for a single dry year for the City in Table 7-2.

Table 7-2. Supply and Demand Comparison – Single Dry Year (DWR Table 33)

	Supply and Demand Comparison – Single Dry Year (ac-ft/yr)					
	2010	2015	2020	2025	2030	2035
Supply totals	15,000	15,000	19,450	19,450	19,450	23,450
Demand totals	11,955	13,095	13,749	14,437	15,158	15,916
Difference	3,045	1,905	5,701	5,013	4,292	7,534
Difference as percent of supply	20%	13%	29%	26%	22%	32%
Difference as percent of demand	25%	15%	41%	35%	28%	47%

Table 7-3 compares supply and demand totals for first, second, and third consecutive years of a multiple dry year scenarios.

Table 7-3 Supply and Demand Comparison -Multiple Dry Year Events (DWR Table 34)

		Supply and Demand Comparison – Multiple Dry Year Events (ac-ft/yr)					
		2010	2015	2020	2025	2030	2035
Multiple-dry year First year supply	Supply totals	15,000	15,000	19,450	19,450	19,450	23,450
	Demand totals	11,955	13,095	13,749	14,437	15,158	15,916
	Difference	3,045	1,905	5,701	5,013	4,292	7,534
	Difference as percent of supply	20%	13%	29%	26%	22%	32%
	Difference as percent of demand	25%	15%	41%	35%	28%	47%
Multiple-dry year Second year supply	Supply totals	15,000	15,000	19,450	19,450	19,450	23,450
	Demand totals	11,955	13,095	13,749	14,437	15,158	15,916
	Difference	3,045	1,905	5,701	5,013	4,292	7,534
	Difference as percent of supply	20%	13%	29%	26%	22%	32%
	Difference as percent of demand	25%	15%	41%	35%	28%	47%
Multiple-dry year Third year supply	Supply totals	15,000	15,000	19,450	19,450	19,450	23,450
	Demand totals	11,955	13,095	13,749	14,437	15,158	15,916
	Difference	3,045	1,905	5,701	5,013	4,292	7,534
	Difference as percent of supply	20%	13%	29%	26%	22%	32%
	Difference as percent of demand	25%	15%	41%	35%	28%	47%

Section 8

Water Shortage Contingency Plan

In 1992, in accordance with the requirements of AB 11, the City developed a comprehensive emergency response plan. The complete plan is included in Appendix L. Accordingly, this plan would be incorporated into any actual City emergency response activity affecting the water supply. The City's plan is consistent with provisions in the state regulations pertaining to water planning. The plan contains procedures for the distribution and allocation of potable water in a water shortage condition or disaster. These procedures are consistent with guidelines prepared by the California State Office of Emergency Services.

The emergency response plan is structured to be activated through authorization by the City Council. Prior to any Council action, the Natural Resources Commission would review the recommendation and provide feedback to the Council on the proposed action. Under a water shortage condition, the actual water supply and demand information and conditions would be assessed to determine whether activating the plan is warranted. If so, City staff would recommend activation of the appropriate stage alert, and request Council authorization to initiate the measures necessary to achieve the appropriate demand reduction target. The public would be encouraged to understand and be involved in the decision-making process, and provide feedback to the Council on such an action. The response plan is flexible, and can be implemented to best match actual conditions of a particular water shortage event.

During the short intense drought event of 1976-77, City groundwater levels dropped severely. This was due in part to increased agricultural pumping to compensate for reduced raw surface water deliveries. During the 1986-92 drought, the community was better prepared to handle drought impacts, due to: (1) the adoption by the City Council of a "No-Waste" Ordinance in the early 1990's; (2) initiation of a meter retrofit program in 1990 heightening customer awareness of water use; and (3) implementation of conservation programs, including toilet rebates for replacements, water audits on request, distribution of toilet leak detection dye tablets for all residential customers, regular newsletter communications to the community and an educational water conservation program with the local schools. An approximate 10 percent reduction in per capita water demand was achieved.

8.1.1 Stages of Action

The City has developed a four-stage water shortage contingency plan, as shown in Table 8-1, to invoke during declared water shortages. The rationing plan includes voluntary and mandatory rationing, depending on the causes, severity, and anticipated duration of the water supply shortage.

The initial Stage 1 demand reduction of 10 percent coincides with one or more months of static water levels more than 100 feet below ground surface. The approach of the City's water shortage reduction plan is to gradually reduce groundwater pumping as groundwater levels decline and hydrologic conditions worsen. In the more severe stages, the implementation of a temporary drought water rate schedule is planned which would help all user classes achieve necessary demand reductions to meet given shortage level goals. A 50 percent reduction in demands versus historic average is triggered with one or more months at or below 140 feet below the ground surface, considered to be the worst case scenario. The City has not triggered its emergency response plan since it was developed. These current trigger levels will have to be updated for the 2015 Plan to reflect the planned wholesale water supply.

Table 8-1. Water Shortage Contingency – Rationing Stages to Address Water Supply Shortages (DWR Table 35)				
Stage	Interim groundwater level trigger (feet below ground surface)	Demand reduction goal	Current per capita target, gpcd	Per capita target based on normal of 167 gpcd
1	-100	10% Voluntary	207	150
2	-120	20% Voluntary	185	134
3	-130	30% Drought Rates/Mandatory	161	117
4	-140	50% or > Drought Rates/Mandatory	115	84

Under water shortage conditions, the City would continue to implement BMPs as part of its overall long term demand management program. The City would likely increase media attention to the water supply situation during a shortage. The City would step up public water education programs, encourage property owners to request a landscape and interior water use survey, and continue to advertise the importance to customers of installing water efficient appliances and fixtures (e.g. toilets, clothes washers).

Priorities for use of available potable water during shortages were based on the difference between basis needs (e.g. drinking, toilet flushing) and discretionary uses (e.g. landscape irrigation), and legal requirements set forth in the California Water Code, Sections 350-358. Water allocations are established for all customers according to the following ranking method:

- Minimum health and safety allocations for interior residential needs (includes single family, multifamily, hospitals and convalescent facilities, retirement and mobile home communities, and student housing, and fire fighting and public safety)
- Commercial, industrial, institutional/governmental operations (where water is used for manufacturing and for minimum health and safety allocations for employees and visitors), to maintain jobs and economic base of the community (not for landscape uses)
- Existing landscaping
- New customers, proposed projects without permits when shortage declared

It is not expected that any potable water supply reductions would result in recycled water shortages. However, this may change in the future if there are more water commitments for water reclamation uses.

As the water purveyor, the City must provide the minimum health and safety water needs of the community at all times. The water shortage response is designed to provide a minimum of 50 percent of normal supply during a severe or extended water shortage. The water shortage contingency plan triggering levels shown in Table 8-2 were established to ensure that this goal is met.

Although an actual shortage may occur at any time during the year, a shortage condition can usually be forecasted by the Water Division on or about May 1 each year. The City monitors water production and groundwater level data on a monthly basis. This information is useful for tracking the potential impacts on the City's water supply during a dry period. It is possible that during peak demands, groundwater levels could drop more severely (June-August) in a given year, making it difficult to forecast the activation of a water shortage response stage in advance of such a condition.

Water shortage contingency plan stages may be triggered by a supply shortage or by contamination in one or more wells, or a combination of both. Because shortages can overlap stages, triggers automatically implement the more restrictive stage reduction if voluntary efforts are not successful in meeting demand reduction goals.

Specific criteria for triggering the City's rationing stages are shown in Table 8-2.

Table 8-2. Water Shortage Contingency Stages and Triggering Mechanisms

Water supply condition	% Supply reduction			
	Stage 1 Up to 10%	Stage 2 20%	Stage 3 30%	Stage 4 50% or >
Current supply	Total supply is 85-90% of "normal" & Below "normal year is declared or	Total supply is 75-85% of "normal" OR 3rd consecutive dry year is declared or	Total supply is 65-75% of "normal" OR 4th consecutive dry year is declared or	Total supply is less than 85% of "normal" OR 5th consecutive dry year is declared or
Future supply	Projected supply insufficient to provide 90% of "normal" deliveries for the next two years or	Projected supply insufficient to provide 80% of "normal" deliveries for the next two years or	Projected supply insufficient to provide 70% of "normal" deliveries for the next two years or	Projected supply insufficient to provide 50% of "normal" deliveries for the next two years or
Groundwater	No excess groundwater pumping undertaken or	No excess groundwater pumping undertaken or	Excess deep well groundwater pumping undertaken or	No excess supply OR Well limitations to reduce supply availability or
Water quality	1 to 2 wells exceed primary drinking water standards	2 to 3 wells exceed primary drinking water standard	3 to 4 wells exceed primary drinking water standard	5 or more wells exceed primary drinking water standard or
Disaster loss	N/A	N/A	N/A	Disaster Loss

8.1.2 Three-Year Minimum Water Supply

The three-year minimum water supply is presented in Section 4.

8.1.3 Catastrophic Supply Interruption Planning – Emergency Response Plan

The City has prepared a security vulnerability assessment and maintains an Emergency Response Plan to address responding to catastrophic supply interruptions as well as other emergencies. Due to security reasons, only the Emergency Response Plan Table of Contents is included in this document in Appendix L.

During declared Stage 4 shortages, or when a shortage declaration appears imminent, the Public Works Director, would be in charge of managing related activities. The Director would coordinate efforts with the City Manager and other Departments including water, fire, planning, police, parks and recreation, and the City Manager's Office. During a declared Stage 4 water shortage, the City would not accept applications for new building permits. If the shortage condition warrants, permit issuance policy may need to be evaluated and modified until the shortage declaration is rescinded.

The City has four emergency generators available keep several wells online during a water shortage event. In addition the City has two 4-million gallon water storage tank that provide needed emergency backup and fire fighting capacity. These improvements are particularly useful should a shortage be caused by a power outage or other natural disaster. All existing water supply storage, treatment, and distribution, and wastewater treatment facilities are inspected per a maintenance schedule.

The following Table 8-3 summarizes the actions the City will take during a water supply catastrophe.

Table 8-3. Preparation Actions for a Catastrophe	
Possible catastrophe	**Potential actions**
• Earthquake • Fire/explosion • Medical • Flood • Tornado/severe weather • Bomb threat • Hard freeze • Loss of normal water supply • Hazardous material release • Contamination of District water supplies • Terrorist attack	• Stretch existing water storage • Obtain additional water supplies • Develop alternative water supplies • Determine where the funding will come from • Contact and coordinate with other agencies • Create an emergency response team/coordinator • Implement the emergency response plan • Put employees/contractors on-call • Develop methods to communicate with the public • Develop methods to prepare for water quality interruptions

8.1.4 Prohibitions, Consumption Reduction Methods, and Penalties

Mandatory prohibition consumption reduction methods and penalties in the City's emergency response plan are presented in Appendix L and discussed in this section. The City's "No Waste" Ordinance includes prohibitions on various wasteful water uses such as offsite irrigation runoff, washing sidewalks and driveways with potable water, and allowing plumbing leaks to go uncorrected more than 24 hours after customer notification.

In Stage 1 and 2 shortages, customers may adjust either interior or outdoor water use (or both), in order to meet the voluntary water reduction goal. However, under Stage 3 and Stage 4 mandatory rationing programs, the City would enhance fixture and appliance replacement programs to encourage the installation of highly water efficient models. This would reduce potential impacts on lifestyle as a result of demand reductions. Those customers who already have several water efficient fixtures would likely not be impacted by an established health and safety allotments or usage targets. More reliance on outdoor water savings would be required to meet water shortage contingency plan demand reduction targets.

Stage 4 mandatory rationing, which is likely to be declared only as the result of a prolonged water shortage or as a result of a disaster, would require that customers make changes in their interior water use habits (for instance, not flushing toilets unless “necessary” or taking less frequent showers). All irrigation usage would be eliminated, or greatly limited in a severe water shortage condition.

Table 8-4 provides a summary of the mandatory prohibitions and the stage when the prohibitions become mandatory.

Table 8-4. Water Shortage Contingency – Mandatory Prohibitions (DWR Table 36)	
Prohibitions	Stage when prohibition becomes mandatory
Street/sidewalk cleaning	2
Washing cars (residential)	3
Watering lawns/landscapes	3
Uncorrected plumbing leaks	1
Gutter flooding	1
No refilling or filling of pools	3
Car wash facilities (must use recycled water)	2
No new connections	4

The City would follow a community-wide per capita demand reduction goal for residential customers. Commercial, industrial, and City facility user classes would follow a user class reduction goal. Landscape-only accounts would meet reductions based use per acre and local evapotranspiration data. In general, the majority of savings would come from the single family residential and multi-family residential sectors which represent about 80 percent of the metered demands in the water system.

As it relates to meeting a user class goal, the very low water users in each sector would be relatively unaffected by prescribed demand reductions. High water users would be asked to curtail their discretionary uses in particular as water shortage conditions worsen. Special temporary rates would be introduced for stages 3 and 4 to encourage demand reduction and to meet conservation targets. No specific account allocations or allotments are proposed unless the public and/or City Council choose to adopt such an approach in the future.

The City classifies each customer in the utility billing software to ensure equitable billing for water service. A multi-year water use history is maintained in the billing software database. The City provides internet bill access capability to customers so they can easily access the past several years of their water use. This would be particularly useful during a water shortage condition for both the City and its customers. In summary, the goal would be to meet the community demand reduction goal by having each user class meet their proportional share. The consumption reduction methods are summarized in Table 8-5.

Table 8-5. Water Shortage Contingency –Consumption Reduction Methods (DWR Table 37)		
Examples of consumption reduction methods	Stage when method takes effect	Projected reduction, % [(a)]
Demand reduction program	All stages	10-50
Reduce pressure in water lines	4	50
Restrict building permits	4	50
Use prohibitions	All stages	30-50
Water shortage pricing	3 and 4	30-50
Per capita allotment by customer type	3 and 4	30-50
Plumbing fixture replacement	1 and 2	10-20
Voluntary rationing	1 and 2	10-20
Mandatory rationing	3 and 4	30-50
Incentives to reduce water consumption	Will be considered	
Education program	All stages	10
Percentage reduction by customer type	3 and 4	30-50

[(a)]*Projected reduction from all actions implemented for the identified stage.*

Any customer violating the regulations and restrictions on water use set forth in the "No Waste" Ordinance shall receive a written warning for the first and second violations. Upon a third violation, the customer shall receive a written warning and the City may cause a flow-restrictor to be installed in the service. If a flow-restrictor is placed, the violator shall pay the cost of the installation and removal. Additional violations may cause the City to temporarily terminate water service until water waste violations are remedied. The City would prefer to avoid such actions and would work with customers diligently to this end before taken any severe corrective action. During a severe water shortage, enforcement would be critical to preserve valuable limited water supplies. If water service is terminated, it shall be restored only upon payment of the turn-on charge fixed by the City Council. The penalties and changes are summarized in Table 8-6.

Table 8-6. Water Shortage Contingency – Types of Penalties and Charges (DWR Table 38)	
Types of penalties and charges	Stage when penalty takes effect
Penalties for not reducing consumption	2
Termination of Service	4

8.1.5 Analysis of Revenue Impacts of Reduced Sales During Shortages

All revenues the City collects that are not expended in the same year on system operations and maintenance or capital improvements are used to fund deferred maintenance and to complete necessary capital improvements, such as main and well replacements. The City understands the projected ranges of water sales by shortage stage and what the impact would be on projected revenues and expenditures by each shortage stage. Special rates would have to be adopted to avoid severe financial hardship during a water shortage condition.

In Stage 1 and 2 conditions, the City would attempt to avoid rate adjustments. However if the water shortage conditions persisted and/or became more severe thereby further reducing demands, rate changes would be imperative.

Table 8-7 summarizes the proposed measures to overcome revenue impacts.

Table 8-7. Proposed Measures to Overcome Revenue Impacts

Name of measures	Summary of effects
Rate adjustment	The magnitude of water rate increases during a severe water shortage condition would be as follows: 25 percent rate increase at Stage 3; 40 percent rate increase at Stage 4. If severe water shortage conditions persisted, further rate increases would be needed to remain solvent as a water utility. To cover increased expenses and decreased sales, rate increases would need to be "severe", however would be relatively short term in nature.

Table 8-8 summarizes the proposed measures to overcome expenditure impacts.

Table 8-8. Proposed Measures to Overcome Expenditure Impacts

Name of measures	Summary of effects
Development of reserves	The City has a reserve policy (contingency fund) in place to help offset expenditure impacts during times of emergency.

8.1.6 Reduction Measuring Mechanisms

Under normal water supply conditions, potable water production figures are recorded daily. Daily totals are reported monthly by the water division. The City runs its water system on a computerized SCADA system, which allows instantaneous viewing of water system conditions.

During a Stage 1 or 2 water shortage, weekly production figures would be evaluated during the peak period to determine if demand reduction targets were being met. The water division would compare the weekly production to the target weekly production to verify that the reduction goal is being met. The Public Works Director would review the weekly production reports and determine if further action is required to demand reduction goals. Monthly production reports would be sent to the City Council. If reduction goals are not met, the Director would notify the City Council so that corrective action could be considered and/or taken.

During a Stage 3 or 4 water shortage, the procedure listed above will be followed, with the addition of a daily production report to the water division manager. During emergency shortages, production figures would be reviewed during peak demand periods and reported to the water division manager. Daily production reports would also be maintained for review if necessary for the Director and/or City Council.

Table 8-9 summarizes the City's water use monitoring mechanisms.

Table 8-9. Water Use Monitoring Mechanisms

Mechanism for determining actual reduction	Type and quality of data expected
Water production meters	Use will be monitored from the water production meters on a daily or weekly basis, dependant upon the severity of the water shortage. Production meters are accurate within +/- 5 percent.
Customer records	All customers are metered, therefore customer accounts can be grouped by type or by specific customers to monitor usage. Data will be evaluated monthly depending on situation. Data is based on customer meters which are accurate within +/- 1 percent.

References

Brown and Caldwell and Kennedy/Jenks Consultants Engineers & Scientists. Water Distribution System Optimization Plan. May 2011.

Brown and Caldwell and West Yost & Associates Consulting Engineers. Phase II Deep Aquifer Study July 2005.

City of Davis. 2005 Urban Water Management Plan Update March 2006 (Adopted June 2006).

Department of Water Resources (DWR). California's Groundwater Bulletin 118-Update 2003 Sacramento Valley Groundwater Basin, North American Subbasin 27 February 2004.

Luhdorff and Scalmanini Consulting Engineers. Hydrogeologic Conceptualization of the Deep Aquifer Prepared for the University of California, Davis. May 2003.

West Yost & Associates Consulting Engineers. City of Davis & University of California, Davis Joint Water Supply Feasibility Study. September 2002.

West Yost & Associates Consulting Engineers. Deep Aquifer Study 1998.

Appendix A: Notice of Public Hearing

NOTICE OF PUBLIC HEARING
URBAN WATER MANAGEMENT PLAN 2010
CITY OF DAVIS

The Davis City Council will hold a public hearing at 6:30pm on Tuesday, July 19, 2011, in the Community Chambers at City Hall, 23 Russell Boulevard, Davis, California, for the purpose of receiving comments on the 2010 Urban Water Management Plan (UWMP).

The UWMP is required by the Urban Water Management Planning Act, sections 10610 through 10656 of the California Water Code. The goals of the Urban Water Management Plan are to summarize historic, current and projected potable and recycled water use for the area; identify conservation and reclamation measures already adopted and practiced; to evaluate the ability of the current water supply to meet future demands; to evaluate potential alternative available supplies; to evaluate the effectiveness of specific alternative conservation measures; and to provide a schedule for implementation of proposed actions.

Copies of the City of Davis 2010 UWMP are available for review at the following locations:

- Davis City Hall, 23 Russell Boulevard, Davis, California
- Davis Public Works Department, 1717 5th Street, Davis, California
- Yolo County Library, Davis Branch, 315 East 14th Street, Davis, California
- 2010 UWMP is available for online review at: cityofdavis.org/pw/water/

Oral and written testimony will be taken at the meeting. Written comments may be submitted to the Davis Public Works Department, 1717 5th Street, Davis, CA 95616, for receipt prior to the hearing.

The Davis City Council will open and close the public hearing and intend to adopt the City of Davis 2010 UWMP in accordance with state law on July 19, 2011.

If you have any questions regarding the City’s 2010 UWMP, please contact Jacques DeBra, Utilities Manger at (530) 757-5686.

Appendix B: Documentation of City/County Notification

PUBLIC WORKS DEPARTMENT
1717 Fifth Street Davis, California 95616
530/757-5686 FAX: 530/758-4738 TDD: 530/757-5666

Davis
California

May 16, 2011

Distribution To:
Yolo County Public Works Department and Library
Neighboring Cities
Water Resources Association of Yolo County

Subject: Notification of Preparation of Urban Water Management Plan – 2010

The City of Davis is in the process of updating its Urban Water Management Plan (UWMP) that was last prepared in 2005. The UWMP is scheduled to be adopted on July 19, 2011 by the Davis City Council.

The Urban Water Management Planning Act requires the City to notify any city or county within which we provide water supplies that we are reviewing and considering changes to the UWMP. The requirement is to provide this notification at least 60 days prior to the public hearing. The public hearing is scheduled for July 19, 2011. The City's 2010 UWMP will be available for public review starting June 1, 2011 prior to the public hearing.

The City's 2010 UWMP will be posted online at www.cityofdavis.org/pw/water beginning June 1, 2011. Please provide comments and/or direct any questions to Jacques DeBra, Utilities Manager at jdebra@cityofdavis.org or by calling 530-757-5686.

Sincerely,

Jacques DeBra
Utilities Manager

c: Diane Phillips
Dianna Jensen
Michael Lindquist

J:\PW\URM\Program 7520\UWMP 2010\2010 UWMP Notice of Preparation 05-16-2011.doc

Appendix C: Urban Water Management Plan Adoption Resolution

RESOLUTION NO. 11-133, SERIES 2011

RESOLUTION OF THE CITY COUNCIL OF THE CITY OF DAVIS ADOPTING THE 2010 URBAN WATER MANAGEMENT PLAN

WHEREAS, the California Legislature enacted Senate Bill 553 during the 2000 Session of the California Legislature (California Water Code Section 10610, et seq.); and

WHEREAS, the City of Davis 2010 Urban Water Management Plan (UWMP) has been prepared consistent with the requirements under Water Code Sections 10610 through 10656 of the Urban Water Management Planning Act (Act), which were added by Statute 1983, Chapter 1009, and became effective on January 1, 1984; and

WHEREAS, the Act requires "every urban water supplier providing water for municipal purposes to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually" to prepare, adopt, and file an UWMP with the California Department of Water Resources (DWR) every five years: and

WHEREAS, Senate Bill No. 7 was enacted by the California Legislature in November 2009 for the purpose of better managing California's limited water supplies in the future; and

WHEREAS, the City of Davis has adopted Method 3 as its approach for complying with Senate Bill No. 7 (Statewide Water Conservation) requirements, establishing a future water use target not-to-exceed 167 gallons per capita per day (total water production divided by total population served) by or before December 31, 2020; and

WHEREAS, the Davis City Council may establish a per capita water use target lower than 167 gallons per capita day in the future; and

WHEREAS, the Natural Resources Commission has reviewed the City's 2010 UWMP and recommends that the City Council consider establishing a long term 20% per capita water use reduction (equivalent to 134 gallons per capita per day) target by 2020 that would include developing a work plan by December 2012 for accomplishing this objective; and

WHEREAS, the City of Davis is an urban water supplier serving more than 3,000 customers and providing water supplies exceeding 3,000 acre-feet of water per year, and has therefore prepared an Urban Water Management Plan in compliance with the requirements of the Act and the Davis City Council has considered any and all evidence presented at a properly noticed public hearing regarding said Plan held by the City Council on the 19th day of July, 2011.

NOW, THEREFORE, BE IT RESOLVED, that the City Council of the City of Davis hereby determines the following:

1. The 2010 Urban Water Management Plan on file with the City is hereby adopted and order filed with the City Clerk; and

2. The Interim City Manager is hereby authorized and directed to file a copy of the City's adopted 2010 Urban Water Management Plan with the California Department of Water Resources immediately following adoption.

PASSED AND ADOPTED by the City Council for the City of Davis this 19th day of July, 2011 by the following vote:

AYES: Souza, Swanson, Wolk, Krovoza

NOES: None

ABSTAIN: Greenwald

Joseph F. Krovoza
Mayor

ATTEST:

Ann M. Waid
Deputy City Clerk

Appendix D: DWR 2010 Urban Water Management Plan Checklist

Table D-1 Urban Water Management Plan checklist, organized by legislation number

No.	UWMP requirement [a]	Calif. Water Code reference	Subject [b]	Additional clarification	UWMP location
1	Provide baseline daily per capita water use, urban water use target, interim urban water use target, and compliance daily per capita water use, along with the bases for determining those estimates, including references to supporting data.	10608.20(e)	System Demands		Section 3.3
2	*Wholesalers:* Include an assessment of present and proposed future measures, programs, and policies to help achieve the water use reductions. *Retailers:* Conduct at least one public hearing that includes general discussion of the urban retail water supplier's implementation plan for complying with the Water Conservation Bill of 2009.	10608.36 10608.26(a)	System Demands	Retailer and wholesalers have slightly different requirements	Section 1.3
3	Report progress in meeting urban water use targets using the standardized form.	10608.40	Not applicable	Standardized form not yet available	Not applicable
4	Each urban water supplier shall coordinate the preparation of its plan with other appropriate agencies in the area, including other water suppliers that share a common source, water management agencies, and relevant public agencies, to the extent practicable.	10620(d)(2)	Plan Preparation		Section 1.4
5	An urban water supplier shall describe in the plan water management tools and options used by that entity that will maximize resources and minimize the need to import water from other regions.	10620(f)	Water Supply Reliability . . .		Section 1.2`
6	Every urban water supplier required to prepare a plan pursuant to this part shall, at least 60 days prior to the public hearing on the plan required by Section 10642, notify any city or county within which the supplier provides water supplies that the urban water supplier will be reviewing the plan and considering amendments or changes to the plan. The urban water supplier may consult with, and obtain comments from, any city or county that receives notice pursuant to this subdivision.	10621(b)	Plan Preparation		Section 1.3
7	The amendments to, or changes in, the plan shall be adopted and filed in the manner set forth in Article 3 (commencing with Section 10640).	10621(c)	Plan Preparation		Not applicable

No.	UWMP requirement [a]	Calif. Water Code reference	Subject [b]	Additional clarification	UWMP location
8	Describe the service area of the supplier	10631(a)	System Description		Section 2.1
9	(Describe the service area) climate	10631(a)	System Description		Section 2.2
10	(Describe the service area) current and projected population . . . The projected population estimates shall be based upon data from the state, regional, or local service agency population projections within the service area of the urban water supplier . . .	10631(a)	System Description	Provide the most recent population data possible. Use the method described in “Baseline Daily Per Capita Water Use.” See Section M.	Section 3.1
11	. . . (population projections) shall be in five-year increments to 20 years or as far as data is available.	10631(a)	System Description	2035 and 2040 can also be provided to support consistency with Water Supply Assessments and Written Verification of Water Supply documents.	Section 3.1
12	Describe . . . other demographic factors affecting the supplier's water management planning	10631(a)	System Description		Section 3.1
13	Identify and quantify, to the extent practicable, the existing and planned sources of water available to the supplier over the same five-year increments described in subdivision (a).	10631(b)	System Supplies	The ‘existing’ water sources should be for the same year as the “current population” in line 10. 2035 and 2040 can also be provided to support consistency with Water Supply Assessments and Written Verification of Water Supply documents.	Section 4.1 – groundwater Section 4.2 – surface water Section 4.6 Section 5 – recycled water
14	(Is) groundwater . . . identified as an existing or planned source of water available to the supplier . . .?	10631(b)	System Supplies	Source classifications are: surface water, groundwater, recycled water, storm water, desalinated sea water, desalinated brackish groundwater, and other.	Section 4.1

No.	UWMP requirement [a]	Calif. Water Code reference	Subject [b]	Additional clarification	UWMP location
15	(Provide a) copy of any groundwater management plan adopted by the urban water supplier, including plans adopted pursuant to Part 2.75 (commencing with Section 10750), or any other specific authorization for groundwater management. Indicate whether a groundwater management plan been adopted by the water supplier or if there is any other specific authorization for groundwater management. Include a copy of the plan or authorization.	10631(b)(1)	System Supplies		Appendix G
16	(Provide a) description of any groundwater basin or basins from which the urban water supplier pumps groundwater.	10631(b)(2)	System Supplies		Section 4.1
17	For those basins for which a court or the board has adjudicated the rights to pump groundwater, (provide) a copy of the order or decree adopted by the court or the board	10631(b)(2)	System Supplies		Section 4.1 (not adjudicated)
18	(Provide) a description of the amount of groundwater the urban water supplier has the legal right to pump under the order or decree.	10631(b)(2)	System Supplies		Not applicable (not adjudicated)
19	For basins that have not been adjudicated, (provide) information as to whether the department has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current official departmental bulletin that characterizes the condition of the groundwater basin, and a detailed description of the efforts being undertaken by the urban water supplier to eliminate the long-term overdraft condition.	10631(b)(2)	System Supplies		Section 4.1
20	(Provide a) detailed description and analysis of the location, amount, and sufficiency of groundwater pumped by the urban water supplier for the past five years. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.	10631(b)(3)	System Supplies		Section 2.3.1
21	(Provide a) detailed description and analysis of the amount and location of groundwater that is projected to be pumped by the urban water supplier. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.	10631(b)(4)	System Supplies	Provide projections for 2015, 2020, 2025, and 2030.	Section 3.2

No.	UWMP requirement [a]	Calif. Water Code reference	Subject [b]	Additional clarification	UWMP location
22	Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage, to the extent practicable, and provide data for each of the following: (A) An average water year, (B) A single dry water year, (C) Multiple dry water years.	10631(c)(1)	Water Supply Reliability . . .		Section 4.8 Table 4-9
23	For any water source that may not be available at a consistent level of use - given specific legal, environmental, water quality, or climatic factors - describe plans to supplement or replace that source with alternative sources or water demand management measures, to the extent practicable.	10631(c)(2)	Water Supply Reliability . . .		Section 4.8.2
24	Describe the opportunities for exchanges or transfers of water on a short-term or long-term basis.	10631(d)	System Supplies		Section 4.4
25	Quantify, to the extent records are available, past and current water use, and projected water use (over the same five-year increments described in subdivision (a)), identifying the uses among water use sectors, including, but not necessarily limited to, all of the following uses: (A) Single-family residential; (B) Multifamily; (C) Commercial; (D) Industrial; (E) Institutional and governmental; (F) Landscape; (G) Sales to other agencies; (H) Saline water intrusion barriers, groundwater recharge, or conjunctive use, or any combination thereof;(I) Agricultural.	10631(e)(1)	System Demands	Consider "past" to be 2005, present to be 2010, and projected to be 2015, 2020, 2025, and 2030. Provide numbers for each category for each of these years.	Section 3.4

No.	UWMP requirement [a]	Calif. Water Code reference	Subject [b]	Additional clarification	UWMP location
26	(Describe and provide a schedule of implementation for) each water demand management measure that is currently being implemented, or scheduled for implementation, including the steps necessary to implement any proposed measures, including, but not limited to, all of the following: (A) Water survey programs for single-family residential and multifamily residential customers; (B) Residential plumbing retrofit; (C) System water audits, leak detection, and repair; (D) Metering with commodity rates for all new connections and retrofit of existing connections; (E) Large landscape conservation programs and incentives; (F) High-efficiency washing machine rebate programs; (G) Public information programs; (H) School education programs; (I) Conservation programs for commercial, industrial, and institutional accounts; (J) Wholesale agency programs; (K) Conservation pricing; (L) Water conservation coordinator; (M) Water waste prohibition;(N) Residential ultra-low-flush toilet replacement programs.	10631(f)(1)	DMMs	Discuss each DMM, even if it is not currently or planned for implementation. Provide any appropriate schedules.	Section 6 Appendix H (2009/2010 BMP reports) Appendix J(summary of the City's planned conservation activities)
27	A description of the methods, if any, that the supplier will use to evaluate the effectiveness of water demand management measures implemented or described under the plan.	10631(f)(3)	DMMs		Appendix H (2009/2010 BMP reports)
28	An estimate, if available, of existing conservation savings on water use within the supplier's service area, and the effect of the savings on the supplier's ability to further reduce demand.	10631(f)(4)	DMMs		Appendix H (2009/2010 BMP reports) Per item no. 32 in this table, since the City is a signer of the MOU and submits the annual reports, they are deemed with no. 28 and 29 in this table.

No.	UWMP requirement [a]	Calif. Water Code reference	Subject [b]	Additional clarification	UWMP location
29	An evaluation of each water demand management measure listed in paragraph (1) of subdivision (f) that is not currently being implemented or scheduled for implementation. In the course of the evaluation, first consideration shall be given to water demand management measures, or combination of measures, that offer lower incremental costs than expanded or additional water supplies. This evaluation shall do all of the following: (1) Take into account economic and noneconomic factors, including environmental, social, health, customer impact, and technological factors; (2) Include a cost-benefit analysis, identifying total benefits and total costs; (3) Include a description of funding available to implement any planned water supply project that would provide water at a higher unit cost; (4) Include a description of the water supplier's legal authority to implement the measure and efforts to work with other relevant agencies to ensure the implementation of the measure and to share the cost of implementation.	10631(g)	DMMs	See 10631(g) for additional wording.	Appendix H (2009/2010 BMP reports) Per item no. 32 in this table, since the City is a signer of the MOU and submits the annual reports, they are deemed with no. 28 and 29 in this table.
30	(Describe) all water supply projects and water supply programs that may be undertaken by the urban water supplier to meet the total projected water use as established pursuant to subdivision (a) of Section 10635. The urban water supplier shall include a detailed description of expected future projects and programs, other than the demand management programs identified pursuant to paragraph (1) of subdivision (f), that the urban water supplier may implement to increase the amount of the water supply available to the urban water supplier in average, single-dry, and multiple-dry water years. The description shall identify specific projects and include a description of the increase in water supply that is expected to be available from each project. The description shall include an estimate with regard to the implementation timeline for each project or program.	10631(h)	System Supplies		Section 4.7
31	Describe the opportunities for development of desalinated water, including, but not limited to, ocean water, brackish water, and groundwater, as a long-term supply.	10631(i)	System Supplies		Section 4.3

No.	UWMP requirement [a]	Calif. Water Code reference	Subject [b]	Additional clarification	UWMP location
32	Include the annual reports submitted to meet the Section 6.2 requirement (of the MOU), if a member of the CUWCC and signer of the December 10, 2008 MOU.	10631(j)	DMMs	Signers of the MOU that submit the annual reports are deemed compliant with Items 28 and 29.	Appendix H (2009/2010 BMP reports)
33	Urban water suppliers that rely upon a wholesale agency for a source of water shall provide the wholesale agency with water use projections from that agency for that source of water in five-year increments to 20 years or as far as data is available. The wholesale agency shall provide information to the urban water supplier for inclusion in the urban water supplier's plan that identifies and quantifies, to the extent practicable, the existing and planned sources of water as required by subdivision (b), available from the wholesale agency to the urban water supplier over the same five-year increments, and during various water-year types in accordance with subdivision (c). An urban water supplier may rely upon water supply information provided by the wholesale agency in fulfilling the plan informational requirements of subdivisions (b) and (c).	10631(k)	System Demands	Average year, single dry year, multiple dry years for 2015, 2020, 2025, and 2030.	Section 4.6
34	The water use projections required by Section 10631 shall include projected water use for single-family and multifamily residential housing needed for lower income households, as defined in Section 50079.5 of the Health and Safety Code, as identified in the housing element of any city, county, or city and county in the service area of the supplier.	10631.1(a)	System Demands		Section 3.4.2
35	Stages of action to be undertaken by the urban water supplier in response to water supply shortages, including up to a 50 percent reduction in water supply, and an outline of specific water supply conditions which are applicable to each stage.	10632(a)	Water Supply Reliability . . .		Section 8.1.1
36	Provide an estimate of the minimum water supply available during each of the next three water years based on the driest three-year historic sequence for the agency's water supply.	10632(b)	Water Supply Reliability . . .		Section 4.8
37	(Identify) actions to be undertaken by the urban water supplier to prepare for, and implement during, a catastrophic interruption of water supplies including, but not limited to, a regional power outage, an earthquake, or other disaster.	10632(c)	Water Supply Reliability . . .		Section 8.1.3

No.	UWMP requirement [a]	Calif. Water Code reference	Subject [b]	Additional clarification	UWMP location
38	(Identify) additional, mandatory prohibitions against specific water use practices during water shortages, including, but not limited to, prohibiting the use of potable water for street cleaning.	10632(d)	Water Supply Reliability . . .		Section 8.1.4
39	(Specify) consumption reduction methods in the most restrictive stages. Each urban water supplier may use any type of consumption reduction methods in its water shortage contingency analysis that would reduce water use, are appropriate for its area, and have the ability to achieve a water use reduction consistent with up to a 50 percent reduction in water supply.	10632(e)	Water Supply Reliability . . .		Section 8.1.4
40	(Indicated) penalties or charges for excessive use, where applicable.	10632(f)	Water Supply Reliability . . .		Section 8.1.4
41	An analysis of the impacts of each of the actions and conditions described in subdivisions (a) to (f), inclusive, on the revenues and expenditures of the urban water supplier, and proposed measures to overcome those impacts, such as the development of reserves and rate adjustments.	10632(g)	Water Supply Reliability . . .		Section 8.1.5
42	(Provide) a draft water shortage contingency resolution or ordinance.	10632(h)	Water Supply Reliability . . .		Appendix N
43	(Indicate) a mechanism for determining actual reductions in water use pursuant to the urban water shortage contingency analysis.	10632(i)	Water Supply Reliability . . .		Section 8.1.6
44	Provide, to the extent available, information on recycled water and its potential for use as a water source in the service area of the urban water supplier. The preparation of the plan shall be coordinated with local water, wastewater, groundwater, and planning agencies that operate within the supplier's service area	10633	System Supplies		Section 5
45	(Describe) the wastewater collection and treatment systems in the supplier's service area, including a quantification of the amount of wastewater collected and treated and the methods of wastewater disposal.	10633(a)	System Supplies		Section 5.2
46	(Describe) the quantity of treated wastewater that meets recycled water standards, is being discharged, and is otherwise available for use in a recycled water project.	10633(b)	System Supplies		Section 5.2.1

No.	UWMP requirement [a]	Calif. Water Code reference	Subject [b]	Additional clarification	UWMP location
47	(Describe) the recycled water currently being used in the supplier's service area, including, but not limited to, the type, place, and quantity of use.	10633(c)	System Supplies		Section 5.3
48	(Describe and quantify) the potential uses of recycled water, including, but not limited to, agricultural irrigation, landscape irrigation, wildlife habitat enhancement, wetlands, industrial reuse, groundwater recharge, indirect potable reuse, and other appropriate uses, and a determination with regard to the technical and economic feasibility of serving those uses.	10633(d)	System Supplies		Section 5.4.1
49	(Describe) The projected use of recycled water within the supplier's service area at the end of 5, 10, 15, and 20 years, and a description of the actual use of recycled water in comparison to uses previously projected pursuant to this subdivision.	10633(e)	System Supplies		Section 5.4.2
50	(Describe the) actions, including financial incentives, which may be taken to encourage the use of recycled water, and the projected results of these actions in terms of acre-feet of recycled water used per year.	10633(f)	System Supplies		Section 5.5.1
51	(Provide a) plan for optimizing the use of recycled water in the supplier's service area, including actions to facilitate the installation of dual distribution systems, to promote recirculating uses, to facilitate the increased use of treated wastewater that meets recycled water standards, and to overcome any obstacles to achieving that increased use.	10633(g)	System Supplies		Section 5.5.2
52	The plan shall include information, to the extent practicable, relating to the quality of existing sources of water available to the supplier over the same five-year increments as described in subdivision (a) of Section 10631, and the manner in which water quality affects water management strategies and supply reliability.	10634	Water Supply Reliability . . .	For years 2010, 2015, 2020, 2025, and 2030	Section 4.5

No.	UWMP requirement [a]	Calif. Water Code reference	Subject [b]	Additional clarification	UWMP location
53	Every urban water supplier shall include, as part of its urban water management plan, an assessment of the reliability of its water service to its customers during normal, dry, and multiple dry water years. This water supply and demand assessment shall compare the total water supply sources available to the water supplier with the total projected water use over the next 20 years, in five-year increments, for a normal water year, a single dry water year, and multiple dry water years. The water service reliability assessment shall be based upon the information compiled pursuant to Section 10631, including available data from state, regional, or local agency population projections within the service area of the urban water supplier.	10635(a)	Water Supply Reliability . . .		Section 4.6 Section 4.8
54	The urban water supplier shall provide that portion of its urban water management plan prepared pursuant to this article to any city or county within which it provides water supplies no later than 60 days after the submission of its urban water management plan.	10635(b)	Plan Preparation		Section 1.3
55	Each urban water supplier shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the service area prior to and during the preparation of the plan.	10642	Plan Preparation		Section 1.3
56	Prior to adopting a plan, the urban water supplier shall make the plan available for public inspection and shall hold a public hearing thereon. Prior to the hearing, notice of the time and place of hearing shall be published within the jurisdiction of the publicly owned water supplier pursuant to Section 6066 of the Government Code. The urban water supplier shall provide notice of the time and place of hearing to any city or county within which the supplier provides water supplies. A privately owned water supplier shall provide an equivalent notice within its service area.	10642	Plan Preparation		Section 1.3
57	After the hearing, the plan shall be adopted as prepared or as modified after the hearing.	10642	Plan Preparation		Section 1.3
58	An urban water supplier shall implement its plan adopted pursuant to this chapter in accordance with the schedule set forth in its plan.	10643	Plan Preparation		Section 1.3

No.	UWMP requirement [a]	Calif. Water Code reference	Subject [b]	Additional clarification	UWMP location
59	An urban water supplier shall submit to the department, the California State Library, and any city or county within which the supplier provides water supplies a copy of its plan no later than 30 days after adoption. Copies of amendments or changes to the plans shall be submitted to the department, the California State Library, and any city or county within which the supplier provides water supplies within 30 days after adoption.	10644(a)	Plan Preparation		Section 1.3
60	Not later than 30 days after filing a copy of its plan with the department, the urban water supplier and the department shall make the plan available for public review during normal business hours.	10645	Plan Preparation		Section 1.3

a The UWMP Requirement descriptions are general summaries of what is provided in the legislation. Urban water suppliers should review the exact legislative wording prior to submitting its UWMP.

b The Subject classification is provided for clarification only. It is aligned with the organization presented in Part I of this guidebook. A water supplier is free to address the UWMP Requirement anywhere with its UWMP, but is urged to provide clarification to DWR to facilitate review.

Appendix E: Water Conservation Planning Technical Memorandum

FINAL
Technical Memorandum

Brown AND Caldwell
10540 White Rock Road, Suite 180
Rancho Cordova, California 95670
Tel: 916-444-0123
Fax: 916-635-8805

Prepared for: City of Davis, California

Project Title: Davis Water Conservation Planning

Project No: 138905

Technical Memorandum No. 1

Subject: Water Conservation Planning

Date: September 14, 2010

To: Jacques Debra, Utilities Manager

From: Paul Selsky, PE

Prepared by: Paul Selsky, Vice President

Report Purpose:

1. Select the preferred demand target option as required by SBx7-7.
2. Based on the selected demand target option, define the 2015 and 2020 water use targets for use in the 2010 urban water management plan.
3. Evaluate recent trends in City water use.
4. Develop water demand projections necessary for the 2010 urban water management plan.

Attachments:

Attachment A: City of Davis SFR End Use Study

Attachment B: SBx7-7 Information

Attachment C: City of Davis Metrics

Limitations:

This document was prepared solely for City of Davis in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Davis and Brown and Caldwell dated Feb. 22, 2010. This document is governed by the specific scope of work authorized by City of Davis; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Davis and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

1. INTRODUCTION

The efficient use of water has been an objective of the City of Davis (City) for many years since 1990. Water conservation is also a state-wide priority in meeting the future water needs of the state and region as outlined in the 2009 California Water Plan. The City has focused on the reduction of peak demands because of the significant summer water demand peaking patterns (3/1 ratio of July to January use) and benefits for sizing and cost of future water supply facilities. The rate water is used, including the aspects of annual use, maximum day use, and peak hour demand, directly impact the extent of needed water supply facilities. The costs to construct water supply facilities will impact the future cost of water with higher water rates, which then may affect the customer's demand for water through the effects of price elasticity, particularly during peak summer demand periods.

This report presents an overview of the water conservation efforts implemented by the City since 1990, describes the City's water use characteristics, and describes an approach for the City to meet the water use targets according to recent state legislation.

The City has been implementing water conservation for decades. Table 1 summarizes the key water conservation activities that have been implemented and their timelines.

Table 1. City of Davis Water Conservation Program Chronology (1990-2010)

Effort	
1990	Adopted 1990 UWMP and Water Master Plan
1990-92	Performed landscape water audits at 30 park sites
1990-94	Completed various Water Meter Retrofit Project studies
1990	Began City Water Meter Retrofit Project
1990	Meters required on new construction
1990	Adopted "No-Waste" Ordinance
1990	Began providing customer water audits/conservation services
1991	Introduced initial Landscape Water Conservation Ordinance for New Development
1992	Initiated toilet rebate program
1992	Developed initial Water Shortage Contingency Plan
1993-94	Parks installs initial Central Control Irrigation System
1995	Adopted 1995 UWMP Update
1995	Initiated CII Toilet Rebate Program
1995	CUWCC Signatory - MOU for Urban Best Management Practices
1995	1995 UWMP
1996	Began Clothes Washer Rebate Program
1997	Completed Water Meter Retrofit Project
1998	Introduced single tier SFR water rates to compliment other two-tier water rates [a]
1998	Performed Water System Audit
2000	Performed Water System Leak Survey
2000	Adopted 2000 UWMP Update
2000	Terminated toilet rebate program
2000	DWR Pilot Parks Water Audit

Table 1. City of Davis Water Conservation Program Chronology (1990-2010)	
Effort	
2003	Introduced two-tier SFR water rates [(a)]
2003	Introduced metered construction water charge
2003	Metered El Macero Service Area
2005	Adopted 2005 UWMP Update
2007	Introduced consumption-based sewer rates [(a)]
2007	Conversion from flat to consumption-based SFR sewer rates
2008	Participated in State-wide Residential End Use Study
2009	Playfields Park Artificial Turf Installation Project
2009	Implemented voluntary landscape watering of 3 times a week
2010	Continued Clothes Washer Rebate Program w/PG&E
2010	Updating Landscape Water Conservation Ordinance for New Development
2010	Developing compliance with state 20x2020 water conservation targets
2010-11	Completing 2010 UWMP Update
2011-15 Ideas	AMR/AMI, landscape programs TBD, Water System Audit and Water System Leak Survey, implement new Lands Ordinance

(a) *These items correlate with and help explain changes in demand over time. Drought and economic influences also result in changes in demand.*

2. WATER USE CHARACTERISTICS

This section describes the City's population, customer, and water use characteristics and trends over time.

The City's water system serves a population of 67,953 in 2009 through a total of 16,438 customer accounts. The population that is served by the City's municipal water system includes two areas located outside of the City's boundary known as El Macero and Willowbank. Figure 1 presents the historical population and number of connections or customers that are served by the City's water system. The population is based on the May 2010 estimate from the California Department of Finance (DOF) for the City's municipal boundary plus an estimated 1,383 people served in the El Macero and Willowbank areas. The DOF population is for January 1 of each year, and is assumed to represent the population for the prior twelve month period.

A comparison can be made of the City's historical population and number of connections to determine the overall people per connection trend. As shown in Figure 2, the number of people per residential connection has been relatively stable at approximately at 4.5 people per residential connection. This value is for all residential connections, both single family and multifamily.

The City's water customers are broken down into five categories consisting of single family residential, multifamily residential, commercial including institutional and industrial, landscape and other categories. As shown in Figure 3, most of the City's customers are residential.

As depicted in Figure 4, the City's total annual water use grew steadily until 2002, when it peaked at 15,112 acre-feet per year (ac-ft/yr), and has decreased since to 12,835 ac-ft in 2009. Water use during January to May 2010 is down about 18 percent YTD, and indicates that 2010 water use may be even lower than 2009. For Figure 4, total water use is considered to be total water produced from all of the groundwater supply wells, and includes water use that is not metered, such as water used for pipe flushing and fire hydrant flow testing, and system leaks.

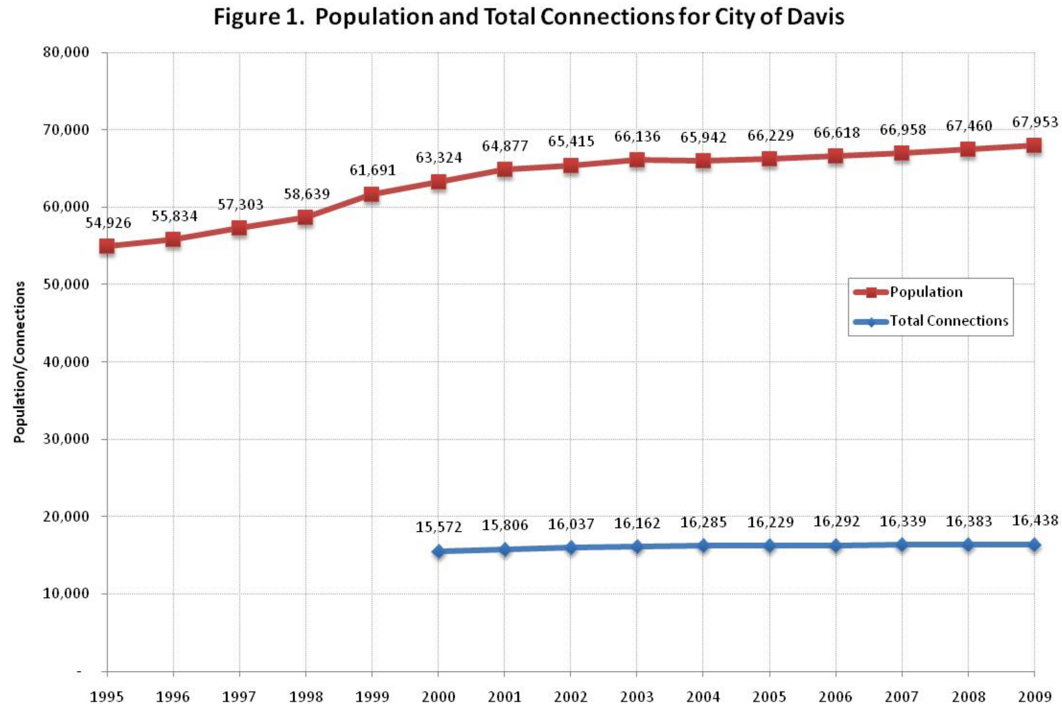


Figure 1. Population and Total Connections for City of Davis
Population/Connections
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
54,926 55,834 57,303 58,639 61,691 63,324 64,877 65,415 66,136 65,942 66,229 66,618 66,958 67,460 67,953
15,572 15,806 16,037 16,162 16,285 16,229 16,292 16,339 16,383 16,438
Population
Total Connections

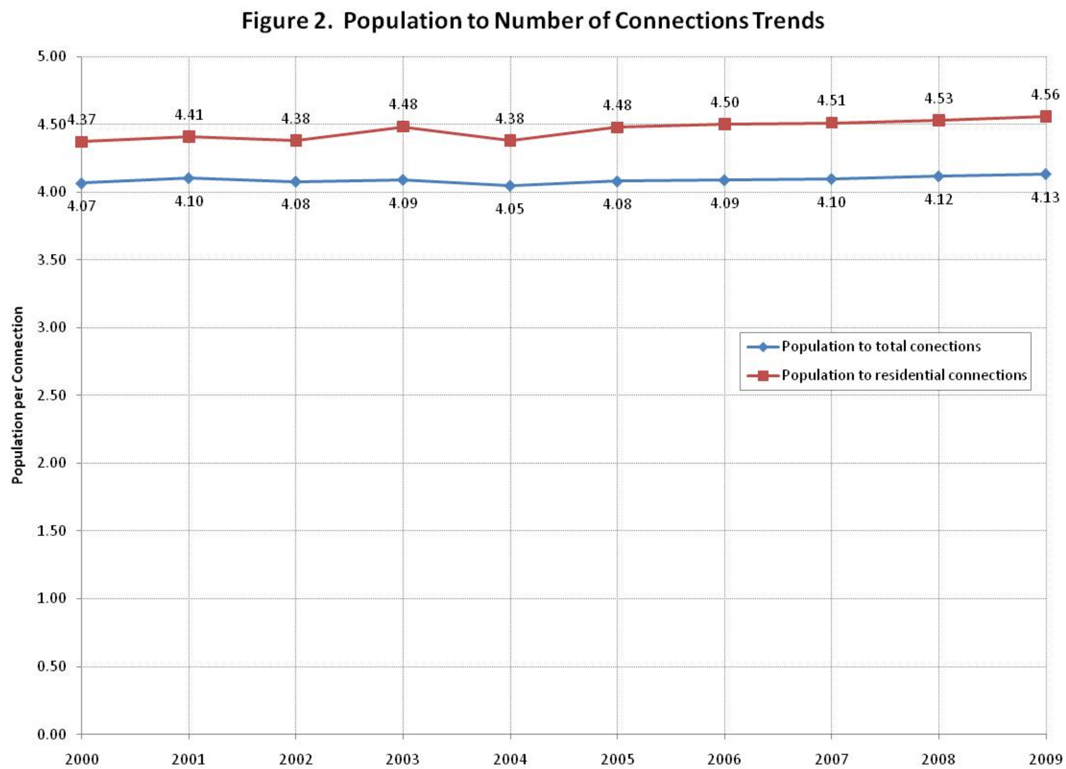


Figure 2. Population to Number of Connections Trends
Population per Connection
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
4.37 4.41 4.38 4.48 4.38 4.48 4.50 4.51 4.53 4.56
4.07 4.10 4.08 4.09 4.05 4.08 4.09 4.10 4.12 4.13
Population to total conections
Population to residential connections

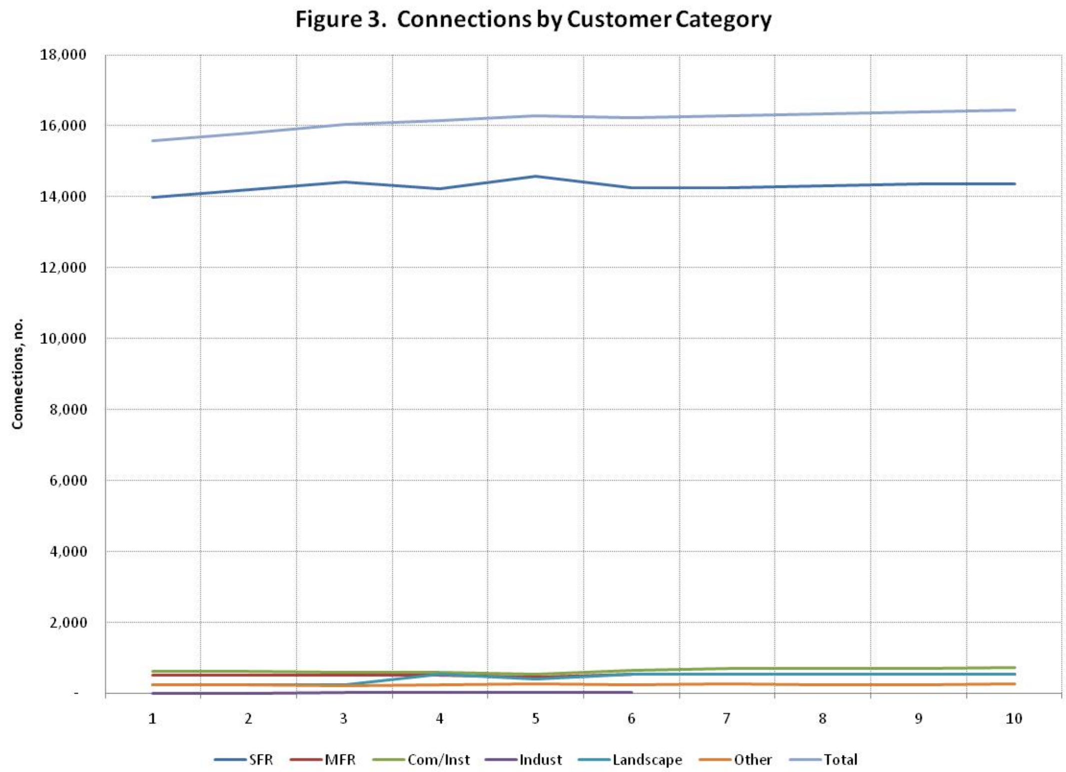


Figure 3. Connections by Customer Category
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
Connections, no.
1
2
3
4
5
6
7
8
9
10
SFR
MFR
Com/Inst
Indust
Landscape
Other
Total

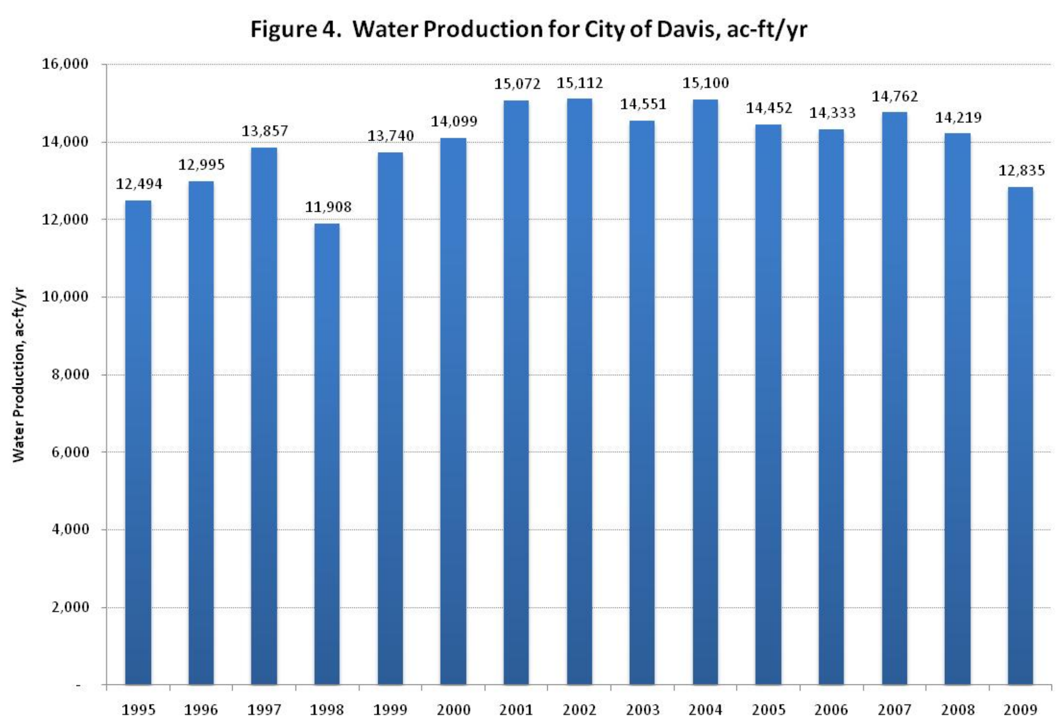


Figure 4. Water Production for City of Davis, ac-ft/yr
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
Water Production, ac-ft/yr
12,494
12,995
13,857
11,908
13,740
14,099
15,072
15,112
14,551
15,100
14,452
14,333
14,762
14,219
12,835
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

Comparing the City's total annual water use to population shows that the City's per capita water use has been exhibiting a declining trend since 2007. Figure 5 depicts the City's total annual water use per person expressed as gallons per capita per day (GPCD). Figure 6 presents a comparison of the GPCD for the City to several other water suppliers in California for 2008. Figure 7 depicts the total annual water use per connection, which has been exhibiting a similar downward trend.

Since the City completed metering all of its customers in 1997, actual bi-monthly water sales data is available to identify the amount of water being used by each customer category, as well as the difference between total water production and total water sales. Figure 8 depicts the total annual water use by each customer category over time. The amount of other category water use and unaccounted-for water for 2002 to 2006 was estimated for this analysis because the applicable data was not available from the City. As shown in Figure 8, the largest amounts of water are used by the residential and CII customer categories. Comparing total water production to water sales allows for the determination of unaccounted-for water. Unaccounted-for water has varied from 9% to 14% of total water production, and as shown in Figure 8, is exhibiting a decreasing trend. The trend of decreasing amounts of unaccounted-for water may be partially due to less construction water being used. In order to accurately identify unaccounted-for water use levels, all water services must be metered to accurately measure actual water use and more water demand information needs to be collected and evaluated on a system-wide basis.

Figure 9 presents the annual water use per connection for each customer category over time. As depicted in Figure 9, most customer categories have had a decreasing amount of water use per connection over the last ten years. Decreases in multifamily residential water and CII use can perhaps be partially explained by the recent higher vacancy rates and lower economic activity in recent years. Table 2 presents some observations regarding customer category water use trends.

Table 2. Summary of Recent User Class Demand Changes—Water Use/Connection

User Class	2007 vs 2009	Water Use Trends
Single Family Residential	- 12%	Declining peak demand
Multifamily Residential	- 11%	Slightly lower use overall
Commercial/Industrial	- 11.5%	Slightly lower use overall

Indoor water use can be determined by examining the water use during winter months, when outdoor irrigation by customers is likely to be very low. The lowest month of water production and the lowest two months of water sales are tracked by the City. These amounts should be directly related to the lowest month of wastewater influent at the City's wastewater treatment plant. Figure 10 depicts the results of an analysis comparing low month wastewater influent to low month water production and lowest two month period of water sales. The month of low wastewater flow does not always correlate with the low two month water sales period. Nevertheless, for this analysis, the lowest month periods of wastewater flow, water production, and water sales were used, regardless if the period matched.

As shown in Figure 10, wastewater flows during low flow months tend to be approximately 80% of low month water production. This makes sense given that some low month water production is lost to distribution system and customer leaks, unmetered uses, some outdoor use, and indoor uses for cooking and car washing, before the remainder enters the wastewater system. The low two month period of water sales excludes the water that is used for non-metered uses and lost to distribution system leaks. The low month wastewater flow is approximately 90% of lowest two months of water sales. This comparison of wastewater flows to low period water sales shows that indoor water use can be most accurately estimated by using the low period water use. The analysis suggests that a factor of 90% of the low period water sales should be used to estimate actual indoor water use. For the purposes of this draft report, the indoor water use is assumed to be 90% of the low period water sales due to the high correlation between the two factors.

Figure 5. Gallons per Capita per Day for City of Davis

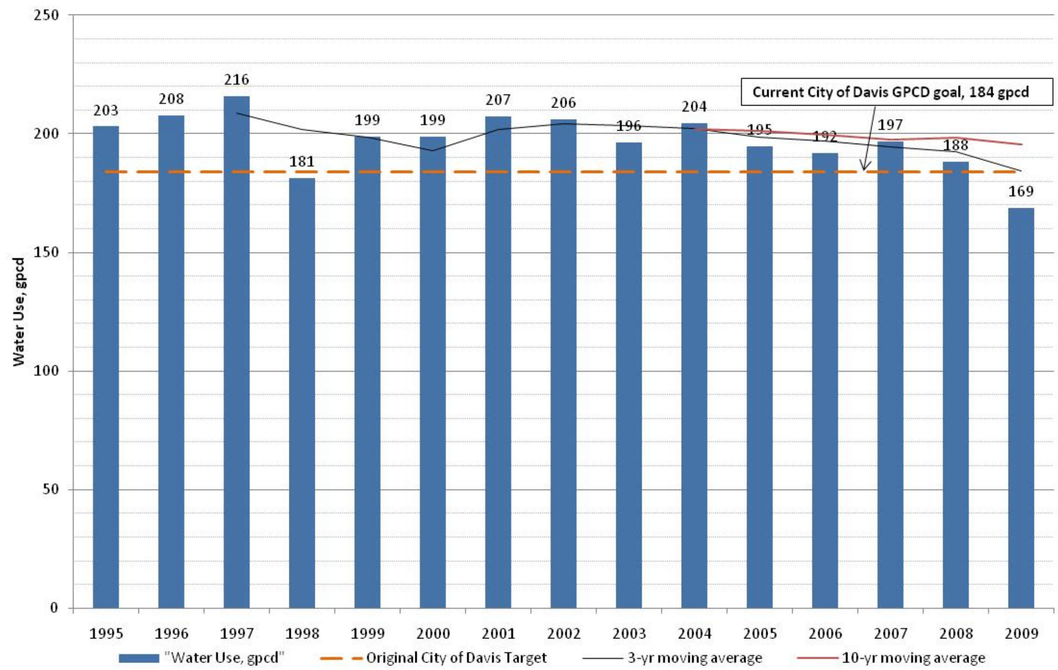
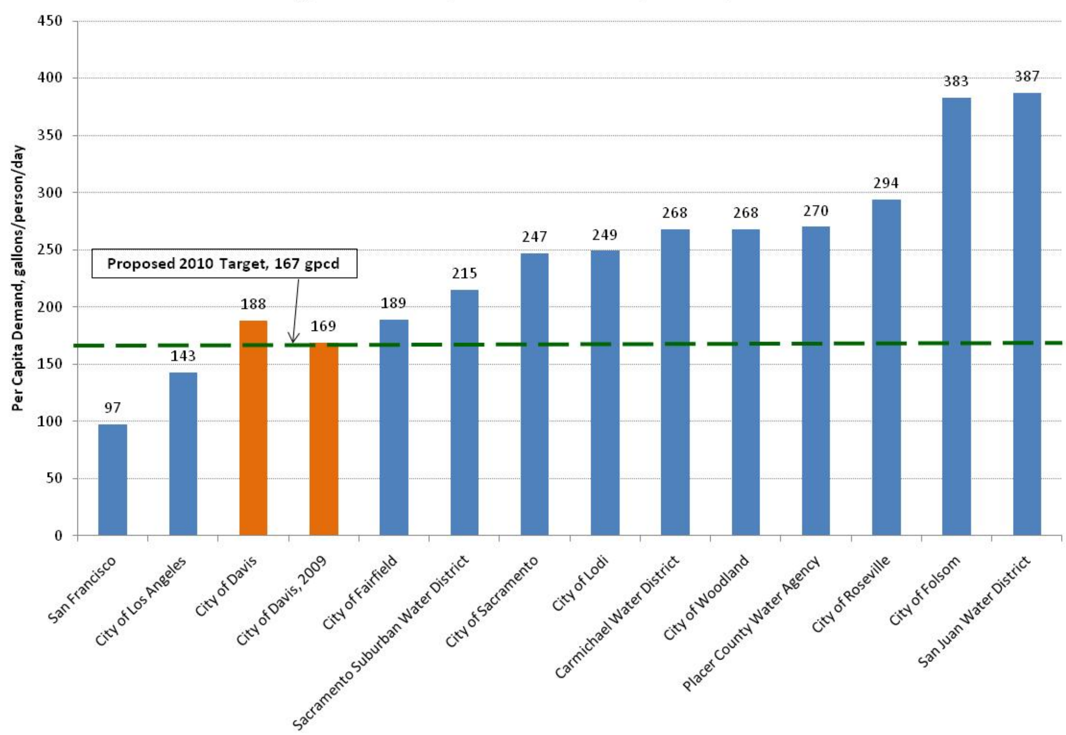


Figure 6. Per Capita Demand Comparison, 2008



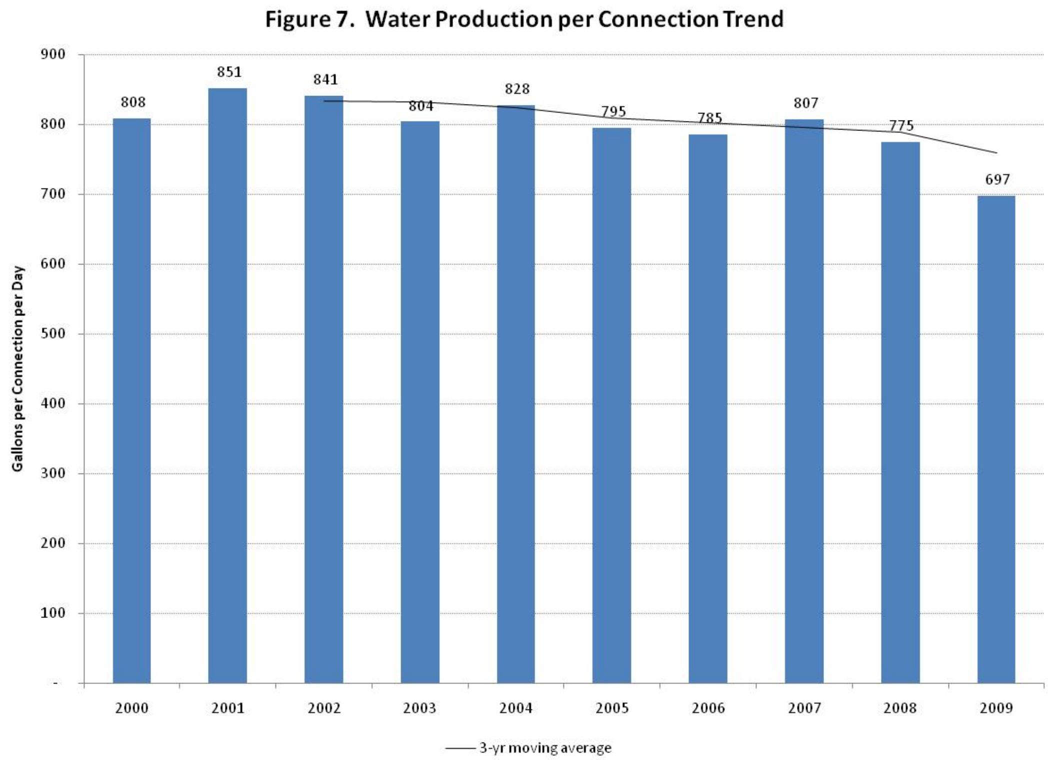


Figure 7. Water Production per Connection Trend
Gallons per Connection per Day
900
800
700
600
500
400
300
200
100
-
808
851
841
804
828
795
785
807
775
697
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
3-yr moving average

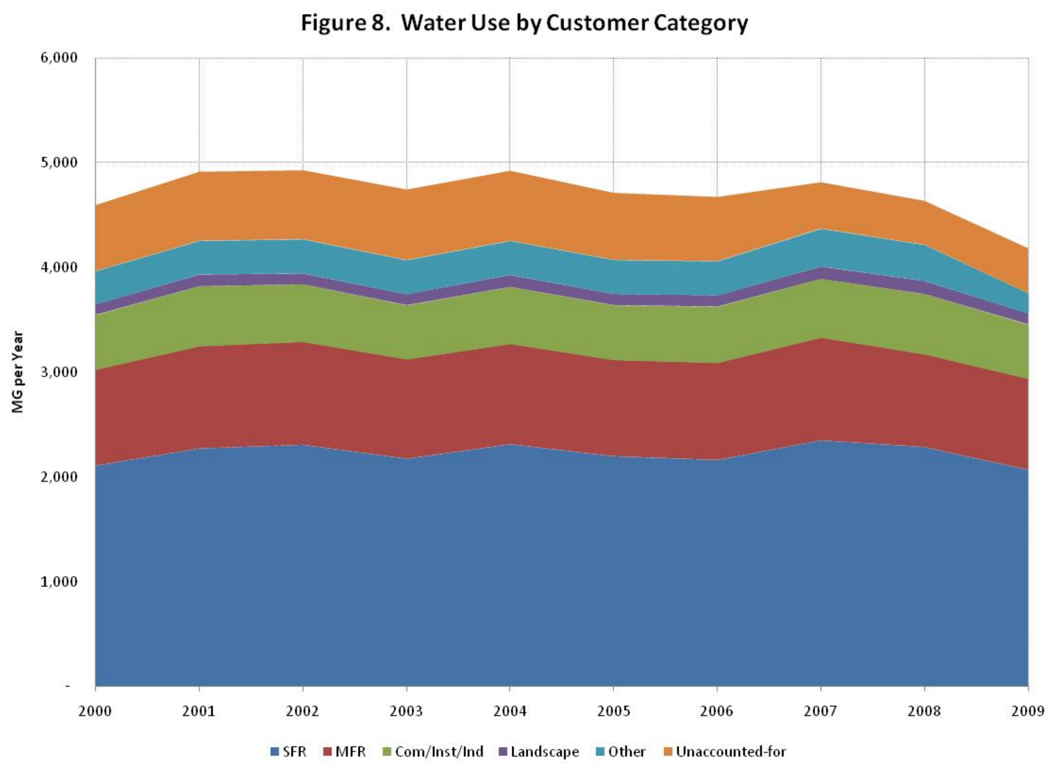


Figure 8. Water Use by Customer Category
MG per Year
6,000
5,000
4,000
3,000
2,000
1,000
-
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
SFR
MFR
Com/Inst/Ind
Landscape
Other
Unaccounted-for

Figure 9. Water Use per Connection Trends by Customer Category

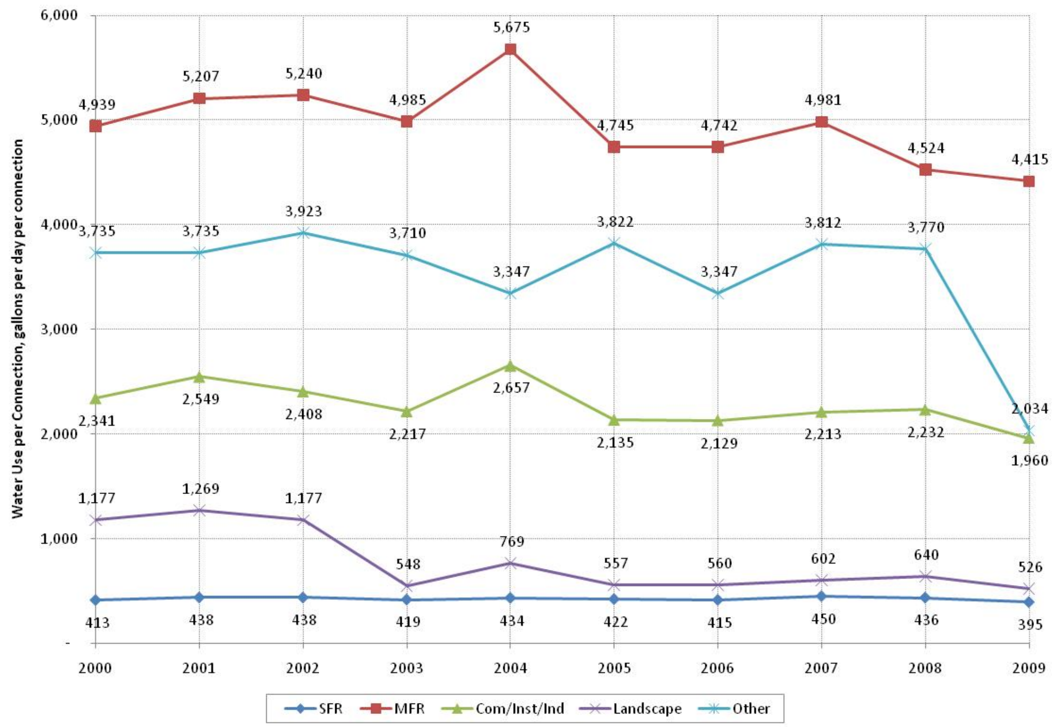
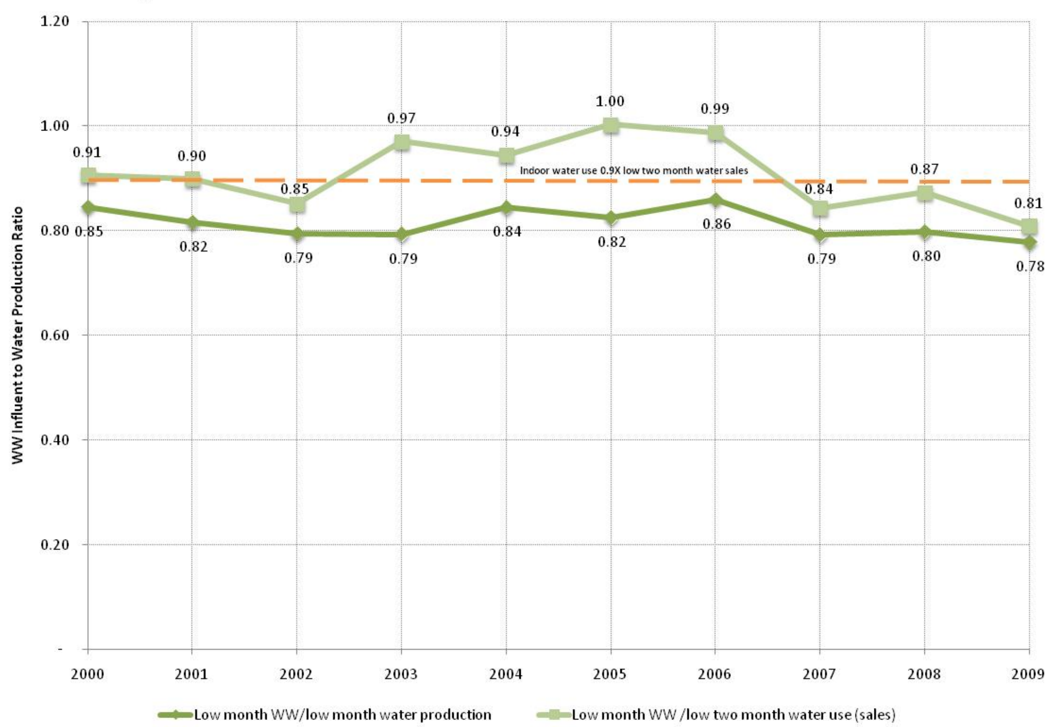


Figure 10. Ratio of WW Influent Low Month to Water Production Low Month



The indoor water use per connection was determined for each customer category over time by using 90% of the low two month water use period for every year, as depicted in Figure 11. The analysis shows that the indoor water use for a single family residential connection was 176 gallons per day (gpd) per connection. As a comparison, the unpublished SFR End Use Study (City of Davis participated) noted that indoor single family water use averaged 171 gpd per connection for Davis accounts included in the study sample.

The difference in total water use and indoor water use per connection per customer allows for the determination of the outdoor water use per connection per customer category, as shown in Figure 12. Outdoor water use will vary year to year due to different climate conditions. This analysis does not normalize outdoor water use for climate. As can be seen in Figure 12, some customer categories have had a decreasing trend in outdoor water use, especially the single family category.

The annual single family and residential water use was compared to population to arrive at the residential water use per person, as shown in Figure 13. Figure 13 also breaks down the per capita water use into the indoor and outdoor water use components.

The overall total annual per capita water use that is presented in Figure 5 is broken down into its customer category and indoor and outdoor water use components, as presented in Figure 14.

Water use also varies on a daily and monthly basis. Figure 15 presents the historical maximum month and maximum day peaking factors. The maximum day peaking factor is important for sizing water supply facilities. A maximum day peaking factor of 2.0 has been used by the City for water planning. As shown in Figure 15, the maximum day peaking factor has averaged 1.7 over the last ten years, and has exceeded 1.8 only one time. The City should have an evaluation performed on the peak hour water use to better define that important peaking factor.

Figure 16 presents the maximum month to minimum month water production ratio. This ratio has been relatively constant, though with a slight downward tend. This indicates that both outdoor and indoor water uses are being reduced, with a slightly greater decrease of indoor water uses. This is not surprising considering City indoor water conservation efforts including a Toilet Rebate Program for nine years and the still going Clothes Washer Rebate Program which began in 1996. New construction standards requiring low flow fixtures also explain this finding.

Figure 17 depicts monthly water use for the last three years for all of the customer categories. This figure provides a good visualization of how water use for the different customer categories varies on a monthly basis over a several year period, and was developed using bimonthly water sales data. Greater water use during the summer months due to outside watering is evident. Figure 19 presents a stacked chart of monthly water use for all of the customer categories plus unaccounted-for water, which was calculated as the difference between total monthly water production and total monthly water sales.

Figure 11. Indoor Water Use per Connection Trends by Customer Category

(based on 90% of lowest two month water use)

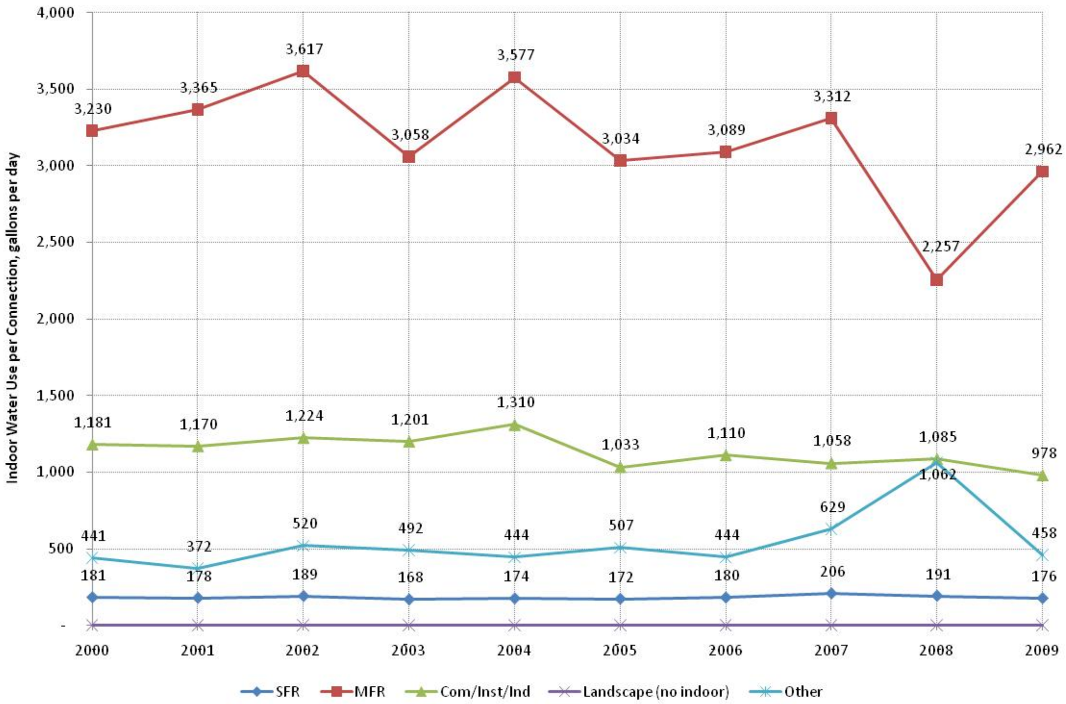


Figure 12. Outdoor Water Use per Connection Trends by Customer Category

(difference between total and indoor use)

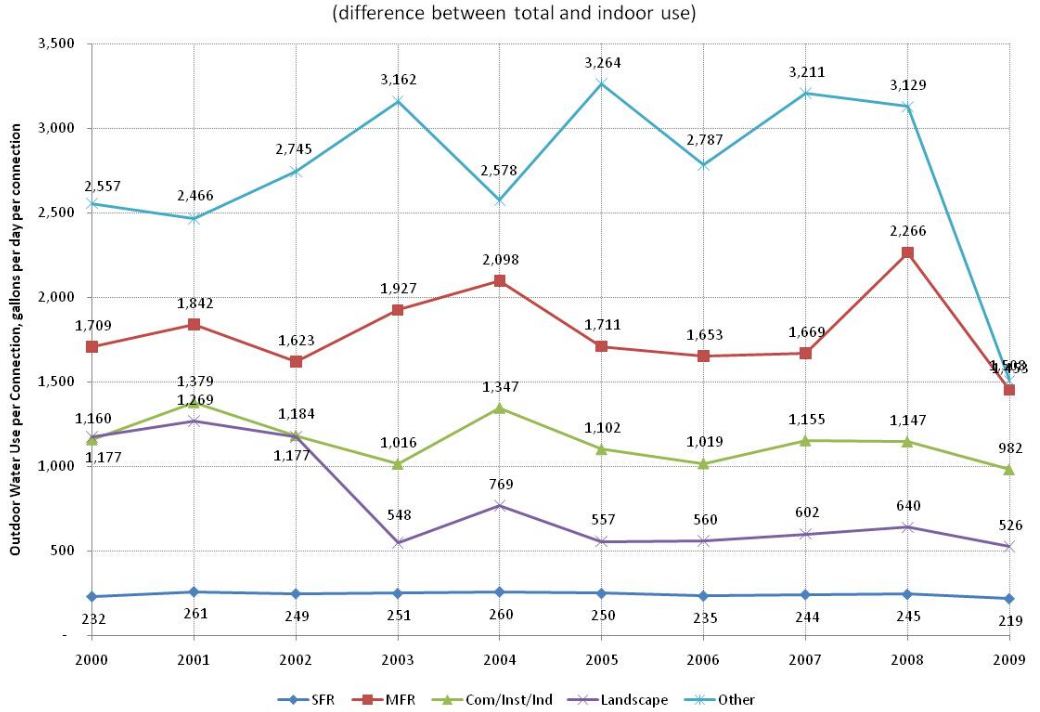


Figure 13. Residential Per Capita Water Use Trends (SF+MF)

(based on residential water sales divided by population)

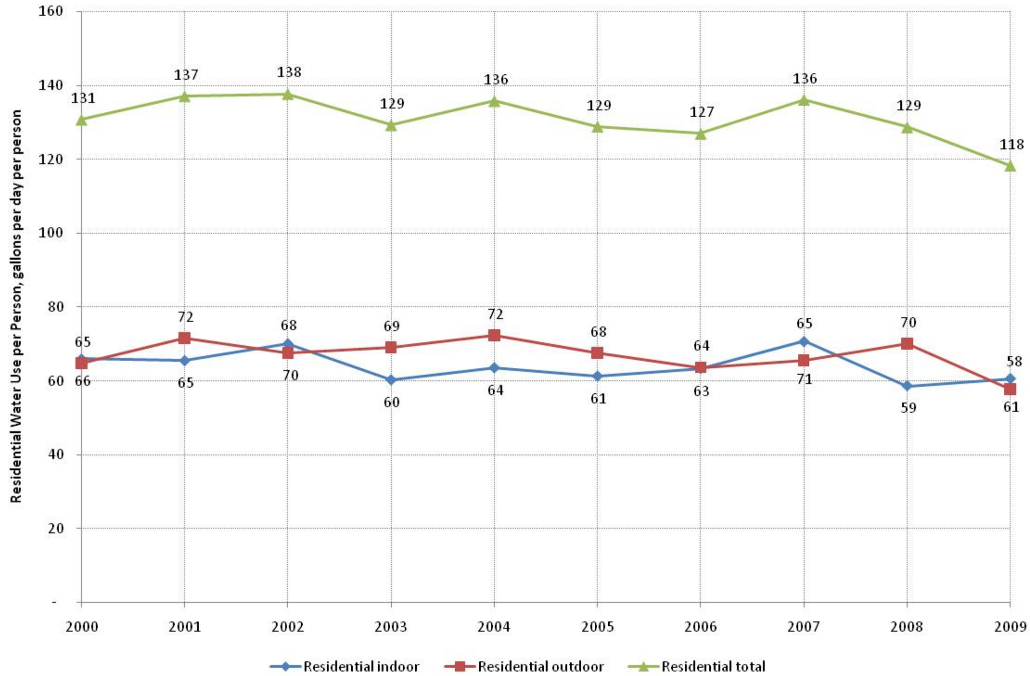
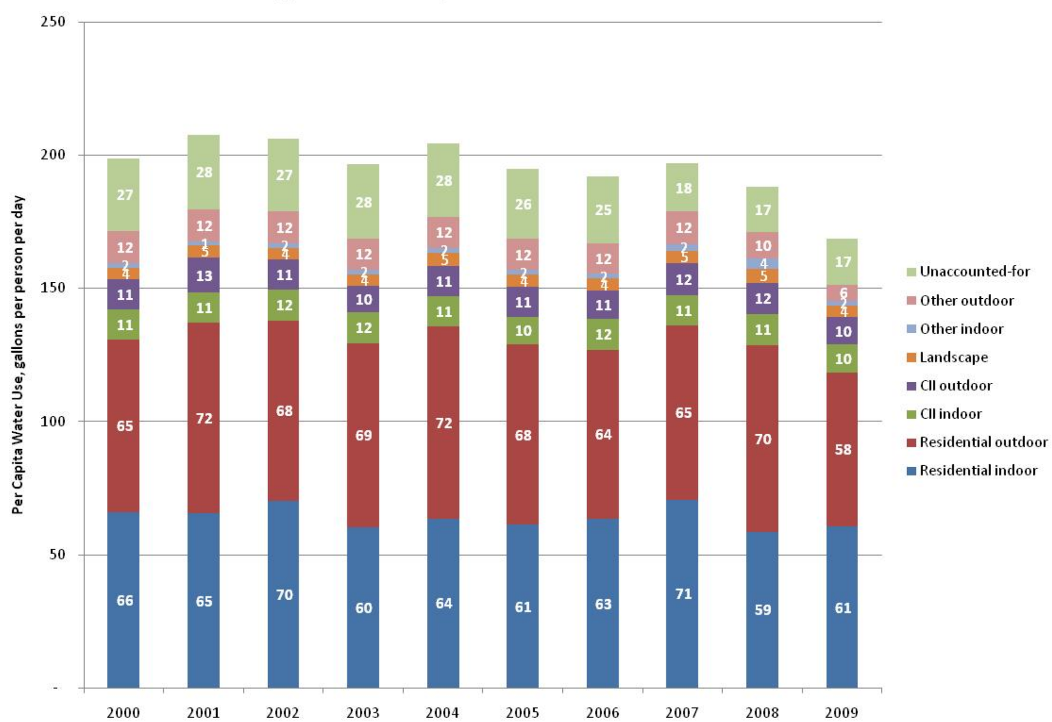


Figure 14. Per Capita Water Use Breakdown Trend



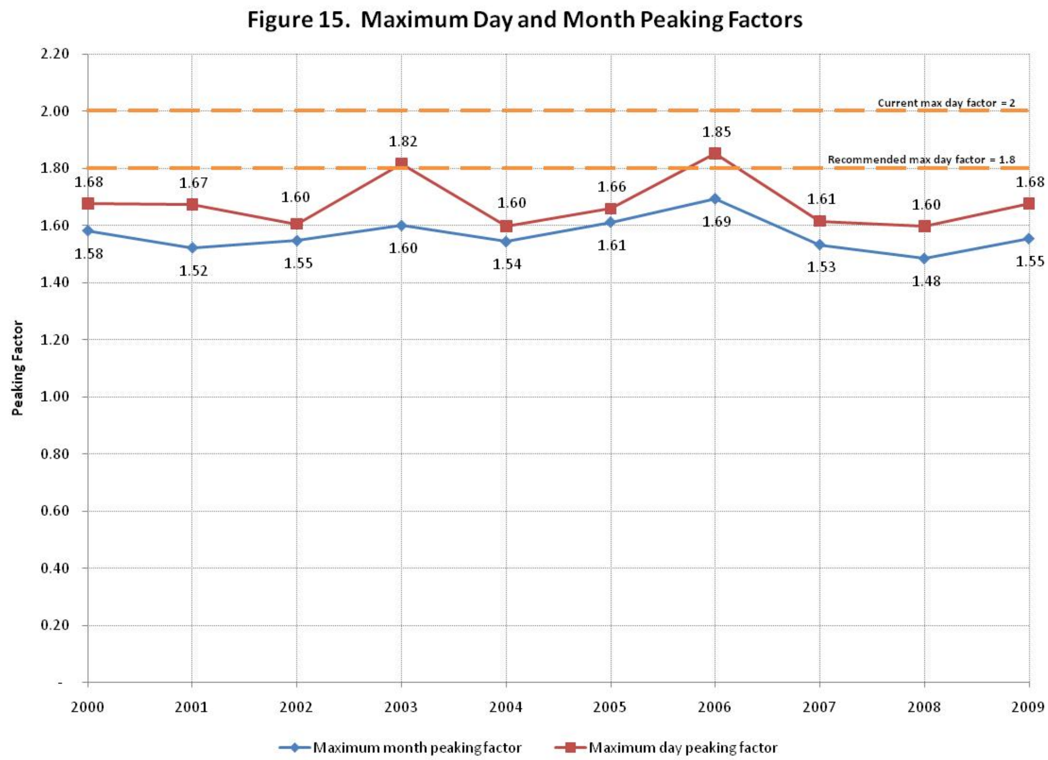


Figure 15. Maximum Day and Month Peaking Factors
Peaking Factor
Current max day factor = 2
Recommended max day factor = 1.8
1.68
1.67
1.60
1.82
1.60
1.66
1.85
1.61
1.60
1.68
1.58
1.52
1.55
1.60
1.54
1.61
1.69
1.53
1.48
1.55
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Maximum month peaking factor
Maximum day peaking factor

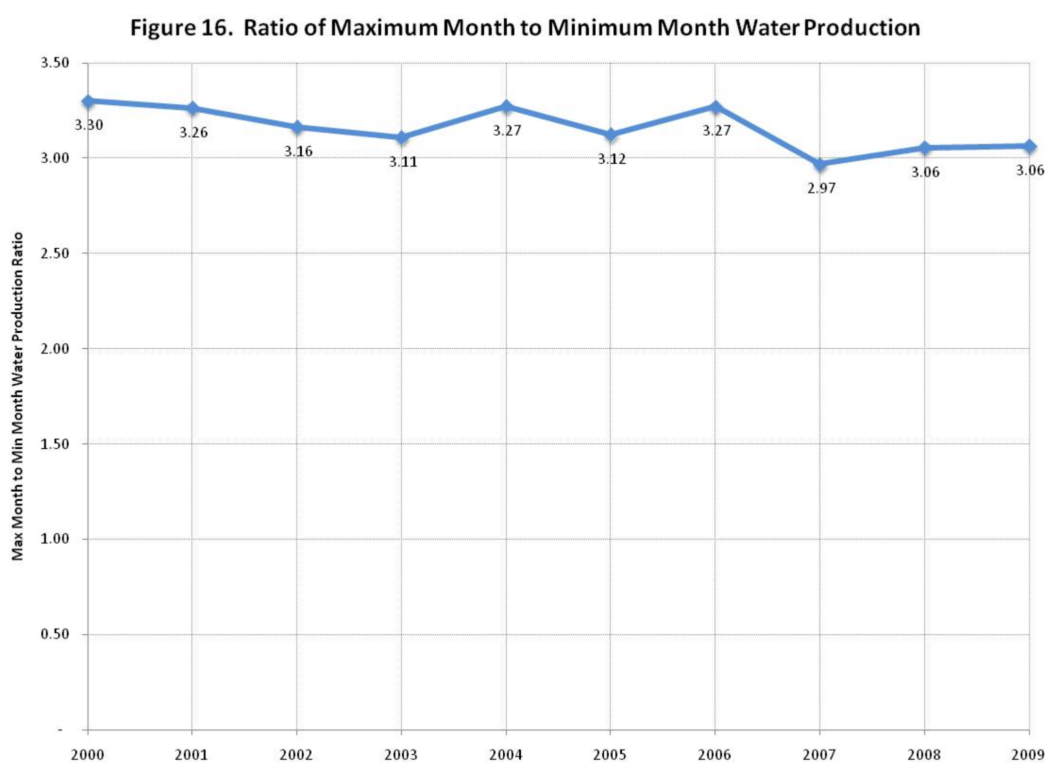
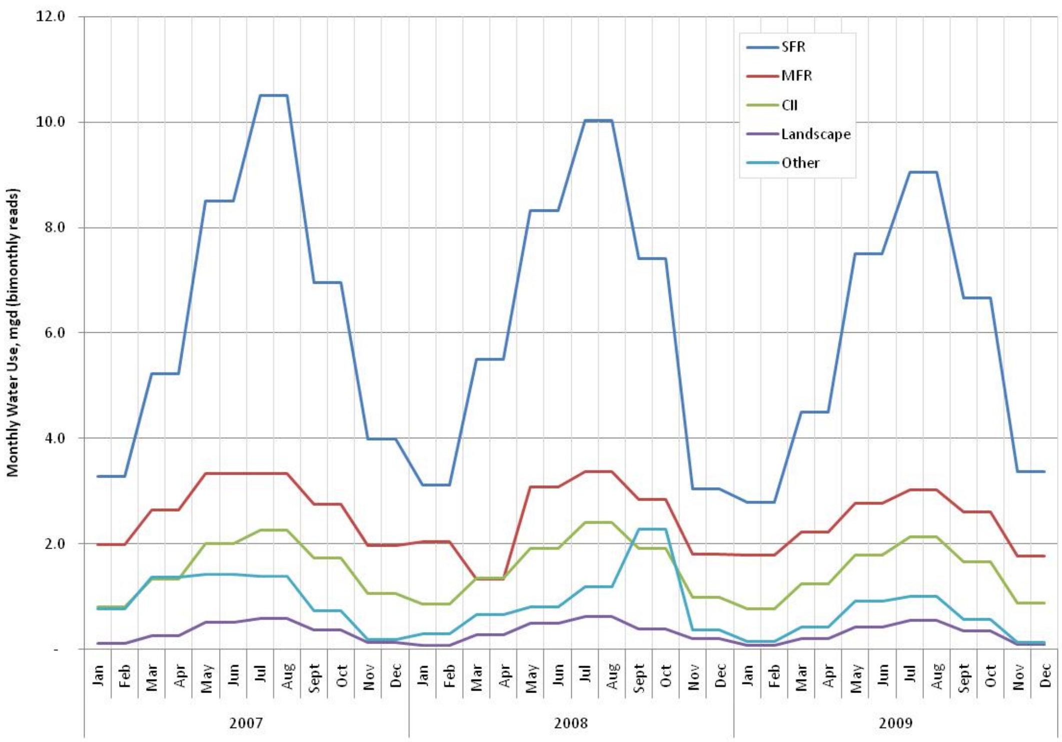


Figure 16. Ratio of Maximum Month to Minimum Month Water Production
Max Month to Min Month Water Production Ratio
3.30
3.26
3.16
3.11
3.27
3.12
3.27
2.97
3.06
3.06
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

Figure 17. Monthly Water Use by Customer Category



3. GPCD TARGET

New requirements regarding water use targets are in the SBX 7-7 bill passed in early November 2009 by the state legislature.

There are four methods that the legislation defines for establishing a GPCD target. Water agencies will have to select one of the methods to establish their 2020 water use target, as well as the interim 2015 target. The four methods available to establish a water agency's GPCD target are described below.

1. Eighty percent of the urban retail water supplier's baseline per capita daily water use using a 10-year average, starting no earlier than 1995. Method 1 is relatively straightforward in that it involves computing the population divided by the total water production by year. DWR is developing guidelines for this method that may result in revisiting the calculations presented herein.
2. The per capita daily water use that is estimated using the sum of several defined performance standards. This method requires quantifying the landscaped area and the baseline CII. Outdoor water use would be limited to the amount of landscape water use defined for the Model Landscape Ordinance. DWR is preparing the details of how this method should be developed.
3. Ninety-five percent of the applicable state hydrologic region target, as set forth in the state's 20x2020 Water Conservation Plan (dated February, 2010). Method 3 is the simplest of the methods as it involves looking up a table value for the applicable hydrologic region.
4. A method that shall be developed by DWR that considers density, climate, and other factors and reported to the Legislature no later than December 31, 2010, with a public draft available by October 1, 2010. The method will identify per capita targets that cumulatively result in a statewide 20-percent

reduction in urban daily per capita water use by December 31, 2020. Method 4 cannot be evaluated at this time because DWR has not yet defined the methodology.

Figure 19 presents the results of a preliminary analysis for Methods 1, 2, and 3, in comparison to the City's most recent 3-year average GPCD. The 1995 to 2004 period gives the highest 10-year GPCD baseline for the City. The analysis for Method 2 must be considered very preliminary at this time since Method 2 requires quantifying the landscaped area that receives water. This landscaped area is not precisely known, and was approximated as a range for this analysis. The City is also looking at a more aggressive water conservation target contained in the DWWSP EIR.

The City will have to select the GPCD method it will use for the urban water management plan due by July 1, 2011. Factors to consider in selecting the GPCD method include ease of calculation, consistency with current water use trends, and benefits of certain GPCD targets on future water facility costs.

For this analysis, it is assumed that the City will select Method 3, which is a 2020 target of 167 GPCD. The City's per capita water use is already lower than the 2015 target of 204 GPCD. And 2009 per capita water use was 169 GPCD.

The City's future annual water demand is projected in Figure 20 based on the Method 3 target. The projection assumes that the population will increase by 2.5% from 2010 to 2015, and then 5% for every subsequent 5-year interval. The 2015 GPCD is assumed to be halfway between the most recent 3-year average GPCD and the 2020 target GPCD. Figure 20 also depicts the demand projection that was made by the City in 2005 and a projection based on a per capita demand of 161 GPCD that was described in the EIR.

Figure 21 presents the projection of maximum day demand for the EIR annual demand projection combined with a 2.0 maximum day demand peaking factor, and the 167 and 161 GPCD annual demand projections combined with a 1.8 maximum day demand peaking factor.

As shown in Figures 20 and 21, the City has been experiencing declining annual and maximum day water use over the last few years. This decline in water use is also occurring with other nearby water agencies, as depicted in Figures 22 and 23.

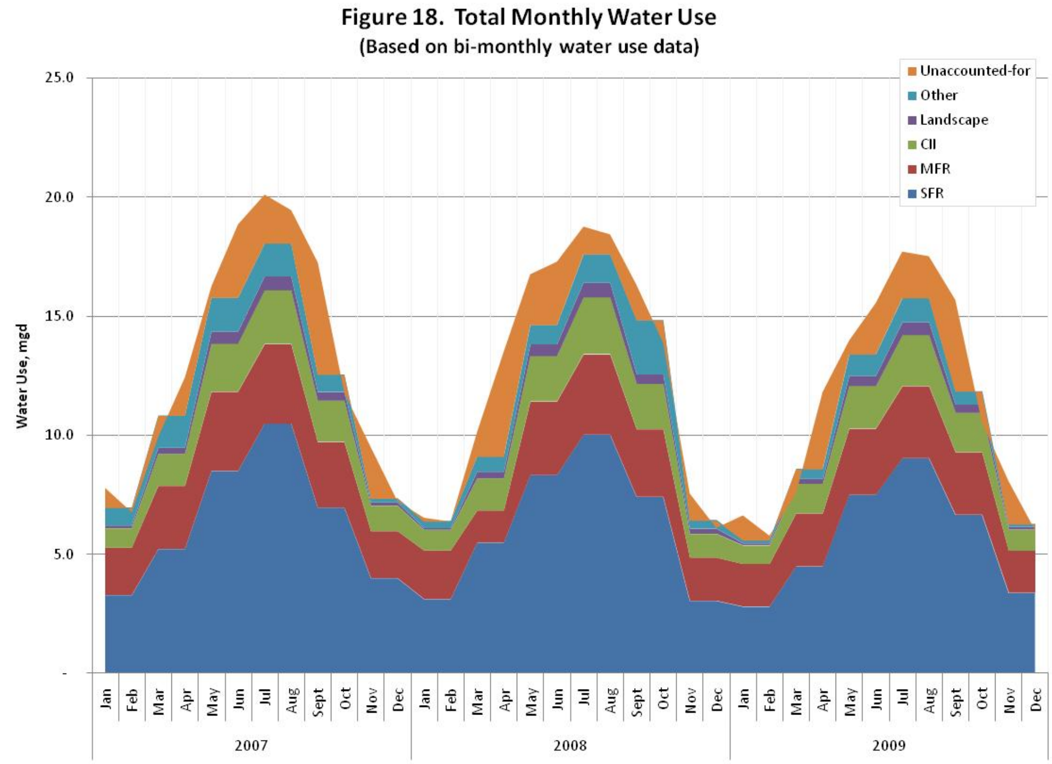


Figure 18. Total Monthly Water Use
(Based on bi-monthly water use data)
Unaccounted-for
Other
Landscape
CII
MFR
SFR
Water Use, mgd
25.0
20.0
15.0
10.0
5.0
-
Jan Feb Mar Apr May Jun Jul Aug Sept Oct Nov Dec
2007
2008
2009

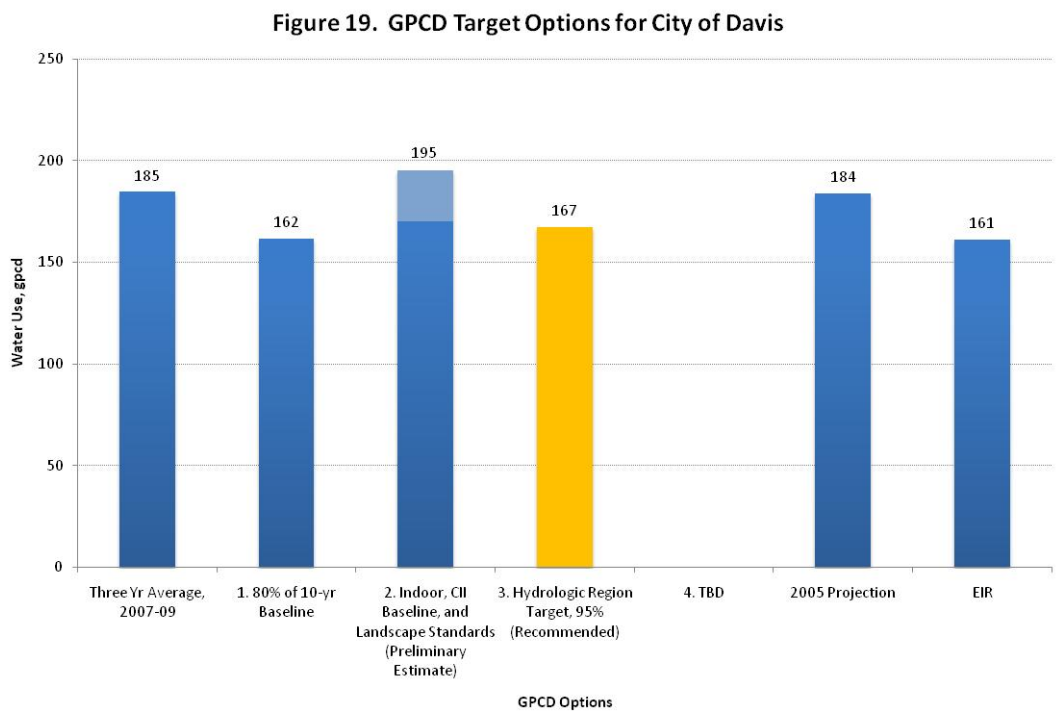


Figure 19. GPCD Target Options for City of Davis
Water Use, gpcd
250
200
150
100
50
0
185
162
195
167
184
161
Three Yr Average, 2007-09
1. 80% of 10-yr Baseline
2. Indoor, CII Baseline, and Landscape Standards (Preliminary Estimate)
3. Hydrologic Region Target, 95% (Recommended)
4. TBD
2005 Projection
EIR
GPCD Options

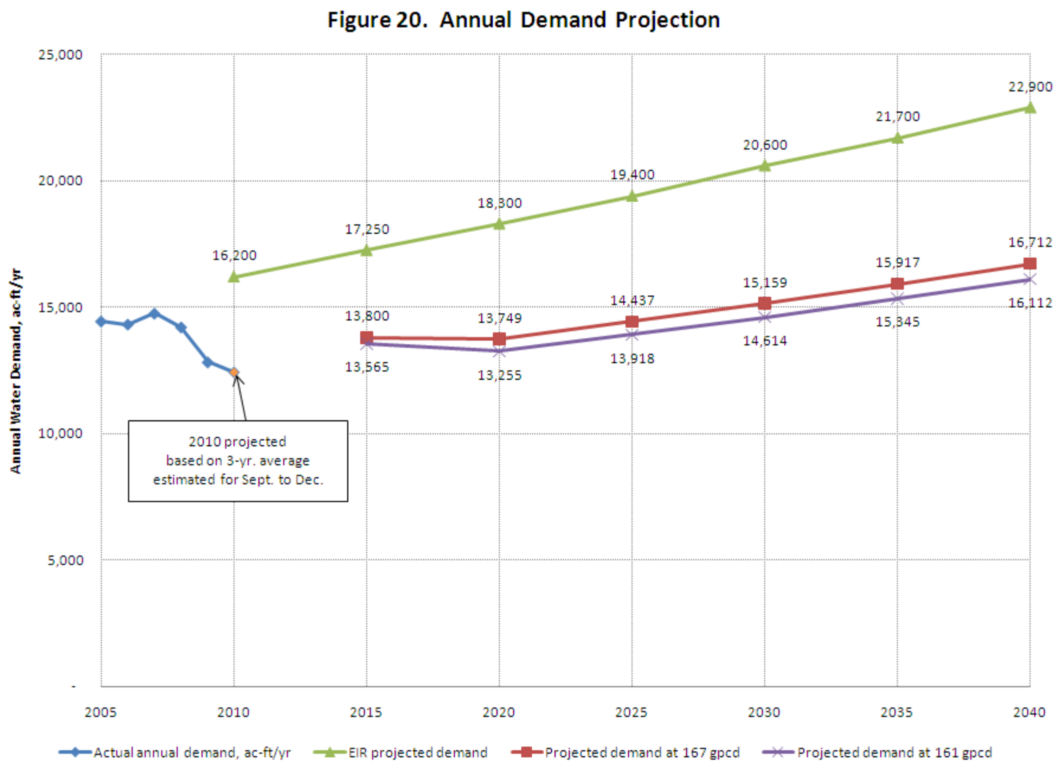


Figure 20. Annual Demand Projection
Annual Water Demand, ac-ft/yr
25,000
20,000
15,000
10,000
5,000
-
2005
2010
2015
2020
2025
2030
2035
2040
16,200
17,250
18,300
19,400
20,600
21,700
22,900
13,800
13,749
14,437
15,159
15,917
16,712
13,565
13,255
13,918
14,614
15,345
16,112
2010 projected based on 3-yr. average estimated for Sept. to Dec.
Actual annual demand, ac-ft/yr
EIR projected demand
Projected demand at 167 gpcd
Projected demand at 161 gpcd

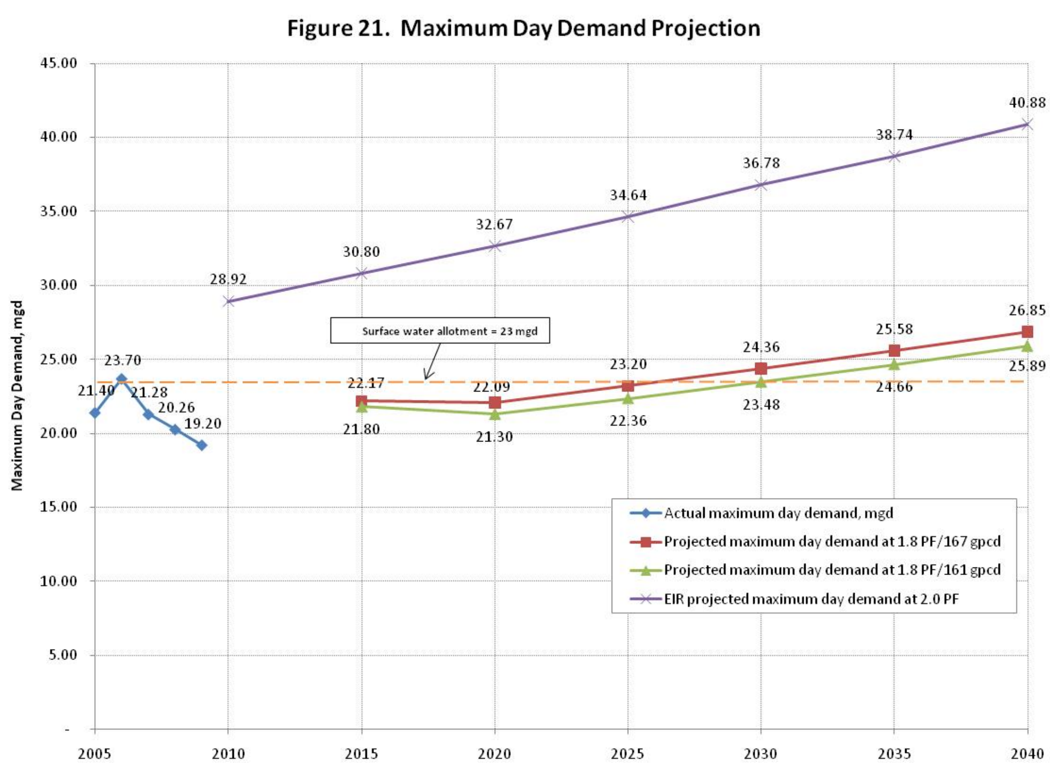


Figure 21. Maximum Day Demand Projection
Maximum Day Demand, mgd
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
-
2005
2010
2015
2020
2025
2030
2035
2040
21.40
23.70
21.28
20.26
19.20
28.92
30.80
32.67
34.64
36.78
38.74
40.88
22.17
22.09
23.20
24.36
25.58
26.85
21.80
21.30
22.36
23.48
24.66
25.89
Surface water allotment = 23 mgd
Actual maximum day demand, mgd
Projected maximum day demand at 1.8 PF/167 gpcd
Projected maximum day demand at 1.8 PF/161 gpcd
EIR projected maximum day demand at 2.0 PF

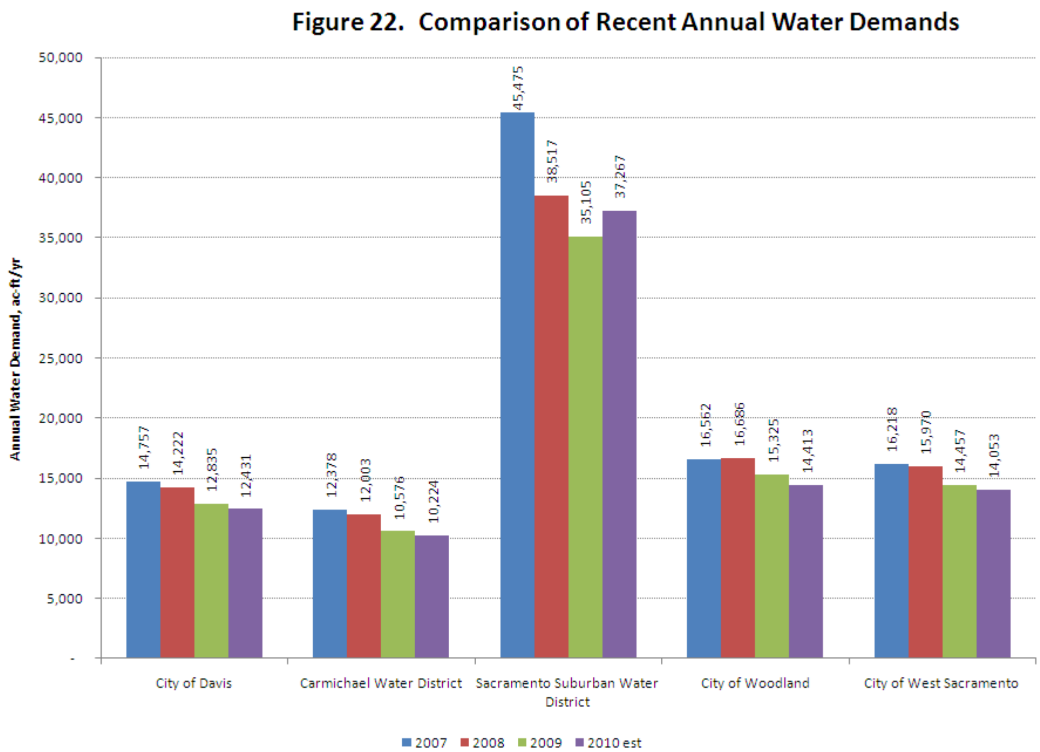


Figure 22. Comparison of Recent Annual Water Demands
Annual Water Demand, ac-ft/yr
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
14,757
14,222
12,835
12,431
12,378
12,003
10,576
10,224
45,475
38,517
35,105
37,267
16,562
16,686
15,325
14,413
16,218
15,970
14,457
14,053
City of Davis
Carmichael Water District
Sacramento Suburban Water District
City of Woodland
City of West Sacramento
2007
2008
2009
2010 est

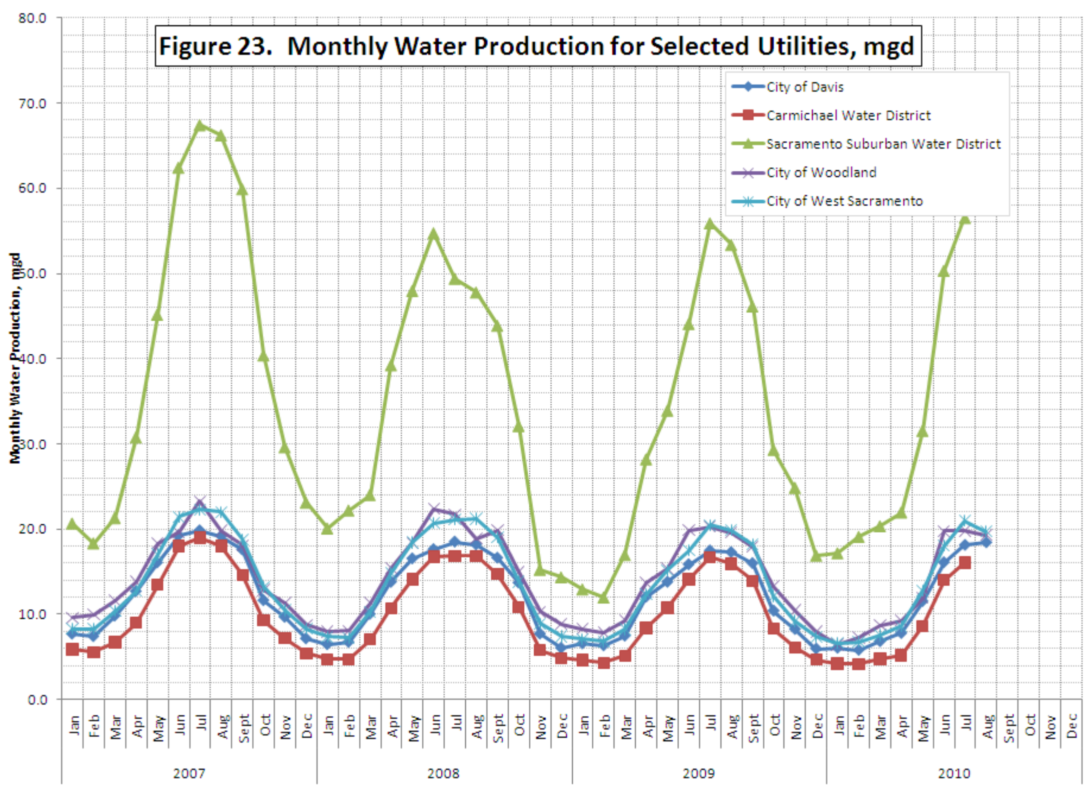


Figure 23. Monthly Water Production for Selected Utilities, mgd
Monthly Water Production, mgd
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
City of Davis
Carmichael Water District
Sacramento Suburban Water District
City of Woodland
City of West Sacramento
Jan Feb Mar Apr May Jun Jul Aug Sept Oct Nov Dec
2007
2008
2009
2010

4. APPROACH TO MEET THE 2020 GPCD TARGET

The City will have to further reduce per capita water use to meet the 2020 GPCD target. A combination of the installation of low flow devices, reduction of distribution system and customer leaks, implementation of outdoor landscaping measures, and price elasticity impacts will reduce demands. It is beyond the scope of this analysis to develop the details of the optimal program to meet the 2020 water use target, however a framework for the recommended approach is presented. The priority will be focused on measures that reduce long term maximum day and peak hour demands that would benefit cost-effective infrastructure planning efforts.

Price elasticity as it pertains to the water supply field refers to the reduction in water use that occurs as a result of an increase in the cost of water. For a situation where the cost of water increases on track with the inflation rate, one would expect the use of water to not decline. However, a larger increase in the cost of water that exceeds the inflation rate would likely result in a reduction in the use of water. For example, a doubling of the cost of water that results in a 10% decrease in water use is defined as a price elasticity coefficient of 0.10.

The End Use Study identified low flow toilets and high efficiency clothes washers as opportunities where the penetration into the customer base still has significant room to grow. Table 3 presents an evaluation of indoor single family residential water savings that could be realized from increasing the penetration of some low flow devices to 75%and reducing customer leakage. Penetration refers to the extent or number of customers that have low flow devices installed. As shown in Table 3, these measures would reduce water use by 7 GPCD. Additional water savings would be expected from applying the same measures to the other customer categories such as multifamily residential and commercial. Note that the penetration of low flow devices will naturally increase as customers replace old fixtures and new homes are constructed. Rebate programs serve to merely accelerate the conversion process.

Table 3. Evaluation of Indoor Water Savings per Single Family Connection from Increased Penetration of Low Flow Devices

Fixture	Average SF indoor water use, End Use Study, gpd/SF con	Actual 3-yr aver SF indoor water use, gpd/SF con	Water use for SF with low flow devices, gpd/SF con	Low flow device penetration, %	Water use for non-low flow SF, gpd/SF con	Average SF indoor water use at 75% penetration/25% leakage reduction, gpd/SF con	Reduction, gpd/SF con	Per capita water use reduction @ 3.0 people/SF con
Toilets	39.1	--	25.4	22%	43.0	29.8	9.3	3.1
Clothes washer	26.9	--	24.3	45%	29.0	25.5	1.4	0.5
Shower	33.0	--	44.1	87%	44.1	33.0	0.0	0.0
Leakage	37.4	--	37.4	--	37.4	28.1	9.4	3.1
Faucet	27.2	--	27.2	--	27.2	27.2	0.0	0.0
Bath	2.8	--	2.8	--	2.8	2.8	0.0	0.0
DW	1.9	--	1.9	--	1.9	1.9	0.0	0.0
Other	2.6	--	2.6	--	2.6	2.6	0.0	0.0
Total indoor use	170.9	193	165.7	--	188.0	150.8	20.1	6.7

Table 4 presents one approach to meeting the 2020 GPCD target through a combination of:

1. Increasing the penetration of low flow toilets and high efficiency clothes washers for single family residential customers to 75% and reducing single family residential customer leaks by 25%. This is 7 GPCD water savings calculation presented in Table 3. Reducing customer leakage would require an automatic meter reading system so that the City could rapidly identify customer leaks. The current method of reading a customer meter every two months cannot identify customer leaks.
2. Reducing outdoor residential water use by 15%.
3. Reducing CII indoor water use by 5%.
4. Reducing outdoor CII, landscape, and other water use by 10%.
5. Reducing unaccounted for water use by 25%.

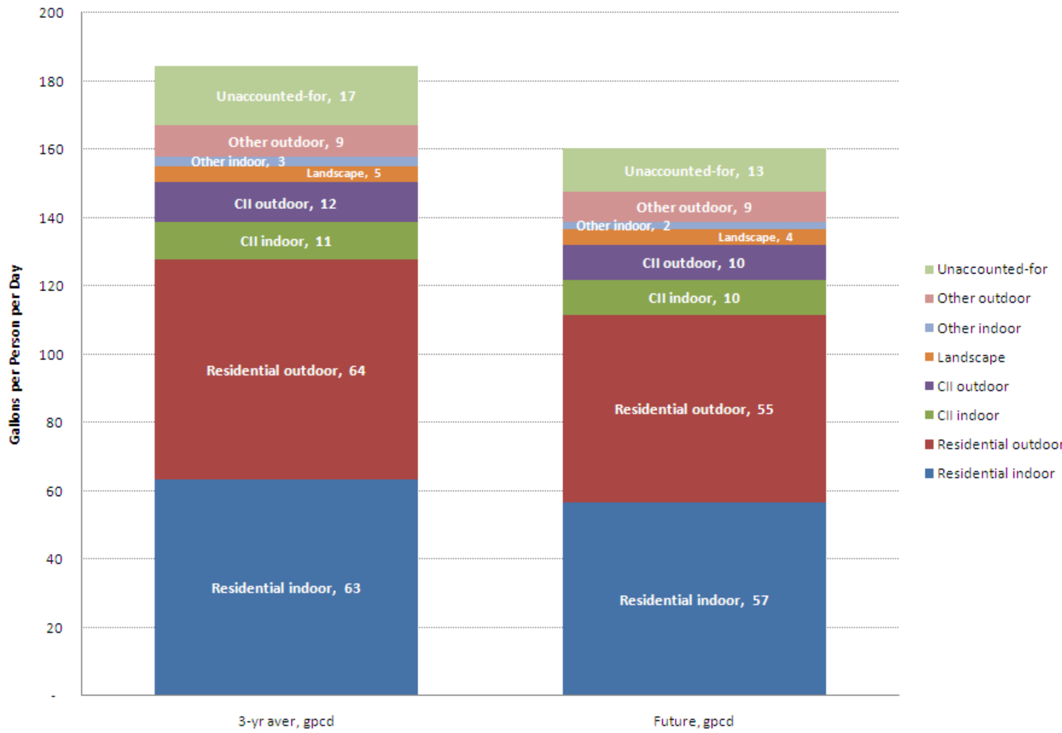
This approach is an example of the possible water savings from a given combination of actions and is not meant to be construed as a recommendation.

Table 4. Approach to Meeting the 2020 GPCD Target

	3-yr aver, gpcd	Future, gpcd	Remarks	AF/yr savings	Annual value @ $300/AF
Residential indoor	64	57	toilet and CW 75% penetration, 25% leakage reduction	539	161,672
Residential outdoor	64	55	15% reduction	789	236,678
CII indoor	11	10	5% reduction	45	13,441
CII outdoor	12	10	10% reduction	94	28,266
Landscape indoor	1	1	0% reduction	--	--
Landscape outdoor	4	3	10% reduction	29	8,816
Other indoor	3	2	0% reduction	22	6,670
Other outdoor	9	9	10% reduction	78	23,284
Unaccounted-for	17	13	25% reduction	356	106,821
TOTAL	185	161	--	1,952	585,647

Figure 24 compares the current GPCD breakdown to the GPCD breakdown that would result from the example approach to meeting the GPCD target.

Figure 24. Current and Future GPCD Breakdown



The City will have to meet the GPCD water target mandate in the new legislation. The City has already made significant progress to improving water use efficiency. Further reductions in water use, particularly maximum day and peak our demand, will provide the benefit of downsizing and/or delaying the construction of new water supply facilities. Following are recommendations for the City to consider:

1. Select GPCD method 3 as the preferred water use target method and the resulting 2015 and 2020 GPCD targets.

2. Refine the current water conservation program to focus on reducing peak demands so as to provide facility capacity size benefits, minimize impacts on customers, and be cost effective. Define the optimal level of water conservation investment to maximize the cost savings from reduced sizes of facilities. The key elements of the program would include:

   a. Customer leak reduction after implementation of automatic meter reading.

   b. Distribution system leak reduction.

   c. Reduction of summer demands by focusing on outdoor water use measures.

   d. Monthly billing to send a quicker price signal to customers.

3. Develop a projection of the future peak hour demand that would result from meeting the 2020 GPCD target and implement recommended outdoor water use reduction measures as a means to reduce peak hour water use.

4. The City needs to collect adequate water revenues in a climate of declining per capita water use. The City's rate setting process needs to be based on a projection of the future water demands that incorporates the pricing effect on customer water use. Conduct an analysis of the likely impact on water use due to the price elasticity impacts of increased water rates. Consider the impact on water use due to water rate revisions that would occur from the implementation of the Davis Woodland Clean Water Project. Evaluate the number of tiers, tiered water use levels and price points.
5. Update the water system audit conducted in 1997, and use the new AWWA approach.
6. Improve the accuracy of measurements of the water used by City facilities.
7. Conduct a survey using a representative sample of customers to gauge the penetration of low flow devices with emphasis on multifamily residential customers.
8. Assess the extent of leaks being experienced by customers. Expand the work done in the End Use Study to also include other categories of customers.
9. Develop a "dashboard" approach to monitoring key water use indicators so that the City and its customers have real time knowledge regarding being on track to meet the GPCD goal.
10. Consider removing some landscaped areas from the potable water system by converting their supply to dedicated intermediate depth wells.
11. Use a maximum day peaking factor of 1.8 as a design basis.
12. Develop a 10-year water conservation program and budget that meets the new water use target with the option to pursue the aggressive water conservation EIR target if facility cost savings substantiate this approach.

ATTACHMENT A

City of Davis SFR End Use Study

SITE REPORT – City of Davis

The City of Davis (Davis) was a participant in the California Single Family Water Use Efficiency Study. The goal of this study was to obtain a detailed analysis on the indoor and outdoor water use patterns of a random sample of single family homes in each of the participating agencies. This information was intended to show how much water was used in the homes for each of the major domestic end-uses. In addition, several types of efficiency data were to be obtained for indoor use such as the average gallons per flush for toilets, the flow rates for showers and faucets, and the gallons per load for clothes washers.

Outdoor water use for the study homes was characterized with respect to the total annual outdoor use, the actual application rate to the landscape in inches and the theoretical irrigation requirement for the home based on the irrigated area by plant type, the local net ET and reasonable irrigation efficiencies based on the type of irrigation system. The ratio of the actual application to the theoretical requirement was used as the main efficiency parameter. Homes with ratios greater than 1 were applying more than their theoretical requirements, and homes with ratios less than 1 were applying less than the theoretical requirements.

Besides providing a benchmark for water use in the community, this information is useful for evaluating how well the agency is doing with implementation for the various water conservation BMP's. As signatories to the CUWCC Memorandum of Understanding each agency has agreed to make good faith efforts to achieve specific coverage levels for each of the BMP's. These coverage levels typically consist of percentages of the households having achieved a targeted level of performance for each measure. Specifically, the information collected in this study is intended to provide data for evaluating performance on BMP 1, residential audits; BMP 2, plumbing retrofits; BMP 6, High Efficiency Clothes Washers; and BMP14, residential ULFT retrofits.

As part of that study several sources of data were used to characterize the water use patterns and efficiency levels of the single family water customers in the agency's service area. This report provides a summary of the statistics and end-use results for these customers. A total of 120 homes were sampled in Davis, and valid data were obtained from 102 homes. Each of the homes had been mailed a survey and a letter requesting permission to participate in the study. The final logging group was selected from homes that had returned surveys and given their consent. Results for both indoor and outdoor use are presented here.

Annual Water Use

Single family residences make up 88% of all of the service connections to the system and they account fo 47% of the treated water use. Multi-family residential account for an additional 19% of water deliveries, so residential customers account for nearly 2/3rds of total water use in the system.[1] Table 1 provides the summary statistics for 2006 annual water use in the single family residents in Davis. These homes were used to select the logging homes in Davis. They were determined to match the water use patterns of the population of single family homes in the service area.

Table 1: Annual water use statistics for Davis Customers 2005

	Total Use (kgal) 2006
Average	158
Number	13194
Median	142

Figure 1 shows the distribution of annual water use for the single family homes in the City of Davis billing database. The final logging group was selected from this group after being checked to verify their statistical similarity. Figure 2 shows the percent of billed deliveries going to each of the customer categories identified in the billing database for the year 2005. This information came from the annual report filed by Davis with the State DWR.

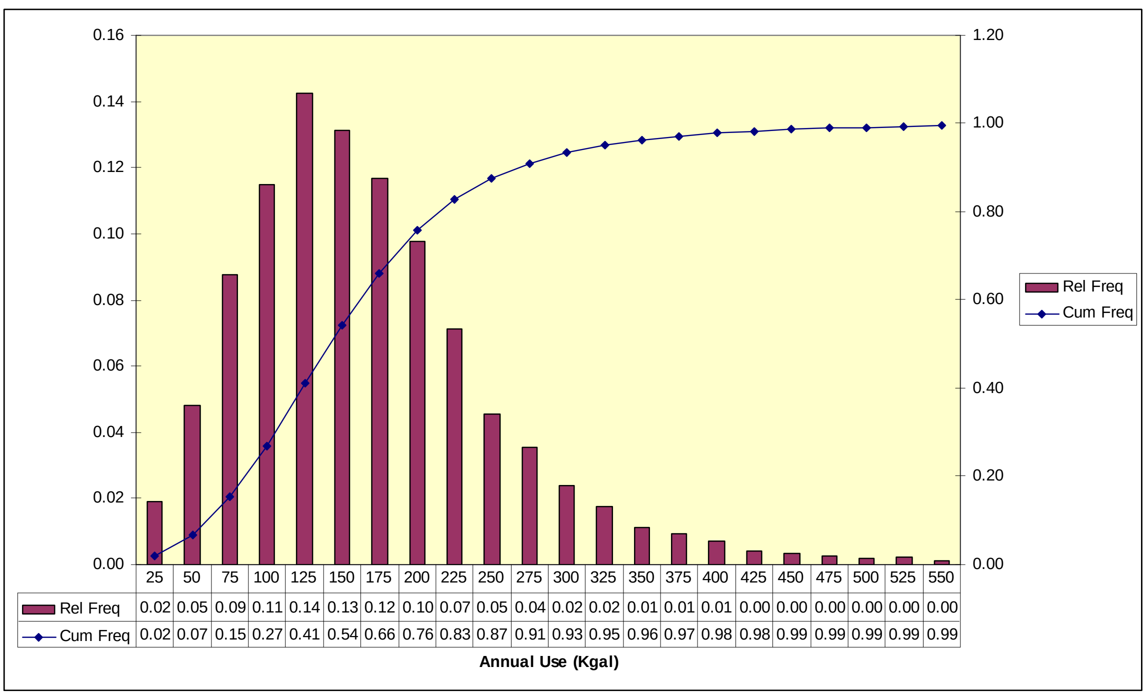


Figure 1: Annual water use in City of Davis study homes (kgal x 1.34 = ccf)

[1] Z:\Projects\IRWD SF Study 2005\T1 StdyGrpSelect\City of Davis\[City of Davis Water Use Data.xls]2005 DWR Form

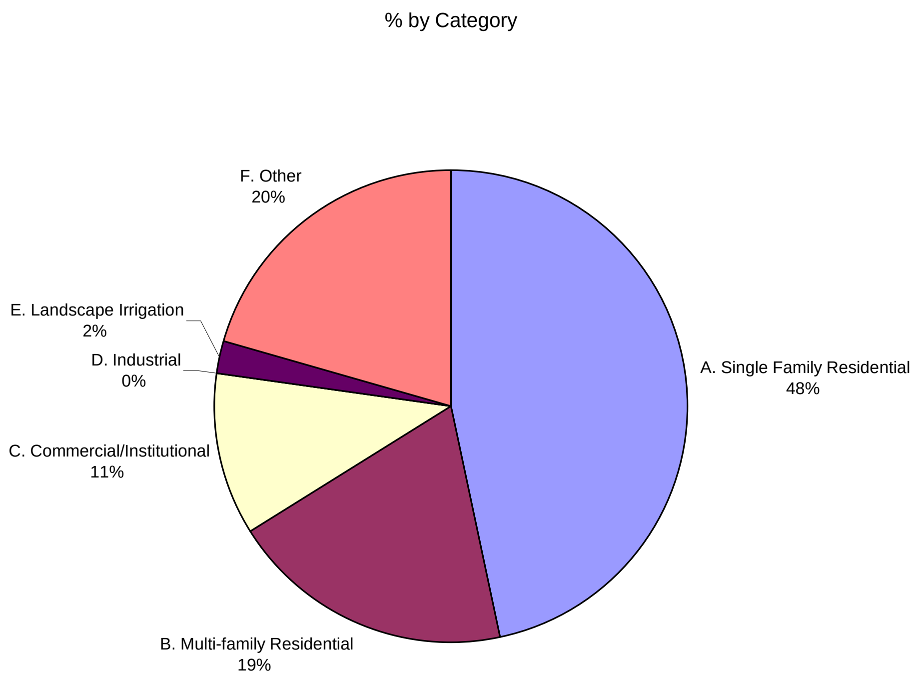


Figure 2: Billed consumption percentages by customer category for Davis

Indoor Uses

Using the event database created from the flow traces it is possible to segregate indoor and outdoor water use in the homes, and examine each type of use separately. This section of the analysis looks at indoor uses. Leakage is included among indoor uses, but it should be kept in mind that many of the leaks may be due to faulty irrigation systems, and it is often impossible to distinguish these from indoor leaks. The analyses are also based on total household use (rather than pre-capita use) since we did not want to normalize the data on a percapita basis separately from the other important explanatory variables. Also, since most utilities do not know the number of residents living in each home it makes more sense to analyze consumption on a household basis, which is something that the billing data provides.

Total Indoor Use

The indoor use events excluded the irrigation events, which eliminates the confusion caused by winter watering. Table 2 compares the total indoor water use for the 59 Davis study homes to the results from the REUWS and the EPA retrofit study. These data show that the total indoor water use for the homes is significantly higher than either the REUWS sample from 1996 and the consumption levels obtained in the EPA study group, which were typical single family homes that were retrofit with high efficiency fixtures and appliances. In 1996 the indoor use measured for these homes when they were part of the REUWS showed their indoor use at 157 gphd, which suggests an increase in indoor water use is occurring over time in these homes.

Figure 3 shows a histogram of the total indoor water use for the study homes. It is clear from this graph that there is still significant potential for water conservation savings in the homes within theDavis service area. The data show that 40% of the homes use more than 150 gpd, and are the best candidates for indoor water conservation measures. Approximately 10% of the homes are using more than 250 gpd for indoor uses.

Table 2: Indoor water use in Davis compared to REUWS and EPA Retrofit data

Parameter	REUWS (gpd)	Davis gpd	EPA Post Retrofit Study (gpd)
Mean ± 95% C.I.	177 ± 5.5	171 ± 26	107 ± 10.3
Median	160	157	100
N	1188	30	96
Std Deviation	96.8	99.6	50.9

Note: The indoor use for these homes in 1996 was 157 gphd.

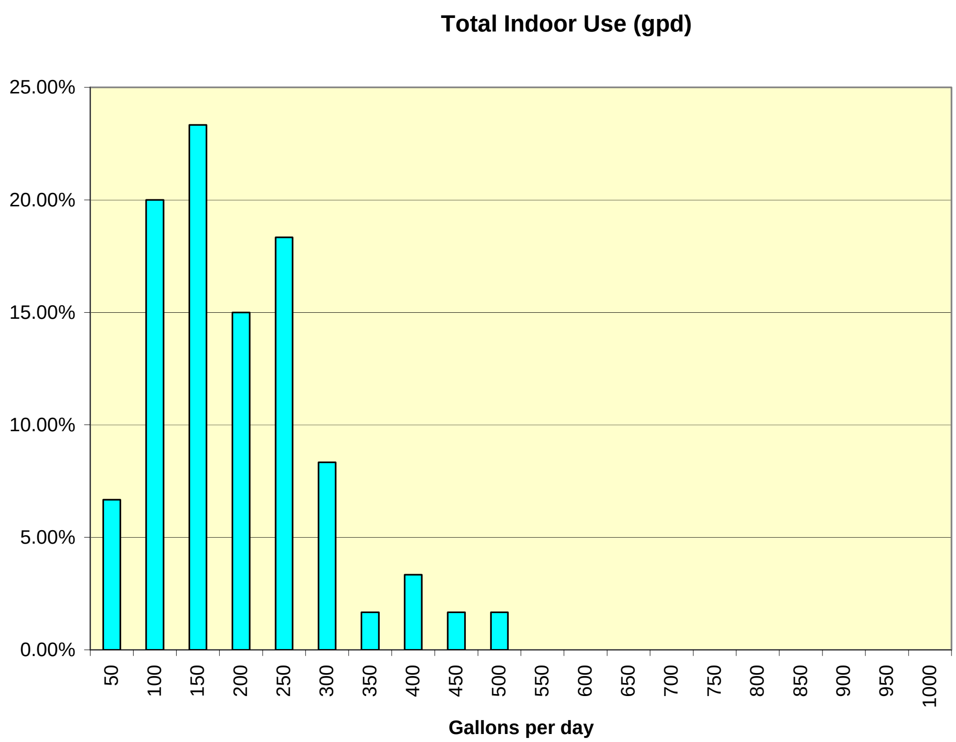


Figure 3: Indoor use histogram for Davis study homes

Disaggregated Household Use

When we look at how the indoor water use breaks down in the Davis study homes, we see that the same five categories: leaks, faucets, showers, clothes washers and toilets still make up the bulk of indoor use. As shown in Figure 4 these categories make up over 92% of total indoor water use in the sample homes.

Figure 5 shows the breakdown of indoor water use into its components in comparison to the REUWS group. The data show that the water use in Davis was higher than the REUWS group for showering, faucets and leakage, and lower for the other categories. The reduction in use for toilets and clothes washers is evidence of the accomplishments of these respective retrofit programs. The fact that the other categories are higher, especially the leaks, shows the difficulty in reducing household water use. As reductions are affected in toilets and clothes washers, increases occur in other categories.

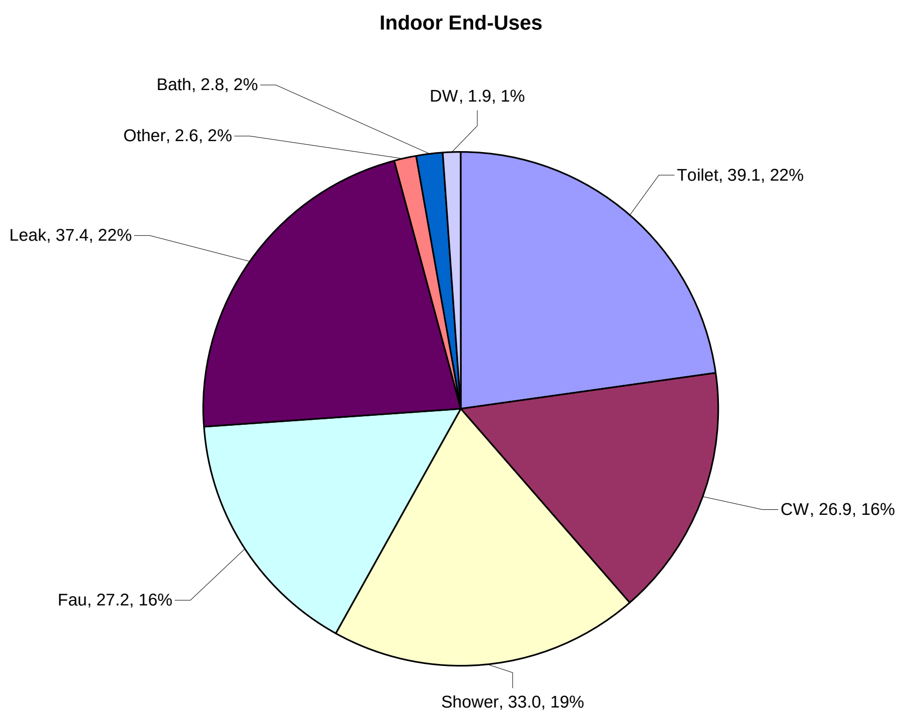
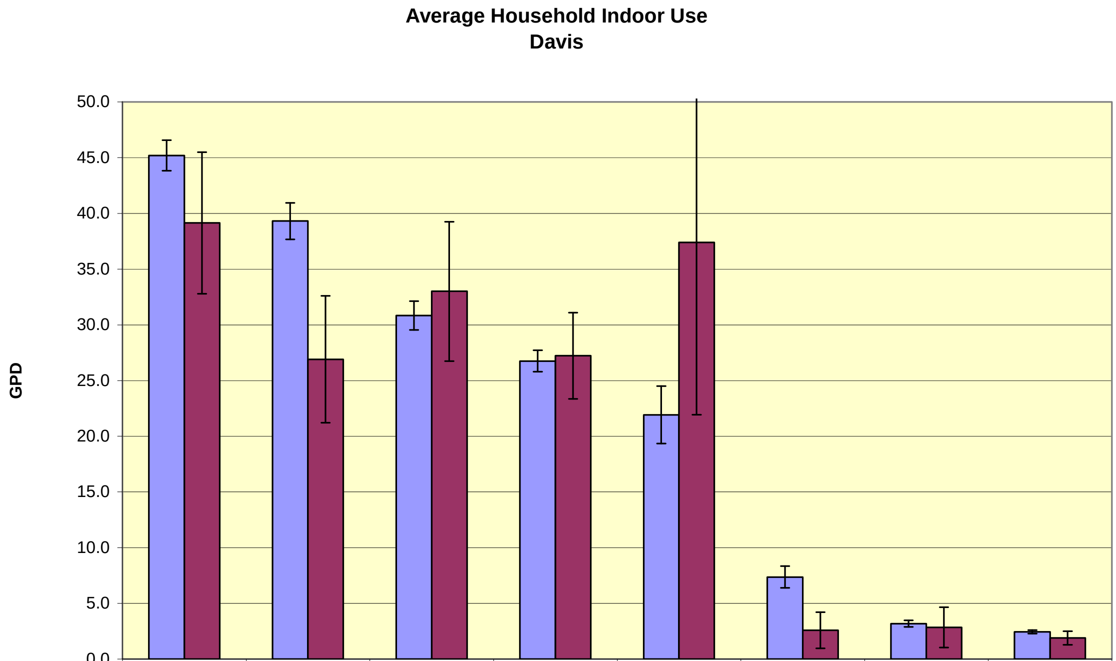


Figure 4: Indoor end-use pie chart – Davis



	Toilet	CW	Shower	Fau	Leak	Other	Bath	DW
REUWS	45.2	39.3	30.8	26.7	21.9	7.4	3.2	2.4
Davis	39.1	26.9	33.0	27.2	37.4	2.6	2.8	1.9

Figure 5: Comparison of household end-uses – Davis to REUWS

Toilet Use

There were a total of 9664 separate toilet flushes recorded by the data loggers during the logging period. This is equivalent to 12.7 flushes per house per day over approximately 12.68 days of logging. The statistics for individual toilet flushes is shown in Table 3. The fact that there are a significant number of ULF toilets is indicated by the fact that nearly 42% of all flushes are less than 2.2 gal, which, given an allowance for adjustment error puts them in the ULF range. At the same time the data show that there is still significant potential from savings from toilet replacements in Davis.

Table 3: Toilet flush volume statistics

Parameter	Value
Total number of flushes in Davis logging	9664
Average flushes per day per household	12.7
Average toilet flush volume (gal)	3.07
Median flush volume (gal)	2.64
% of flushes < 2.2 gal	41.5%

Figure 6 shows a histogram of the average flush volumes determined for each of the 60 logging homes in Davis . These volumes were calculated by dividing the total toilet volume used by each home by the number of flush events recorded by the loggers. As such, the values represent the average of all toilets in the home. Homes in which the average gallons per flush is equal to or less than 2.0 gallons are deemed to meet the ULF criteria. This value was used as the criteria to define a home meeting the ULF criteria. Later in this report when mixtures of toilets in the homes are discussed we use a slightly higher value of 2.2 to capture individual flushes from poorly adjusted ULF toilets.

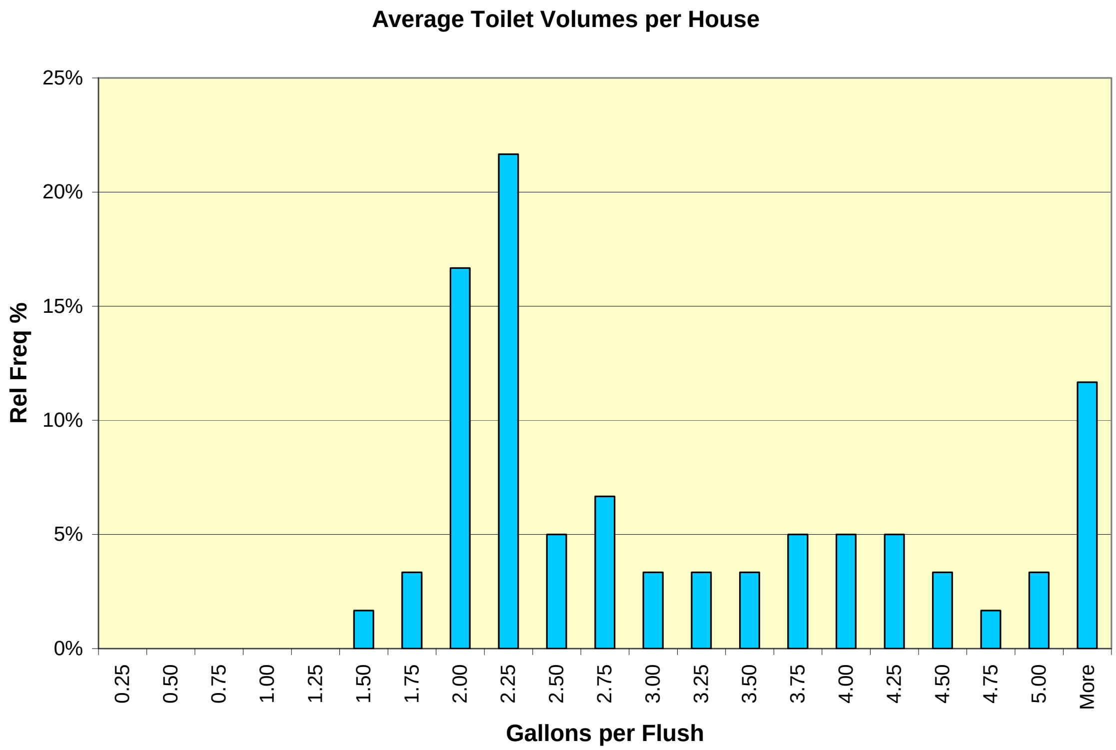


Figure 6: Toilet flush volume histogram - Davis

We know that many houses have a mixture of different types of toilets: standard, ULF and HET. In order to quantify the degree of heterogeneity in the homes the percent of flushes in each home that were less than 2.2 gallons was determined. Houses with 100% of their flushes less than 2.2 gallons are exclusively ULF or HET homes. There were 10% of the study homes which had all of their flushes less than 2.2 gallons. At the other end of the spectrum, 32% of the homes had less than 5% of their flushes less than 2.2 gallons. These homes probably do not contain any ULF type toilets. The rest of the homes fall in between. This distribution is shown in Figure 7. This shows that there is still significant potential for water savings from toilet retrofits. In a perfectly retrofit system all of the homes would have 100% of their flushes less than 2.2 gpf.

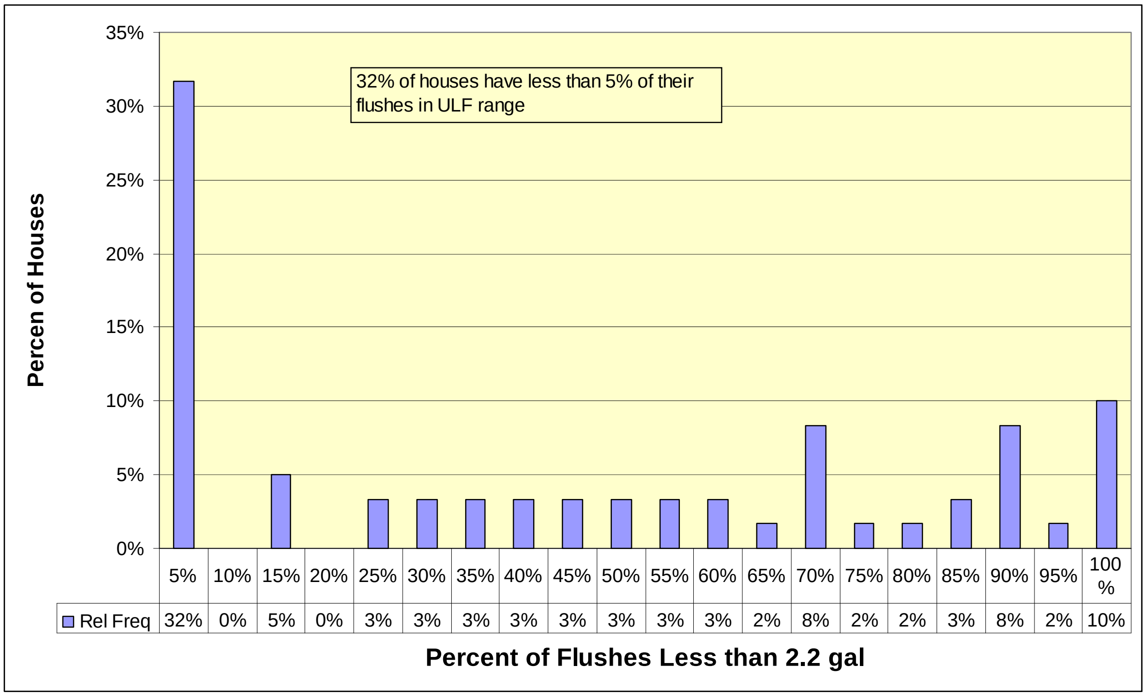


Figure 7: Toilet heterogeneity chart

Clothes Washer Use

During the logging period a total of 828 clothes washer loads were recorded by the data loggers on the 59 homes that used washers during the logging period. This averages to 1.1 loads per house per day over the 765 logged days in the sample. The median gallons per load was 36 gpl and the average was 34 gpl. Compared to the current tier 3 standard for the Consortium for Energy Efficiency of 15 gpl the Davis stock of clothes washers uses water at over twice the best available technology rate, but still represents a significant improvement from the pre NEPA generation of homes. A total of 36% of the houses had clothes washer use of less than 30 gpl, the benchmark being used in this study for high efficiency machines. Table 4 shows the summary statistics for the clothes washer data, and Figure 8 gives a histogram of the average gallons per load in the study homes.

Table 4: Clothes Washer Statistics- Davis

Parameter	Value
Total number of loads in database	616
Average loads per day per household	0.81
Average gallons per load	35.1
Median gallons per load	34.7
% of houses with < 30 gpl	45%

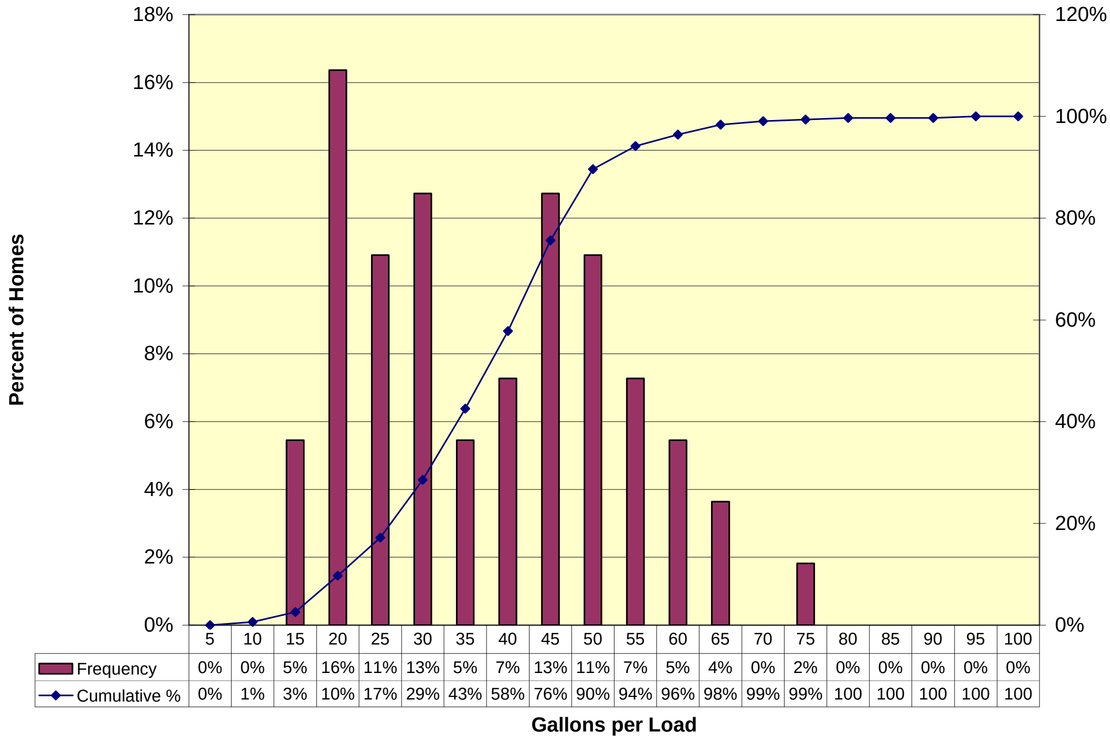


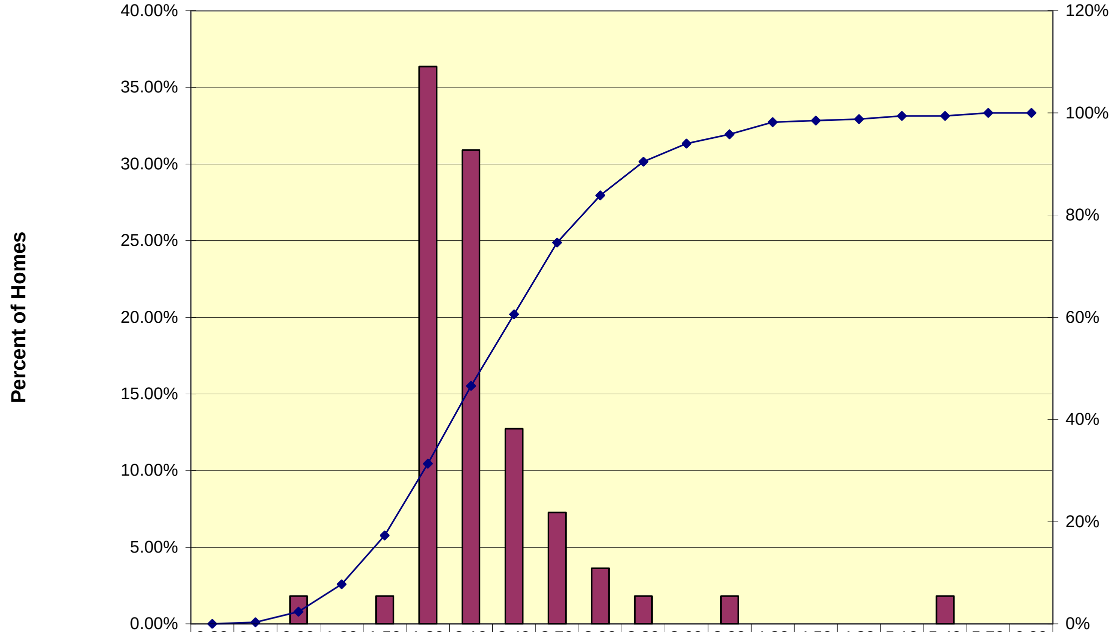
Figure 8: Distribution of clothes washer volumes - Davis

Shower Use

There were a total of 1398wers logged during the study period in Davis . This averaged out at 1.96 showers per household per day. The average shower used 17.7 gallons of water, and the average shower flow rate was 2.03 gpm. Approximately 87% of all housed in the Davis had average shower flow rates of less than 2.5 gpm. Histograms of flow rates and volumes are provided in the following figures.

Table 5: Shower statistics - Davis

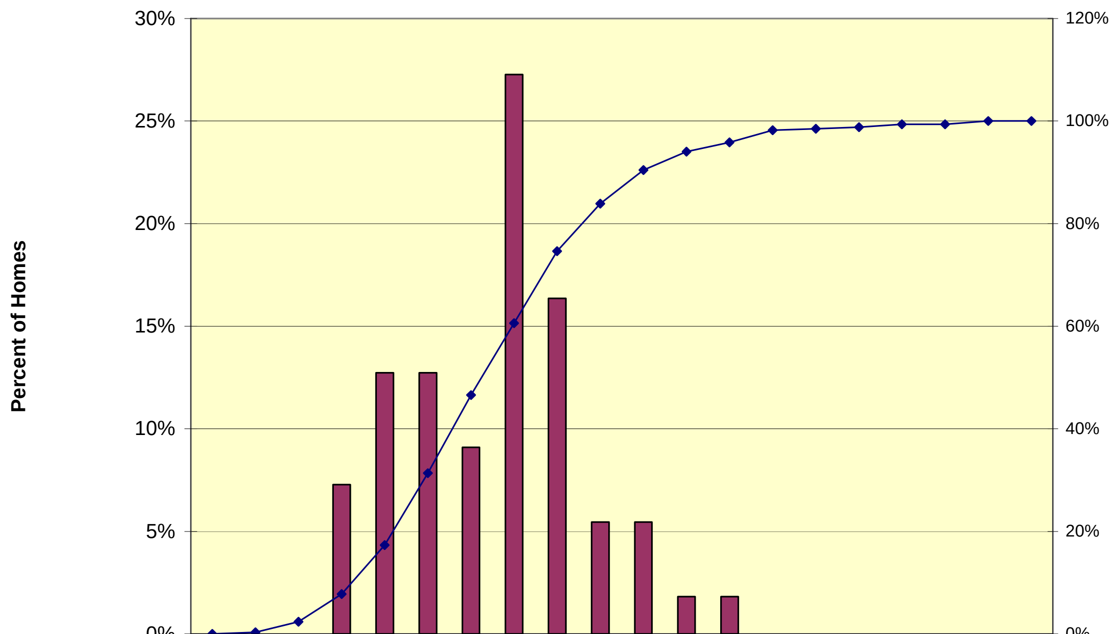
Parameter	Value
Total number of showers in database	1398
Average showers per day per household	1.96
Average gallons per shower	18.5
Average shower duration (min)	9.0
Average shower gpm	2.03
Median shower gpm	1.92
% of showers < 2.5 gpm	87%



	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00
Rfreq	0.00	0.00	1.82	0.00	1.82	36.3	30.9	12.7	7.27	3.64	1.82	0.00	1.82	0.00	0.00	0.00	0.00	1.82	0.00	0.00
Cumulative %	0%	0%	2%	8%	17%	31%	47%	61%	75%	84%	90%	94%	96%	98%	99%	99%	99%	99%	100	100

Flow Rate (gpm)

Figure 9: Distribution of shower flow rates - Davis



	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0	27.5	30.0	32.5	35.0	37.5	40.0	42.5	45.0	47.5	50.0
Bin	0%	0%	0%	7%	13%	13%	9%	27%	16%	5%	5%	2%	2%	0%	0%	0%	0%	0%	0%	0%
Cumulative %	0%	0%	2%	8%	17%	31%	47%	61%	75%	84%	90%	94%	96%	98%	99%	99%	99%	99%	100	100

Shower Volumes (gal)

Figure 10: Distribution of shower volumes - Davis

Leakage

During the logging period some leaks were recorded in virtually all of the homes. The average leakage rate was 37.4 gpd per house, while the median rate was 24.25 gpd. It is difficult to say precisely where the leaks are occurring in these homes. They may be in the internal plumbing or in irrigation systems. This high value of leakage, however, warrants further investigation. Figure 11 shows the typical pattern for leakage where the majority of homes are leaking at a fairly low rate. In this case 45% of the homes are leaking at less than 10 gpd, and the median leakage rate is just over 13 gpd. There are enough homes with significan leaks, however, that they raise the mean to over 37 gpd. To make matters more challenging, the homes that are experiencing major leaks are probably constantly changing as leaks are repaired and develop.

Table 6: Statistics on leakage - Davis

Parameter	Value
Total number of days in database	761
Average leakage, gpd	37.4
Median leakage, gpd	13.4
Max leakage in set, gpd	308
% houses w/ leakage > 50 gpd	20%
% of house w/ leakage > 100 gpd	8%

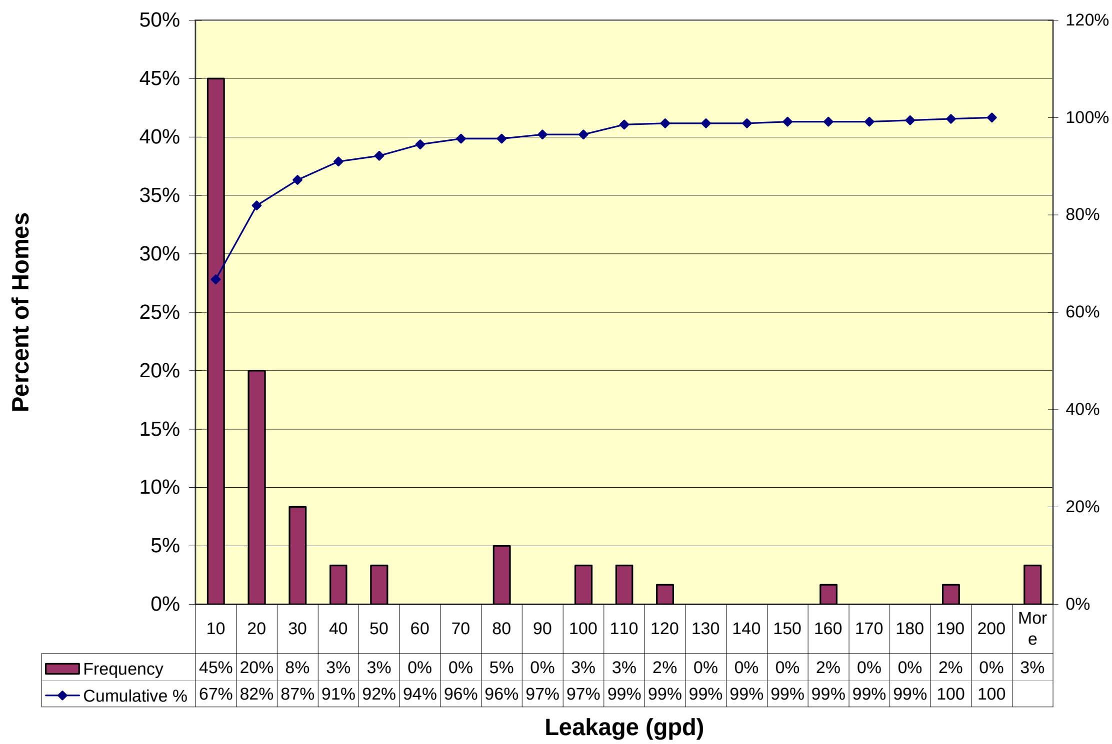


Figure 11: Distribution of daily leakage - Davis

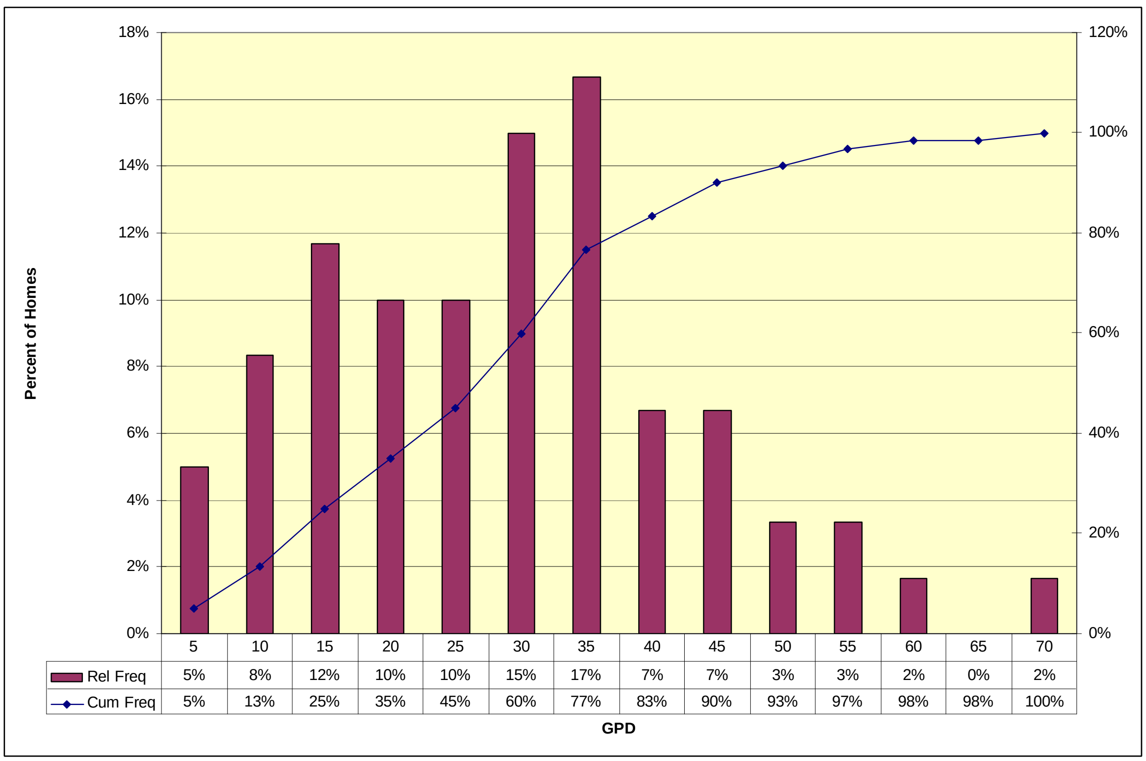
Faucet Use

The miscellaneous faucet use category contains most of the use events that do not fit into any of the other categories. It is possible that water used for bathing could show up as miscellaneous faucet use if the event that created the water use did not match either a shower or bathtub pattern. Filling a basin with a couple of gallons of water to wash a child would most likely show up as faucet use. The same holds true for filling a bucket to wash a car or change the water in an aquarium. It represents general domestic uses in the home drawn from all of the faucets in the home.

The average home in Davis used 27.2 gallons per day for miscellaneous faucet uses, while the median use was 26.5 gpd. This is a fairly normal distribution, but there are a few homes with significantly larger amounts of miscellaneous use. The highest recorded faucet use was 70 gpd. There were a total of 50,234 faucet events in the Davis event database. Figure 12 shows the distribution of daily household faucet use in the study homes.

Table 7: Faucet statistics- Davis

Parameter	Value
Total number of days in database	765
Average faucet use, gpd	27.2
Median faucet use, gpd	26.5
Max faucet use in set, gpd	70
Number of faucet events	33,125



	5	10	15	20	25	30	35	40	45	50	55	60	65	70
Rel Freq	5%	8%	12%	10%	10%	15%	17%	7%	7%	3%	3%	2%	0%	2%
Cum Freq	5%	13%	25%	35%	45%	60%	77%	83%	90%	93%	97%	98%	98%	100%

Figure 12: Distribution of household faucet use (gpd)

Household Efficiency Rates

One of the main goals of this project was to determine the percentage of homes that are equipped with the types of high efficiency fixtures and appliance encouraged by the CUWCC Best Management Practices. The requirement is for at least 75% of the homes to meet the efficiency criteria at a 95% confidence level. In the case of clothes washers, where the norm is one device per house the results are true penetration rates. In the case of toilets and showers, multiple units of which normally contained in the homes, the results represent the overall efficiency rates for all toilets and showers in the homes.

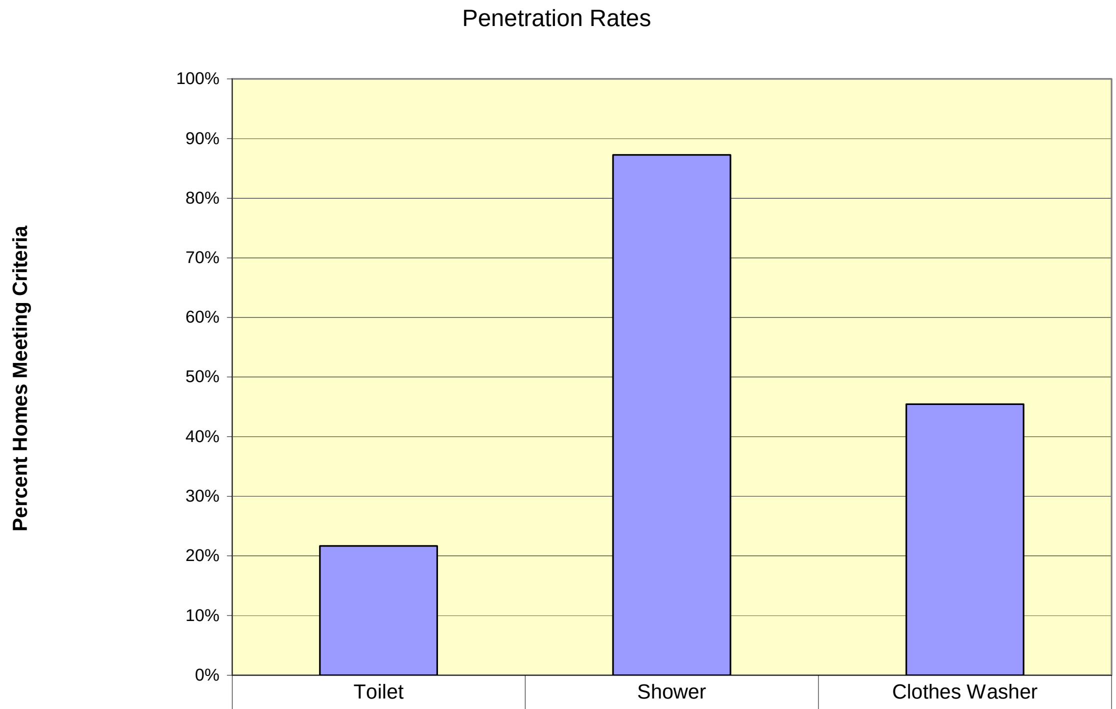
Frequently, water agencies attempt to make these determinations through residential audits, which require a technician to enter the house and examine the toilets, showers and clothes washers. Besides having to schedule a home visit this technique requires that the homeowners volunteer to participate in the program, which leads to questions about bias in the results. With data loggers a strict random sample can be drawn from the customer database (as was done in this study) and the necessary analyses done to determine their efficiency status. All of the houses had toilets in the traces, but not all had shower or clothes washers, so the percentages for these devices was based on ratio of the number of home with high efficiency showers and clothes washers to the total number of homes having showers and clothes washers present in the trace.

In order to qualify as high efficiency each home had to meet the criteria for each device shown in Table 8. The results of the analyses for Davis are shown in Figure 13. This figure shows both the mean penetration rate and the minimum expected rate at a 95 % confidence level. The numbers of homes for with use of each device was evident from the flow traces and the numbers of these which met the high efficiency criteria is shown in Figure 14. The fact that a device does not show up on a trace does not mean that the house didn't have one--probably all of the homes had at least one shower—but that the devices were not used during the two week logging period.

Table 8: Efficiency criteria for penetration rate determination

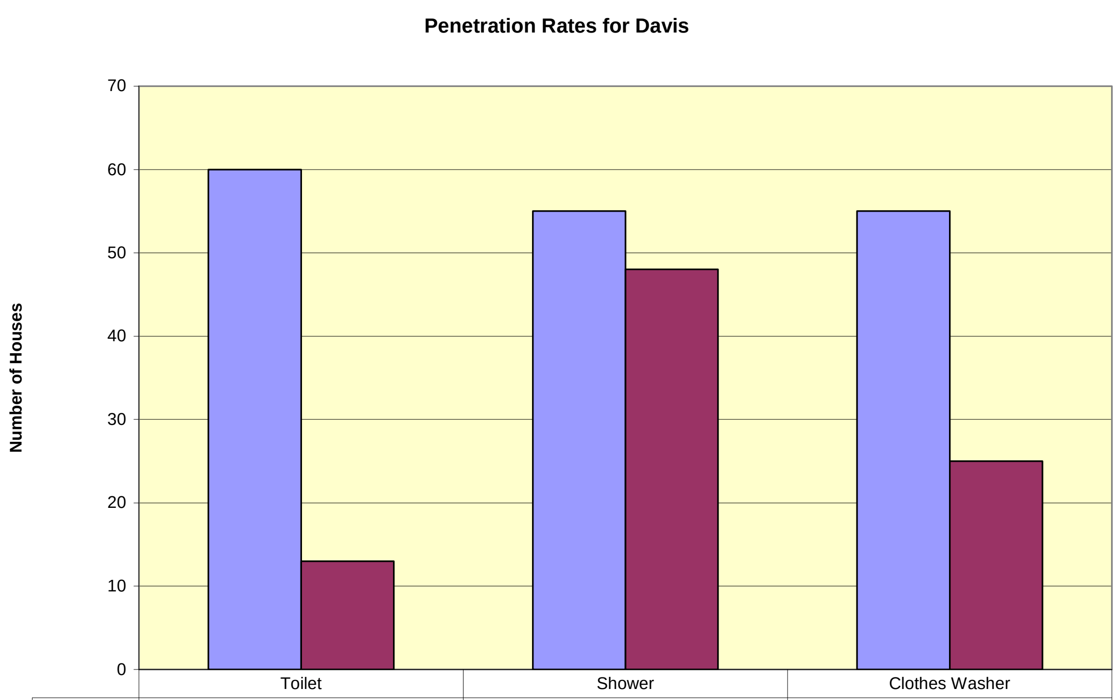
Device	Criteria
Toilets	Ave gallons per flush < 2.0 gpf
Showers	Ave shower flow rate < 2.5 gpm
Clothes Washers	Ave load uses < 30 gal

The data from Davis indicate that approximately 22% of the houses meet the criteria for ULF toilets, while 45% meet high efficiency criteria for clothes washers, and 87% meet the shower criteria.



	Toilet	Shower	Clothes Washer
Penetration Rates	22%	87%	45%

Figure 13: Household compliance rates for toilets, showers and clothes washers - Davis



	Toilet	Shower	Clothes Washer
# w/device	60	55	55
# H.E.	13	48	25

Figure 14: Houses with device present –Davis and number with high efficiency devices

Discussion of Indoor Results

The indoor use results for Davis show that the single family homes in the district consume around the same amount of water as did the "standard" single family homes in terms of their total daily household indoor use. The REUWS group from 1996 averaged 177 gpd and the current Davis group averaged 171 gphd for all indoor uses. Even though water use for the homes was only slightly less than the average from the REUWS, the water use for clothes washers and toilets was significantly lower, which shows the impact of the new technologies for these categories of water use.

The leakage rates at these homes was higher than normal. This could be due to leaks in indoor fixtures and appliances or due to leaks in irrigation systems, both of which are fed by the same meter in most cases. In any case it appears to be worthwhile to do some further investigation of leakage to see if it can be reduced since the leakage outweighed the savings from the toilets and clothes washers.

The data for the fixture penetration rates show that progress has been made. but there is still great potential for both toilets and clothes washer replacements. Only 22% of homes met the ULF toilet criteria and 45% of the homes met the high efficiency clothes washer criteria. That means that nearly 78% of the homes require some level of toilet upgrades and 55% of the homes need a high efficiency clothes washer upgrade.

According to the District billing records there are approximately 13,194 single family accounts in the service area. The average indoor water use in the current study group was 171 gphd. It is reasonable that this could be reduced to at least 120 gpd by employing best technologies, as demonstrated by the EPA Retrofit Study (See Table 2). Assuming that the logging sample is typical, which it appears to be, this implies an annual savings of nearly 51 gphhd, or 18.6 kgal/year per account is achievable over time. Projected to the entire population this is equivalent to an overall savings of 245 million gallons, or 753 acre feet per year from interior retrofits and upgrades to the single family homes.

Irrigation Use

Irrigation use was estimated by taking the total annual water use for each home from the billing data and subtracting the projected indoor use based on the flow trace data or the average winter use, as described in Chapter 4. The GIS analysis for each lot provided information on the total lot sizes (verified against site visits and plat information), and the irrigated areas. Out of the 59 homes in the logging group a total of 43 homes were included in the outdoor analysis because these homes had irrigated areas, and their water use data indicated that they were using water for irrigation.

Irrigated Areas Verses Lot Sizes

Table 9 shows the statistics for the lot size and irrigable areas of the 50 homes in the outdoor use database for Davis. The average lot size was 8503 sf, while the average irrigable area for the lots was approximately 52% of this, at 4429 sf. These values are both skewed by a few larger lots, indicated by the fact that the median values for lot size and irrigable area are both smaller than the means. The ratio of average irrigable area to average lot size for these homes is 52%. The ratio of median irrigable area to median lot size is 49%.

Figure 15 shows an X-Y graph of lot size verses irrigated area for the study homes. The best fit line for the data has been plotted. These data show that the irrigated areas on the lots (essentially the same thing as the irrigable areas) equals 57% of the lot area, with an R^2 value of 78%. This is a very strong relationship.

Table 9 Lot size and irrigable area data for Davis

Lot Size (sf)		*Irr Area (sf)*	
Mean	8053	Mean	4429
Median	6974	Median	3406
Minimum	1263	Minimum	651
Maximum	169878	Maximum	14365
Count	50	Count	50
Confidence Level(95%)	932	Confidence Level(95%)	754

Besides irrigable area, the next most important factor in determining the theoretical irrigation demand is the reference evapotranspiration (ET_o) for the area. For the Davis service area the Davis CIMIS station was used for gross ET_o, and corrected for rainfall to generate net ET data. Table 10 shows the data for this weather station. Both the inches of demand and gallons per square foot are shown. These demands are for the reference crop, which is cool season turf at 6" height. In order to use this to determine the theoretical requirement for other landscape types a crop coefficient must be applied. For this study a factor of .8 was used for turf, 0.65 was used for non-turf landscape and 0.30 was used for xeriscape. Net ET averaged 77% of ETo based on an analysis of daily rainfall and soil moisture balances verses ET for area weather stations.

Table 10: Net ET from Weather Stations in Davis

Weather Station	Net ET	
	Inches	Gal/sf
Davis Cimis station	43.5	26.3

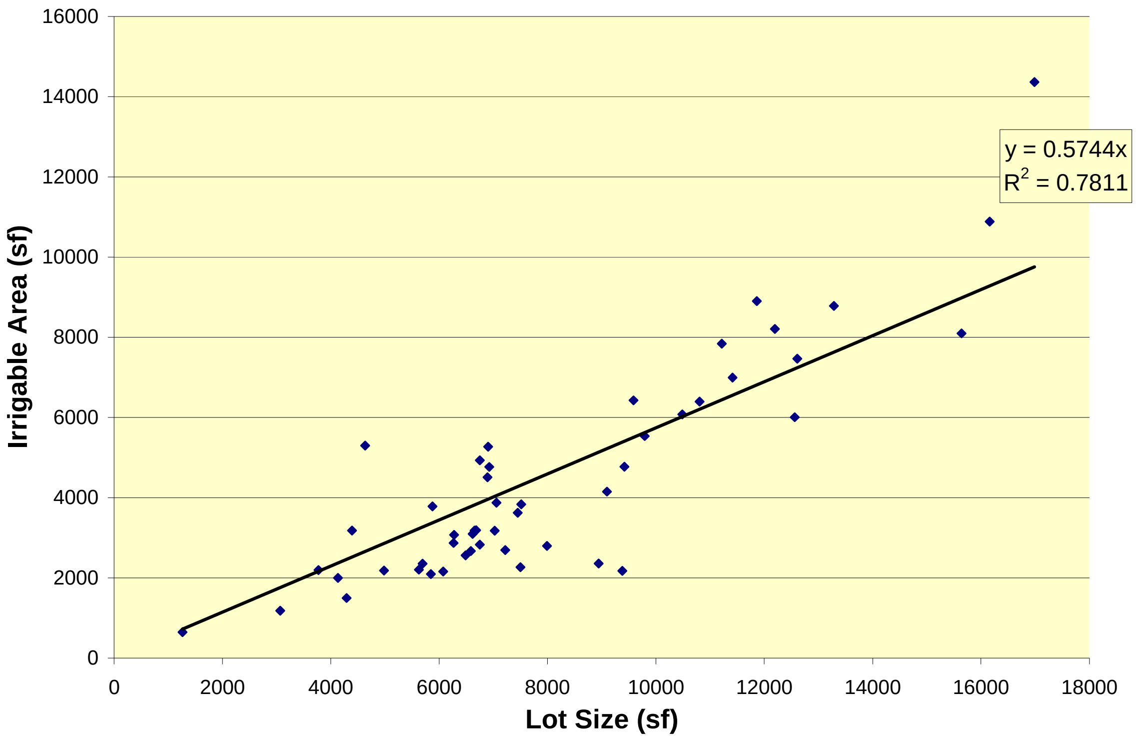


Figure 15: Irrigable area verses lot size for City of Davis

Reference and Theoretical Irrigation Requirements

The reference application assumes a perfect irrigation system irrigating a total turf landscape. It is useful primarily as an indicator of how a system's irrigation demand is linked to ET for a reference landscape type, and how the actual landscape compares to a total turf landscape. The next logical step is to determine the theoretical irrigation requirement for the lots based on their actual landscapes and after making reasonable allowances for irrigation efficiencies assuming a well maintained irrigation system.

Table 11 shows both the reference and theoretical irrigation requirements for Davis. The amount of water needed to satisfy the cool season turf demand on these lots averaged 104 ± 16 kgal. The median value was 93 kgal. The net reference requirement in inches is the same at the ETo, which in this case would average approximately 33.7 inches.

The theoretical demand is reduced by the fact that the landscapes are not entirely turf, which reduces the landscape coefficient and increased by the fact that the irrigation efficiencies are less than 100%. When both factors are applied the theoretical demand averages 89 ± 14 kgal for the study lots. This is the amount of water that the average lot in the study group should need to apply in order to satisfy the irrigation requirements of their landscapes. We define the ratio of the theoretical to reference requirement as the *landscape ratio* since it expresses the relative demand of the actual landscape to a pure turf landscape. In this case the landscape ratio averaged 86% for the lots. In order to estimate the theoretical irrigation demand for the homes one would use 86% of net ET times the landscape area, which can be estimated from the regression formula shown in Figure 15, as a good approximation.

Table 11: Reference and Theoretical Requirement data – City of Davis

	Net Reference Requirement		Theoretical Requirement	
	(kgal)	(in)	(kgal)	(in)
Mean	120	43.5	116	41.4
Median	92.3	43.5	90.9	42.1
Confidence Level	20		20	1.1

Application Ratios

The theoretical irrigation demand shows the amount of water that the landscapes would require in order to satisfy the plant requirements for net ET and reasonable system efficiencies. A well designed system with a properly calibrated smart irrigation controller (or one that is regularly adjusted to ET by the owner) should apply this amount of water to the land. In actual fact, however, landscape use varies significantly from the theoretical requirements. If we define the *application ratio* as the ratio of the actual application of irrigation water to the theoretical requirement and plot these values as a scatter diagram we get the results shown in Figure 16.

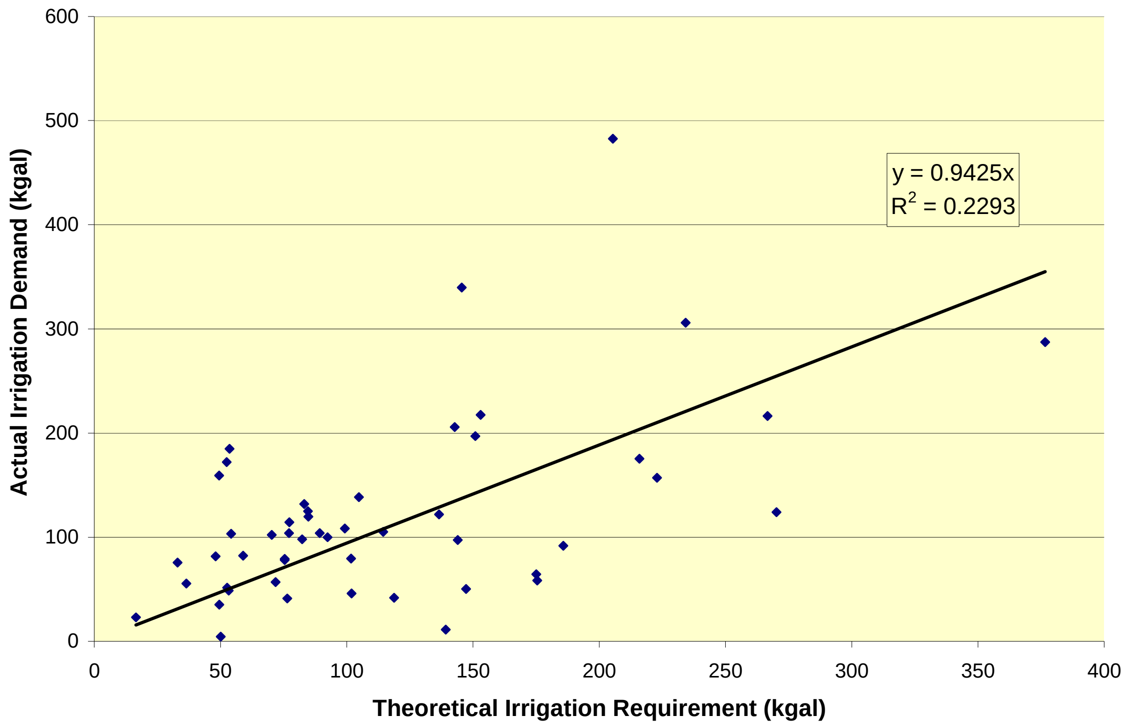


Figure 16: Actual verse theoretical requirements for Davis

Figure 16 shows that while the overall applications in Davis are very close to the theoretical requirements there is still a lot of variability among individual irrigators. This is as one would expect given the fact that the actual applications are much more heavily influenced by behavior than the other landscape demand parameters discussed above, and people often do not have the information or the interest to spend time calibrating their irrigation systems.

Table 12 shows the statistics for the landscape and application ratios. The application ratio is the ratio of the actual irrigation application to the theoretical requirement for each lot. It shows whether the customers are matching their irrigation practices to the theoretical requirements based on the local ET_o and horticulture. In this case we see that the actual application should be around 95% of the ET based on the average landscape, but the actual applications averaged 121% of the theoretical requirement while the median application ratio was 109% of the theoretical requirement. A median application ratio of 109% show that outdoor use in Davis is not far out of synch with the theoretical requirements.

Table 12: Landscape and Application ratios – Davis

	Landscape Ratio[1]	Application Ratio[2]
Mean	0.95	121%

Median	0.97	109%
Confidence Level	0.03	21%

[1] Landscape ratio = theoretical irrigation requirement/reference irrigation requirement
[2] Application ratio = actual irrigation application/theoretical irrigation requirement

Figure 17 shows a histogram of the application ratios for the homes in Davis. The percentage of homes falling into each bin and the cumulative percentage are shown. This graph shows that approximately 44% of the homes in the sample used no more than the theoretical requirement for their lots. Conversely, 56% of the homes used more than their theoretical requirements, and most of these over-irrigators were in the 100-150% bin. Approximately 6% of the homes used 300% or more than their theoretical requirements based on net ET.

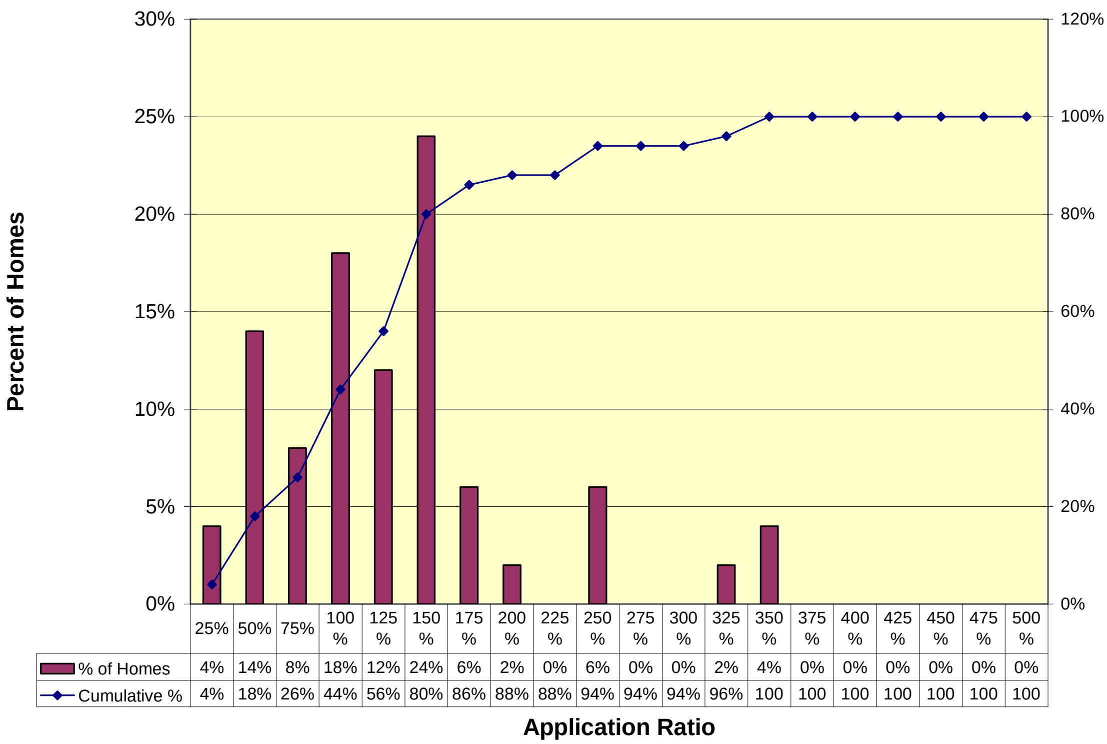


Figure 17: Application ratio histogram – City of Davis

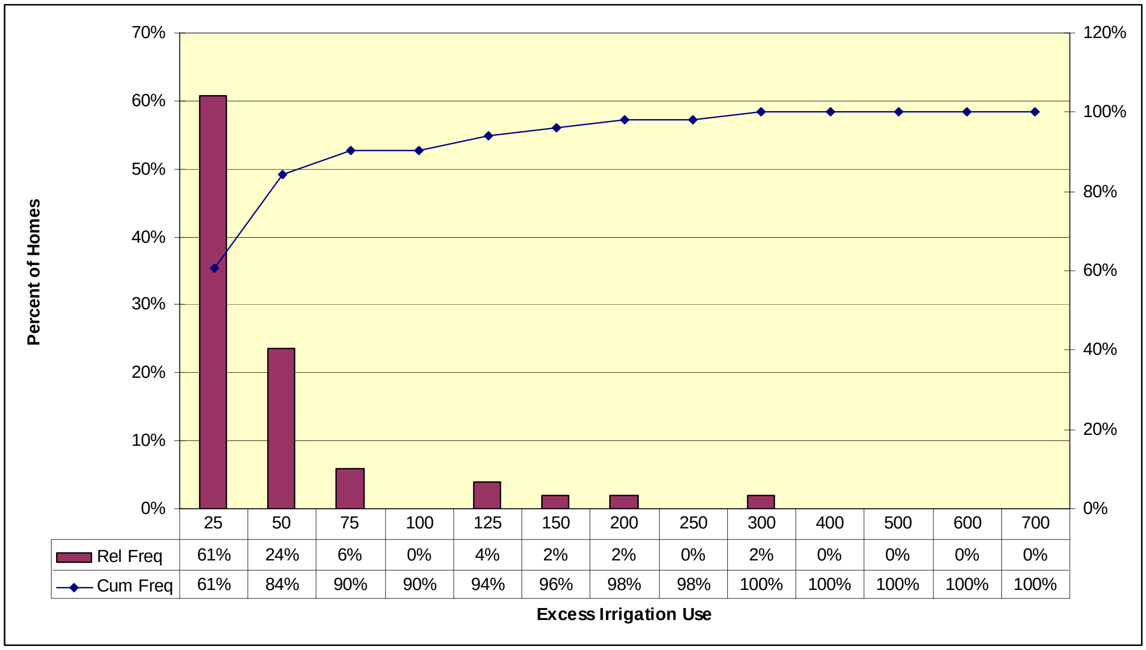
Tables of ratios can be misleading since small lots may have a high application ratio, but they involve only a small amount of water. On the other hand large lots may be deficit irrigating and have low application ratios, and they involve very large amounts of water. A more informative way of looking at the irrigation use is to determine the excess water use on all lots using more than their theoretical requirement. Lots that use less than their requirement would have their excess set at zero, and this would be averaged into the calculation.

When this is done the results are as shown in Table 13. This shows that the average excess irrigation use in Davis was 31 kgal per lot for the 50 customers in the outdoor use database. The total excess for these customers amounted to 0.156 million gallons (0.48 acre feet). If these customers are typical of single family customers in the counties, which the statistics show that they are, then the total potential savings in Davis from improved irrigation management would be 31 kgal x 13,194 (the number of single family customers in the system). This is equivalent to 406 million gallons, or 1247 acre feet of potential water savings.

These outdoor use results show that program of improved irrigation management and better ET based control targeted to just over irrigators would result in significant water savings for the City.

Table 13: Excess applications (kgal)

Excess App (kgal)	
Mean	31
Median	7.0
Sum	1558
Count of over irrigators	28 out of 50



	25	50	75	100	125	150	200	250	300	400	500	600	700
Rel Freq	61%	24%	6%	0%	4%	2%	2%	0%	2%	0%	0%	0%	0%
Cum Freq	61%	84%	90%	90%	94%	96%	98%	98%	100%	100%	100%	100%	100%

Figure 18: Histogram of excess irrigation water use – City of Davis

Discussion

The results of the outdoor analysis show that there was a total of 1558 kgal of excess water use during the study year. This averages approximately 31 kgal per home. If these average outdoor savings are projected to the entire 13194 single family homes in the service population then the estimated total outdoor savings from improved irrigation management would amount to 406 million gallons or 1247 acre feet per year. It was previously estimated that there was a potential for 753 acre feet of indoor savings in the single family accounts. The data analyzed for this study show that the combined indoor and outdoor savings potential in the single family accounts is 2000 acre feet per year. This is a conservative value that could be included as a tangible goal for the District's water conservation planning. It assumes that high efficiency fixtures and appliances are used indoor, and that the outdoor use is brought down to no more than the applied water requirement for the existing landscapes.

According to the billing information supplied by the Davis the average annual water use for the single family accounts was 158 kgal. The total number of accounts was 13194, and the total annual water delivery to the single family accounts was 2084 million gallons, or 6,398 acre feet per year. If water use in the single family accounts could be reduced by 2000 acre feet, as suggest by this study, then the total single family demands could be reduced by approximately 31%, which seems like the type of target that should be considered for the single family water conservation program.

ATTACHMENT B

SBx7-7 Information

Senate Bill No. 7
Statewide Water Conservation

SB 7 creates a framework for future planning and actions by urban and agricultural water suppliers to reduce California's water use. For the first time in California's history, this bill requires the development of agricultural water management plans and requires urban water agencies to reduce statewide per capita water consumption 20 percent by 2020. Specifically, this bill:

- Establishes multiple pathways for urban water suppliers to achieve the statewide goal of a 20 percent reduction in urban water use. Specifically, urban water suppliers may:
  - Set a conservation target of 80 percent of their baseline daily per capita water use;
  - Utilize performance standards for water use that are specific to indoor, landscape, and commercial, industrial and institutional uses;
  - Meet the per capita water use goal for their specific hydrologic region as identified by DWR and other state agencies in the 20 percent by 2020 Water Conservation Plan; or
  - Use an alternate method that is to be developed by DWR before December 31, 2010.

- Requires urban water suppliers to set an interim urban water use target and meet that target by December 31, 2015 and meet the overall target by December 31, 2020.

- Requires DWR to cooperatively work with the California Urban Water Conservation Council to establish a task force that shall identify best management practices to assist the commercial, industrial and institutional sector in meeting the water conservation goal.

- Requires agricultural water suppliers to measure water deliveries and adopt a pricing structure for water customers based at least in part on quantity delivered, and, where technically and economically feasible, implement additional measures to improve efficiency.

- Requires agricultural water suppliers to submit Agricultural Water Management Plans beginning December 31, 2012 and include in those plans information relating to the water efficiency measures they have undertaken and are planning to undertake.

- Makes ineligible for state grant funding any urban or agricultural water supplier who is not in compliance with the requirements of this bill relating to water conservation and efficient water management.

- Requires DWR to, in 2013, 2016 and 2021, report to the Legislature on agricultural efficient water management practices being undertaken and reported in agricultural water management plans.

- Requires DWR, the State Water Resources Control Board, and other state agencies to develop a standardized water information reporting system to streamline water reporting required under the law.

ATTACHMENT C

City of Davis Metrics

Water Use Analysis

City of Davis	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10-yr aver	3-yr aver
Water Production, mg	4,071	4,234	4,515	3,880	4,477	4,594	4,911	4,924	4,741	4,920	4,709	4,670	4,810	4,633	4,182			
ac-ft/yr	12,494	12,995	13,857	11,908	13,740	14,099	15,072	15,112	14,551	15,100	14,452	14,333	14,762	14,219	12,835			
Lowest month, mg	168.70	168.20	177.00	154.90	170.70	183.43	190.70	200.50	203.20	193.30	202.45	201.50	207.00	187.39	176.66			
Maximum month, mg	544.10	574.30	563.20	560.00	596.60	605.52	622.60	634.50	631.80	632.50	632.27	659.03	614.30	572.80	541.40			
Maximum day, mgd						21.09	22.52	21.65	23.60	21.52	21.40	23.70	21.28	20.26	19.20			
Maximum month to lowest month ratio						3.30	3.26	3.16	3.11	3.27	3.12	3.27	2.97	3.06	3.06		3.16	3.03
Maximum month peaking factor						1.58	1.52	1.55	1.60	1.54	1.61	1.69	1.53	1.48	1.55		1.57	1.52
Maximum day peaking factor						1.68	1.67	1.60	1.82	1.60	1.66	1.85	1.61	1.60	1.68		1.68	1.63
Population																		
from DWR Reports						61,665	65,110	66,700	67,740	66,730	66,980	67,740		68,420	66,005			
from 2005 UWMP											67,300							
from DOF Table E-4 for 2000-2010, May 2010	53,543	54,451	55,920	57,256	60,308	61,941	63,494	64,032	64,753	64,559	64,846	65,235	65,575	66,077	66,570			
El Macero/Willowbank	1,383	1,383	1,383	1,383	1,383	1,383	1,383	1,383	1,383	1,383	1,383	1,383	1,383	1,383	1,383			
Total (based on DOF)	54,926	55,834	57,303	58,639	61,691	63,324	64,877	65,415	66,136	65,942	66,229	66,618	66,958	67,460	67,953			
Water Use by Customer Category, mg																		
SFR						2,109	2,272	2,306	2,174	2,312	2,198	2,162	2,349	2,285	2,069			
MFR						914	975	983	948	957	918	926	980	885	867			
Com/Inst/Ind						523	575	551	517	546	523	537	563	576	518			
Landscape						101	113	104	106	114	108	109	119	126	105			
Other						319	319	325	325	325	325	325	359	344	196			
Subtotal						3,966	4,254	4,269	4,070	4,254	4,072	4,059	4,370	4,216	3,755			
Unaccounted-for						628	657	655	671	666	637	611	440	417	427			
Unaccounted-for, % of total						13.7%	13.4%	13.3%	14.2%	13.5%	13.5%	13.1%	9.1%	9.0%	10.2%			
Lowest Two Months Water Use, mg/lowest two months																		
SFR						172	171	185	162	172	166	174	200	186	171			
MFR						111	117	126	108	112	109	112	121	82	108			
Com/Inst/Ind						49	49	52	52	50	47	52	50	52	48			
Landscape						3.2	3.4	3.1	2.2	3.5	3.0	4.7	6.7	4.5	5			
Other						7	6	8	8	8	8	8	11	18	8			
Connections by Customer Category, no																		
SFR						13,984	14,197	14,427	14,232	14,588	14,264	14,267	14,303	14,351	14,365			
MFR						507	513	514	521	462	530	535	539	536	538			
Com/Inst						612	618	595	607	542	640	691	697	707	724			
Indust						-	-	32	32	21	31							
Landscape						235	244	242	530	406	531	533	542	539	547			
Other						234	234	227	240	266	233	266	258	250	264			
Total						15,572	15,806	16,037	16,162	16,285	16,229	16,292	16,339	16,383	16,438			
Residential, total						14,491	14,710	14,941	14,753	15,050	14,794	14,802	14,842	14,887	14,903			
CII, total						612	618	627	639	563	671	691	697	707	724			
GPCD																		
Total	203	208	216	181	199	199	207	206	196	204	195	192	197	188	169		195	185
10 yr average										202	201	200	198	198	195			
Original City of Davis Target	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184			
Climate and Water Rate																		
Annual Eto	52.90	56.50	61.74	49.43	57.41	54.75	59.42	56.10	56.06	58.10	53.64	54.83	57.96	59.53	55.21		56.56	57.57
Annual precipitation	22.82	25.20	20.77	26.25	10.18	18.55	20.42	16.00	15.55	17.83	21.33	16.17	10.33	15.98	13.77		16.59	13.36

Water Use Analysis

City of Davis	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10-yr aver	3-yr aver
Wastewater flow																		
WW low month, MG						155	156	159	161	163	167	173	164	150	137			
Low month WW /low two month water use (sales)						0.91	0.90	0.85	0.97	0.94	1.00	0.99	0.84	0.87	0.81		0.91	0.84
Low month WW/low month water production						0.85	0.82	0.79	0.79	0.84	0.82	0.86	0.79	0.80	0.78		0.81	0.79
Population to connection trends																		
Population to total conections						4.07	4.10	4.08	4.09	4.05	4.08	4.09	4.10	4.12	4.13		4.09	4.12
Population to residential connections						4.37	4.41	4.38	4.48	4.38	4.48	4.50	4.51	4.53	4.56		4.46	4.53
Customer water use trends, gpd/connection																		
SFR						413	438	438	419	434	422	415	450	436	395		426	427
MFR						4,939	5,207	5,240	4,985	5,675	4,745	4,742	4,981	4,524	4,415		4,945	4,640
Com/Inst/Ind						2,341	2,549	2,408	2,217	2,657	2,135	2,129	2,213	2,232	1,960		2,284	2,135
Landscape						1,177	1,269	1,177	548	769	557	560	602	640	526		783	589
Other						3,735	3,735	3,923	3,710	3,347	3,822	3,347	3,812	3,770	2,034		3,523	3,205
Total (including unaccounted-for)						808	851	841	804	828	795	785	807	775	697		799	759
Indoor water use trends, gpd/connection (90% of lowest two months)																		
SFR						181	178	189	168	174	172	180	206	191	176		182	191
MFR						3,230	3,365	3,617	3,058	3,577	3,034	3,089	3,312	2,257	2,962		3,150	2,844
Com/Inst/Ind						1,181	1,170	1,224	1,201	1,310	1,033	1,110	1,058	1,085	978		1,135	1,041
Landscape (no indoor)						-	-	-	-	-	-	-	-	-	-		-	-
Other						441	372	520	492	444	507	444	629	1,062	458		537	717
Outdoor water use trends, gpd/connection																		
SFR						232	261	249	251	260	250	235	244	245	219		245	236
MFR						1,709	1,842	1,623	1,927	2,098	1,711	1,653	1,669	2,266	1,453		1,795	1,796
Com/Inst/Ind						1,160	1,379	1,184	1,016	1,347	1,102	1,019	1,155	1,147	982		1,149	1,095
Landscape						1,177	1,269	1,177	548	769	557	560	602	640	526		783	589
Other						2,557	2,466	2,745	3,162	2,578	3,264	2,787	3,211	3,129	1,508		2,741	2,616
Per Capita Water Use Components, gpcd																		
Residential total						131	137	138	129	136	129	127	136	129	118		131	128
CII total						23	24	23	21	23	22	22	23	23	21		23	22
Landscape						4	5	4	4	5	4	4	5	5	4		5	5
Other total						14	13	14	13	14	13	13	15	14	8		13	12
Residential indoor						66	65	70	60	64	61	63	71	59	61		64	63
Residential outdoor						65	72	68	69	72	68	64	65	70	58		67	64
CII indoor						11	11	12	12	11	10	12	11	11	10		11	11
CII outdoor						11	13	11	10	11	11	11	12	12	10		11	12
Landscape						4	5	4	4	5	4	4	5	5	4		5	5
Other indoor						2	1	2	2	2	2	2	2	4	2		2	3
Other outdoor						12	12	12	12	12	12	12	12	10	6		11	9
Unaccounted-for						27	28	27	28	28	26	25	18	17	17		24	17
Total (check)						199	207	206	196	204	195	192	197	188	169		195	185

Appendix F: Water Loss Audit

AWWA Water Loss Control Committee (WLCC) Free Water Audit Software v4.2

WAS v4.2

PURPOSE: This spreadsheet-based water audit tool is designed to help quantify and track water losses associated with water distribution systems and identify areas for improved efficiency and cost recovery. It provides a "top-down" summary water audit format, and is not meant to take the place of a full-scale, comprehensive water audit format.

USE: The spreadsheet contains several separate worksheets. Sheets can be accessed using the tabs towards the bottom of the screen, or by clicking the buttons on the left below. Descriptions of each sheet are also given below.

THE FOLLOWING KEY APPLIES THROUGHOUT:

- Value can be entered by user
- Value calculated based on input data
- These cells contain recommended default values

Please begin by providing the following information, then proceed through each sheet in the workbook:

NAME OF CITY OR UTILITY: City of Davis | COUNTRY: USA

REPORTING YEAR: 2009 | START DATE(MM/YYYY): | END DATE(MM/YYYY):

NAME OF CONTACT PERSON: | E-MAIL: | TELEPHONE: | Ext.

PLEASE SELECT PREFERRED REPORTING UNITS FOR WATER VOLUME: Acre-feet

Click to advance to sheet…

Click here: ? for help about units and conversions

Instructions	The current sheet
Reporting Worksheet	Enter the required data on this worksheet to calculate the water balance
Water Balance	The values entered in the Reporting Worksheet are used to populate the water balance
Grading Matrix	Depending on the confidence of audit inputs, a grading is assigned to the audit score
Service Connections	Diagrams depicting possible customer service connection configurations
Definitions	Use this sheet to understand terms used in the audit process
Loss Control Planning	Use this sheet to interpret the results of the audit validity score and performance indicators

Comments:

Add comments here to track additional supporting information, sources or names of participants

If you have questions or comments regarding the software please contact us at: wlc@awwa.org

AWWA WLCC Free Water Audit Software: Reporting Worksheet

 WAS v4.2

Back to Instructions

? Click to access definition

Water Audit Report for: City of Davis
Reporting Year: 2009

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: ACRE-FEET PER YEAR

WATER SUPPLIED

<< Enter grading in column 'E'

Volume from own sources:	12,835.000	acre-ft/yr
Master meter error adjustment (enter positive value):		acre-ft/yr
Water imported:	0.000	acre-ft/yr
Water exported:	0.000	acre-ft/yr
WATER SUPPLIED:	12,835.000	acre-ft/yr

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

			Pcnt:	Value:
Billed metered:	11,524.000	acre-ft/yr		
Billed unmetered:	0.000	acre-ft/yr		
Unbilled metered:	0.000	acre-ft/yr		
Unbilled unmetered:	160.438	acre-ft/yr	1.25%	

Default option selected for Unbilled unmetered - a grading of 5 is applied but not displayed

AUTHORIZED CONSUMPTION:	11,684.438	acre-ft/yr

Use buttons to select percentage of water supplied **OR** value

WATER LOSSES (Water Supplied - Authorized Consumption)

1,150.563 acre-ft/yr

Apparent Losses

			Pcnt:	Value:
Unauthorized consumption:	32.088	acre-ft/yr	0.25%	

Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed

Customer metering inaccuracies:	0.000	acre-ft/yr
Systematic data handling errors:	0.000	acre-ft/yr

Systematic data handling errors are likely, please enter a non-zero value; otherwise grade = 5

Apparent Losses:	32.088	

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses:	1,118.475	acre-ft/yr
WATER LOSSES:	1,150.563	acre-ft/yr

NON-REVENUE WATER

NON-REVENUE WATER:	1,311.000	acre-ft/yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	182.0	miles
Number of active AND inactive service connections:	16,438	
Connection density:	90	conn./mile main
Average length of customer service line:	50.0	ft (pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	60.0	psi

COST DATA

Total annual cost of operating water system:	$15,000,000	$/Year
Customer retail unit cost (applied to Apparent Losses):	$2.00	$/100 cubic feet (ccf)
Variable production cost (applied to Real Losses):	$500.00	$/acre-ft

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume of Water Supplied:	10.2%
Non-revenue water as percent by cost of operating system:	4.4%
Annual cost of Apparent Losses:	$27,955
Annual cost of Real Losses:	$559,238

Operational Efficiency Indicators

Apparent Losses per service connection per day:	1.74	gallons/connection/day
Real Losses per service connection per day*:	60.74	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	1.01	gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	310.36	acre-feet/year
From Above, Real Losses = Current Annual Real Losses (CARL):	1,118.48	acre-feet/year
Infrastructure Leakage Index (ILI) [CARL/UARL]:	3.60	

* only the most applicable of these two indicators will be calculated

WATER AUDIT DATA VALIDITY SCORE:

Add a grading value for 10 parameter(s) to enable an audit score to be calculated

PRIORITY AREAS FOR ATTENTION:

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources
2: Billed metered
3: Customer metering inaccuracies

For more information, click here to see the Grading Matrix worksheet

AWWA WLCC Free Water Audit Software: Water Balance

 WAS v4.2

Water Audit Report For:	Report Yr:
City of Davis	2009

Own Sources (Adjusted for known errors) 12,835.000	Water Exported 0.000	Billed Water Exported			
	Water Supplied 12,835.000	Authorized Consumption 11,684.438	Billed Authorized Consumption 11,524.000	Billed Metered Consumption (inc. water exported) 11,524.000	Revenue Water 11,524.000
				Billed Unmetered Consumption 0.000	
			Unbilled Authorized Consumption 160.438	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 1,311.000
				Unbilled Unmetered Consumption 160.438	
		Water Losses 1,150.563	Apparent Losses 32.088	Unauthorized Consumption 32.088	
				Customer Metering Inaccuracies 0.000	
				Systematic Data Handling Errors 0.000	
Water Imported 0.000			Real Losses 1,118.475	Leakage on Transmission and/or Distribution Mains Not broken down	
				Leakage and Overflows at Utility's Storage Tanks Not broken down	
				Leakage on Service Connections Not broken down	

Appendix G: Groundwater Management Plan on CD

Appendix H: CUWCC BMP Reports, 2009-2010

To Be Submitted Separately.

Appendix I: City of Davis Landscape Ordinance

COMMUNITY DEVELOPMENT AND SUSTAINABILITY DEPARTMENT

23 Russell Boulevard, Suite 2 – Davis, California 95616
530/757-5610 – FAX: 530/757-5660 – TDD: 530/757-5666

Davis
California

December 20, 2010

Peter Brostrom
California Department of Water Resources
Water Use and Efficiency Branch
Post Office Box 942836
Sacramento, CA 94236-0001

SUBJECT: City of Davis Water Efficient Landscape Ordinance Adoption

Dear Mr. Brostrom,

This is to notify the Department of Water Resources that on November 30, 2010 the City of Davis adopted a local ordinance in compliance with state requirements under the Water Conservation in Landscaping Act of 2006. The city's Water Efficient Landscape Ordinance is based on the model ordinance provided by the state and is consistent with state requirements. A copy of the city ordinance is enclosed.

Should you have any questions, please feel free to contact me at: (530) 757-5610, or by email at: elee@cityofdavis.org. Thank you.

Sincerely,

Eric Lee

Eric Lee
Assistant Planner

Attachments: City of Davis Water Efficient Landscape Ordinance

ORDINANCE NO. 2369

ORDINANCE AMENDING CHAPTER 40 ZONING OF THE MUNICIPAL CODE OF THE CITY OF DAVIS TO UPDATE CITY STANDARDS FOR WATER EFFICIENT LANDSCAPING BY REPEALING EXISTING STANDARDS IN SECTIONS 40.26.190 THROUGH 40.26.240 AND ADDING UPDATED STANDARDS AS ARTICLE 40.42

WHEREAS, the purpose of the Zoning Ordinance Chapter 40 of the Municipal Code of the City of Davis is to establish clear standards and processes for orderly development in the city; and

WHEREAS, state requirements mandate that local jurisdictions comply with the Water Conservation in Landscaping Act of 2006, Government Code Sections 65591 et. seq. and adopt standards and procedures that promote the design, installation and management of water efficient landscaping consistent with state requirements; and

WHEREAS, water consumption for landscaping represents a substantial amount and the design of landscapes and irrigation systems significantly impact water use and consumption and it is the policy of the city to minimize increases in water use, require water conservation in landscaping, and maintain surface water quality; and

WHEREAS, the updated standards contained in this ordinance comply with state requirements and are consistent with the Water Conservation in Landscaping Act of 2006; and

WHEREAS, existing standards for water conservation located in Sections 40.26.190 through 40.26.240 would be replaced by these updated standards as Article 40.42 of the City Code; and

WHEREAS, the Planning Commission held a public hearing on July 28, 2010 to consider the ordinance and recommended that the City Council adopt these amendments to Chapter 40 of the Municipal Code; and

WHEREAS, the Natural Resources Commission held a public meeting on September 27, 2010 to review and provide comments on the ordinance amendments; and

WHEREAS, the City Council of the City of Davis held a public hearing on November 9, 2010 to consider adoption of these amendments to the Municipal Code; and

WHEREAS, these proposed amendments are categorically exempt from further environmental review pursuant to CEQA Guidelines Section 15307 and 15308 for actions taken by regulatory agencies as authorized by state law to assure the maintenance, restoration, enhancement of natural resources and the protection of the environment.

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF DAVIS DOES HEREBY ORDAIN AS FOLLOWS:

SECTION 1. SECTIONS 40.26.190 THROUGH 40.26.240 FOR WATER CONSERVATION STANDARDS.

Repeal Water Conservation Standards in Sections 40.26.190 through 40.26.240 of Chapter 40 of the Municipal Code of the City of Davis, as amended. Sections 40.26.250 through 40.26.450 shall remain in their current formation.

SECTION 2. ARTICLE 40.42 WATER EFFICIENT LANDSCAPING STANDARDS.
Amend Chapter 40 of the Municipal Code of the City of Davis, as amended, to add updated standards for water efficient landscaping as Article 40.42, as follows:

Article 40.42 WATER EFFICIENT LANDSCAPING

Sections:

Section 40.42.010 Purpose.
The purpose of the landscaping standards contained in this chapter is to comply with the Water Conservation in Landscaping Act of 2006, Government Code Sections 65591 et. seq. and to establish standards and procedures that promote the design, installation and management of water efficient landscaping. These standards may be reviewed and updated, as required.

Section 40.42.020 Applicability
(a) The provisions of this chapter shall apply to all of the following landscape projects within the City of Davis, except as otherwise noted:

(1) Non-Residential Projects and Public Agency Projects. New construction and rehabilitated landscapes for public agency projects and private development projects with a landscape area equal to or greater than 2,500 square feet requiring a building or landscape permit, plan check or design review.

(2) Residential Projects With Developer-Installed Landscaping. New construction and rehabilitated landscapes which are developer-installed in single-family and multi-family projects with a landscape area equal to or greater than 2,500 square feet per lot requiring a building or landscape permit, plan check, or design review.

(3) Residential Projects With Homeowner-Provided Landscaping. New construction landscapes which are homeowner-provided and/or homeowner-hired in single-family and multi-family residential projects with a total project landscape area equal to or greater than 5,000 square feet requiring a building or landscape permit, plan check or design review.

(4) Existing Landscaping. Requirements for existing landscapes installed prior to the effective date of this ordinance and not rehabilitated are limited to Section 40.42.040.

(5) Cemeteries. Recognizing the special landscape management needs of cemeteries, requirements for new and rehabilitated cemeteries are limited to Sections 40.42.070, 40.42.140 and 40.42.150. Requirements for existing cemeteries are limited to Section 40.42.040.

(b) The provisions of this chapter do not apply to:

(1) Historical Sites. Registered local, state or federal historical sites;

(2) Restoration Projects. Ecological restoration projects that do not require a permanent irrigation system;

(3) Reclamation Projects. Mined-land reclamation projects that do not require a permanent irrigation system; or

(4) Plant Collections. Plant collections, as part of botanical gardens and arboretums open to the public.

Section 40.42.030 Definitions.
The terms used in this chapter have the meaning set forth below:

Applied Water. The portion of water supplied by the irrigation system to the landscape.

Automatic Irrigation Controller. An automatic timing device used to remotely control valves that operate an irrigation system. Automatic irrigation controllers schedule irrigation events using either evapotranspiration (weather-based) or soil moisture data.

Backflow Prevention Device. A safety device used to prevent pollution or contamination of the water supply due to the reverse flow of water from the irrigation system.

Certificate of Completion. The document required under Section 40.42.120.

Certified Irrigation Designer. A person certified to design irrigation systems by an accredited academic institution a professional trade organization or other program such as the US Environmental Protection Agency's WaterSense irrigation designer certification program and Irrigation Association's Certified Irrigation Designer program.

Certified Landscape Irrigation Auditor. A person certified to perform landscape irrigation audits by an accredited academic institution, a professional trade organization or other program such as the US Environmental Protection Agency's WaterSense irrigation auditor certification program and Irrigation Association's Certified Landscape Irrigation Auditor program.

Check Valve or Anti-Drain Valve. A valve located under a sprinkler head, or other location in the irrigation system, to hold water in the system to prevent drainage from sprinkler heads when the sprinkler is off.

Common Interest Developments. Community apartment projects, condominium projects, planned developments, and stock cooperatives per Civil Code Section 1351.

Conversion Factor (0.62). The number that converts acre-inches per acre per year to gallons per square foot per year.

Developer-Installed Landscaping. Landscape area on a property installed by the developer of the property or licensed contractor hired by the developer of the property. A developer, for the purposes of this chapter, includes anyone or any group not defined as a homeowner by this chapter.

Drip Irrigation. Any non-spray low volume irrigation system utilizing emission devices with a flow rate measured in gallons per hour. Low volume irrigation systems are specifically designed to apply small volumes of water slowly at or near the root zone of plants.

Ecological Restoration Project. A project where the site is intentionally altered to establish a defined, indigenous, historic ecosystem.

Effective Precipitation (Eppt) or Usable Rainfall. The portion of total precipitation which becomes available for plant growth.

Emitter. A drip irrigation emission device that delivers water slowly from the system to the soil.

Established Landscape. The point at which plants in the landscape have developed significant root growth into the soil. Typically, most plants are established after one or two years of growth.

Establishment Period of the Plants. The first year after installing the plant in the landscape or the first two years if irrigation will be terminated after establishment. Typically, most plants are established after one or two years of growth.

Estimated Total Water Use (ETWU). The total water used for the landscape as described in Section 40.42.070(a).

ET Adjustment Factor (ETAF). A factor of 0.7, that, when applied to reference evapotranspiration, adjusts for plant factors and irrigation efficiency, two major influences upon the amount of water that needs to be applied to the landscape. A combined plant mix with a site-wide average of 0.5 is the basis of the plant factor portion of this calculation. For purposes of the ETAF, the average irrigation efficiency is 0.71. Therefore, the ET Adjustment Factor is (0.7)=(0.5/0.71). ETAF for a Special Landscape Area shall not exceed 1.0. ETAF for existing non-rehabilitated landscapes is 0.8.

Evapotranspiration Rate. The quantity of water evaporated from adjacent soil and other surfaces and transpired by plants during a specified time.

Flow Rate. The rate at which water flows through pipes, valves and emission devices, measured in gallons per minute, gallons per hour, or cubic feet per second.

Hardscapes. Any durable material (pervious and non-pervious).

Homeowner-Provided Landscaping. Any landscaping either installed by a private individual for a single family residence or installed by a licensed contractor hired by a homeowner. A homeowner, for purposes of this chapter, is a person who occupies the dwelling he or she owns. This excludes speculative homes, which are not owner-occupied dwellings.

Hydrozone. A portion of the landscaped area having plants with similar water needs. A hydrozone may be irrigated or non-irrigated.

Infiltration Rate. The rate of water entry into the soil expressed as a depth of water per unit of time (e.g., inches per hour).

Invasive Plant Species. Species of plants not historically found in California that spread outside cultivated areas and can damage environmental or economic resources. Invasive species may be regulated by county agricultural agencies as noxious species. "Noxious weeds" means any weed designated by the Weed Control Regulations in the Weed Control Act and identified on a Regional District noxious weed control list. Lists of invasive plants are maintained at the California Invasive Plant Inventory and USDA invasive and noxious weeds database.

Irrigation Audit. An in-depth evaluation of the performance of an irrigation system conducted by a Certified Landscape Irrigation Auditor. An irrigation audit includes, but is not limited to: inspection, system tune-up, system test with distribution uniformity or emission uniformity, reporting overspray or runoff that causes overland flow, and preparation of an irrigation schedule.

Irrigation Efficiency (IE). The measurement of the amount of water beneficially used divided by the amount of water applied. Irrigation efficiency is derived from measurements and estimates of irrigation system characteristics and management practices. The minimum average irrigation efficiency for purposes of this chapter is 0.71. Greater irrigation efficiency can be expected from well designed and maintained systems.

Irrigation Survey. An evaluation of an irrigation system that is less detailed than an irrigation audit. An irrigation survey includes, but is not limited to: inspection, system test, and written recommendations to improve performance of the irrigation system.

Irrigation Water Use Analysis. An analysis of water use data based on meter readings and billing data.

Landscape Architect. A person who holds a license to practice landscape architecture in the state of California Business and Professions Code, Section 5615.

Landscape Area. All the planting areas, turf areas, and water features in a landscape design plan subject to the Maximum Applied Water Allowance calculation. The landscape area does not include footprints of buildings or structures, sidewalks, driveways, parking lots, decks, patios, gravel or stone walks, other pervious or non-pervious hardscapes, and other non-irrigated areas designated for non-development (e.g., open spaces and existing native vegetation).

Landscape Contractor. A person licensed by the state of California to construct, maintain, repair, install, or subcontract the development of landscape systems.

Landscape Documentation Package. The documents required under Section 40.42.060.

Landscape Project. The total area of landscape in a project as defined in "landscape area" for the purposes of this ordinance, meeting requirements under Section 40.42.020.

Lateral Line. The water delivery pipeline that supplies water to the emitters or sprinklers from the valve.

Local Water Purveyor. Any entity, including a public agency, city, county, or private water company that provides retail water service.

Low Volume Irrigation. The application of irrigation water at low pressure through a system of tubing or lateral lines and low-volume emitters such as drip, drip lines, and bubblers. Low volume irrigation systems are specifically designed to apply small volumes of water slowly at or near the root zone of plants.

Main Line. The pressurized pipeline that delivers water from the water source to the valve or outlet.

Maximum Applied Water Allowance (MAWA). The upper limit of annual applied water for the established landscaped area as specified in Section 40.42.070. It is based upon the area's reference evapotranspiration, the ET Adjustment Factor, and the size of the landscape area. The Estimated Total Water Use shall not exceed the Maximum Applied Water Allowance. Special Landscape Areas, including recreation areas, areas permanently and solely dedicated to edible plants such as orchards and vegetable gardens, and areas irrigated with recycled water are subject to the MAWA with an ETAF not to exceed 1.0.

Microclimate. The climate of a small, specific area that may contrast with the climate of the overall landscape area due to factors such as wind, sun exposure, plant density, or proximity to reflective surfaces.

Mined-Land Reclamation Projects. Any surface mining operation with a reclamation plan approved in accordance with the Surface Mining and Reclamation Act of 1975.

Mulch. Any organic material such as leaves, bark, straw, compost, or inorganic mineral materials such as rocks, gravel, and decomposed granite left loose and applied to the soil surface for the beneficial purposes of reducing evaporation, suppressing weeds, moderating soil temperature, and preventing soil erosion.

New Construction. For the purposes of this chapter, a new building with a landscape or other new landscape, such as a park, playground, or greenbelt without an associated building.

Operating Pressure. The pressure at which the parts of an irrigation system are designed by the manufacturer to operate.

Overhead Sprinkler Irrigation Systems. Systems that deliver water through the air (e.g., spray heads and rotors).

Overspray. The irrigation water which is delivered beyond the target area.

Permit. An authorizing document issued by local agencies for new construction or rehabilitated landscapes.

Pervious. Any surface or material that allows the passage of water through the material and into the underlying soil.

Plant Factor or Plant Water Use Factor. A factor, when multiplied by ETo, estimates the amount of water needed by plants. For purposes of this chapter, the plant factor range for low water use plants is 0 to 0.3, the plant factor range for moderate water use plants is 0.4 to 0.6, and the plant factor range for high water use plants is 0.7 to 1.0. Plant factors cited in this chapter are derived from the Department of Water Resources 2000 publication "Water Use Classification of Landscape Species".

Precipitation Rate. The rate of application of water measured in inches per hour.

Project Applicant. The individual or entity submitting a Landscape Documentation Package, to request a permit, plan check, or design review from the City of Davis. A project applicant may be the property owner or his or her designee.

Rain Sensor or Rain Sensing Shutoff Device. A component which automatically suspends an irrigation event when it rains.

Record Drawing or As-Builts. A set of reproducible drawings which show significant changes in the work made during construction and which are usually based on drawings marked up in the field and other data furnished by the contractor.

Recreational Area. Areas dedicated to active play such as parks, sports fields, and golf courses where turf provides a playing surface.

Recycled Water, Reclaimed Water, or Treated Sewage Effluent Water. Treated or recycled waste water of a quality suitable for non-potable uses such as landscape irrigation and water features. This water is not intended for human consumption.

Reference Evapotranspiration or ETo. A standard measurement of environmental parameters which affect the water use of plants. ETo is expressed in inches per day, month, or year as represented in Section, and is an estimate of the evapotranspiration of a large field of four- to seven-inch tall, cool-season grass that is well watered. Reference evapotranspiration is used as the basis of determining the Maximum Applied Water Allowance so that regional differences in climate can be accommodated.

Rehabilitated Landscape. Any re-landscaping project that requires a permit, plan check, or design review, meets the requirements of Section 40.42.020, and the modified landscape area is equal to or greater than 2,500 square feet and is 50% or more of the total landscape area.

Runoff. Water which is not absorbed by the soil or landscape to which it is applied and flows from the landscape area. For example, runoff may result from water that is applied at too great a rate (application rate exceeds infiltration rate) or when there is a slope.

Soil Moisture Sensing Device or Soil Moisture Sensor. A device that measures the amount of water in the soil. The device may also suspend or initiate an irrigation event.

Soil Texture. The classification of soil based on its percentage of sand, silt, and clay.

Special Landscape Area (SLA). An area of the landscape dedicated solely to edible plants, areas irrigated with recycled water, water features using recycled water and areas dedicated to active play such as parks, sports fields, golf courses, and where turf provides a playing surface.

Sprinkler Head. A device which delivers water through a nozzle.

Static Water Pressure. The pipeline or municipal water supply pressure when water is not flowing.

Station. An area served by one valve or by a set of valves that operate simultaneously.

Swing Joint. An irrigation component that provides a flexible, leak-free connection between the emission device and lateral pipeline to allow movement in any direction and to prevent equipment damage.

Turf. A ground cover surface of mowed grass. Annual bluegrass, Kentucky bluegrass, Perennial ryegrass, Red fescue, and Tall fescue are cool-season grasses. Bermudagrass, Kikuyugrass, Seashore Paspalum, St. Augustinegrass, Zoysiagrass, and Buffalo grass are warm-season grasses.

Valve. A device used to control the flow of water in the irrigation system.

Water Conserving Plant Species. A plant species identified as having a low plant factor.

Water Feature. A design element where open water performs an aesthetic or recreational function. Water features include ponds, lakes, waterfalls, fountains, artificial streams, spas, and swimming pools (where water is artificially supplied). The surface area of water features is included in the high water use hydrozone of the landscape area. Constructed wetlands used for on-site wastewater treatment or stormwater best management practices that are not irrigated and used solely for water treatment or stormwater retention are not water features and, therefore, are not subject to the water budget calculation.

Watering Window. The time of day irrigation is allowed.

WUCOLS. The Water Use Classification of Landscape Species published by the University of California Cooperative Extension, the Department of Water Resources and the Bureau of Reclamation, 2000.

Section 40.42.040. Provisions for Existing Landscapes Installed Prior to Effective Date.

(a) This section shall apply to all existing landscapes that were installed prior to the effective date of this ordinance. However, existing landscapes installed between January 1, 2010 and the effective date of this ordinance are subject to the requirements of the Water Conservation in Landscaping Act of 2006.

(b) All existing landscapes installed prior to the effective date of this ordinance and over one acre in size that have a water meter are subject to programs administered by the City of Davis that may include, but are not limited to, irrigation water use analyses, irrigation surveys, and irrigation audits to evaluate water use and provide recommendations as necessary to reduce landscape water use to a level that does not exceed the Maximum Applied Water Allowance for existing landscapes.

(c) The Maximum Applied Water Allowance for existing landscapes shall be calculated in accordance with section 40.42.070 and using the following equation:

MAWA = (0.8)(ETo)(LA)(0.62)

Where:
0.8 = ET Adjustment Factor (ETAF) for existing non-rehabilitated landscapes
ETo = Reference Evapotranspiration for City of Davis (Annual ETo in inches per year)
LA = Landscape Area (square feet)
0.62 = Conversion Factor

(d) All existing landscapes that do not have a meter are subject to programs administered by the City of Davis that may include, but are not limited to, irrigation surveys and irrigation audits to evaluate water use and provide recommendations as necessary in order to prevent water waste.

(e) All landscape irrigation audits shall be conducted by a certified landscape irrigation auditor.

Section 40.42.050 Provisions for New Construction or Rehabilitated Landscapes.

(a) Prior to construction or issuance of permits, the project applicant for a new construction or rehabilitated landscape project, as described in Section 40.42.020, shall submit a complete Landscape Documentation Package to the Department of Community Development and Sustainability for review and approval.

(b) Upon approval of the Landscape Documentation Package by the Department of Community Development and Sustainability, the project applicant shall:

(1) Receive a permit or approval of the plan check or design review and record the date of the permit in the Certificate of Completion; and

(2) Submit a copy of the approved Landscape Documentation Package along with the record drawings, and any other information to the property owner or his/her designee.

(c) Upon completion of the landscape project and prior to final of the permit or occupancy, the project applicant shall submit a completed Certificate of Completion, as described in Section 40.42.120, to the Department of Community Development and Sustainability for review an approval.

Section 40.42.060 Landscape Documentation Package Requirements.
(a) The Landscape Documentation Package shall include the following six (6) elements and as detailed in the subsequent sections:

(1) Project Information. The project applicant shall provide the following minimum required project information:

(A) Date.

(B) Project Applicant.

(C) Project Address (if available, parcel and/or lot number(s)).

(D) Total Landscape Area (square feet).

(E) Project Type (e.g., new, rehabilitated, public, private, cemetery, homeowner-installed).

(F) Water Supply Type (e.g., potable, recycled, well) and identify the local retail water purveyor if the applicant is not served by a private well.

(G) Checklist of all documents in Landscape Documentation Package.

(H) Project contacts to include contact information for the project applicant and property owner.

(I) Applicant signature and date with statement, "I agree to comply with the requirements of the water efficient landscape ordinance and submit a complete Landscape Documentation Package."

(2) Water Efficient Landscape Worksheet;

(3) Soil Management Report;

(4) Landscape Design Plan;

(5) Irrigation Design Plan; and

(6) Grading Design Plan.

(b) Project applicant shall provide the required information on state-recommended forms or city-equivalent forms if available. All required reports and plans shall be provided in a form determined acceptable by the Director of Community Development and Sustainability and shall be subject to city review and approval.

Section 40.42.070 Water Efficient Landscape Worksheet.

(a) Landscape Worksheet Components. In order to determine the water budget and water needs for project landscaping, the project applicant shall complete the City's Water Efficient Landscape Worksheet which contains two sections:

(1) Hydrozone Information Table; and

(2) Water Budget Calculations for the Maximum Applied Water Allowance (MAWA) and the Estimated Total Water Use (ETWU).

(b) Water Budget Calculation Requirements. Water budget calculations shall adhere to the following requirements:

(1) The plant factor used shall be from WUCOLS. The plant factor ranges from 0 to 0.3 for low water use plants, from 0.4 to 0.6 for moderate water use plants, and from 0.7 to 1.0 for high water use plants.

(2) All water features shall be included in the high water use hydrozone and temporarily irrigated areas shall be included in the low water use hydrozone.

(3) All Special Landscape Areas shall be identified and their water use calculated as described below.

(4) ETAF for Special Landscape Areas shall not exceed 1.0.

(5) For the purposes of determining these water calculations, average irrigation efficiency is assumed to be 0.71.

(6) For the calculation of the Maximum Applied Water Allowance and Estimated Total Water Use, a project applicant shall use the following ETo values, or as may be updated, for the City of Davis:

Reference Evapotranspiration (ETo) Table for City of Davis

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual ETo
1.0	1.9	3.3	5.0	6.4	7.6	8.2	7.1	5.4	4.0	1.8	1.0	52.5

(c) Maximum Applied Water Allowance (MAWA). The Maximum Applied Water Allowance shall be calculated using the equation:

MAWA = (ETo) (0.62) [(0.7 x LA) + (0.3 x SLA)]

(d) Estimated Total Water Use (ETWU). The Estimated Total Water Use shall be calculated using the equation below. The sum of the Estimated Total Water Use calculated for all hydrozones shall not exceed Maximum Applied Water Allowance.

$$ETWU = (ETo)(0.62)\left(\frac{PF \, x \, HA}{IE} + SLA\right)$$

Where:

ETWU = Estimated Total Water Use per year (gallons)
ETo = Reference Evapotranspiration for City of Davis (Annual ETo in inches per year)
PF = Plant Factor from WUCOLS
HA = Hydrozone Area [high, medium, and low water use areas] (square feet)
SLA = Special Landscape Area (square feet)
0.62 = Conversion Factor
IE = Irrigation Efficiency (minimum 0.71)

Section 40.42.080 Soil Management Report.
(a) Soil Report Requirements. In order to reduce runoff and encourage healthy plant growth, a soil management report shall be completed by the project applicant, or designee, and submitted, as follows:

(1) Project applicant shall submit soil samples to a qualified laboratory for analysis and recommendations to be included in the soil report.

(A) Soil sampling shall be conducted in accordance with laboratory protocol, including protocols regarding adequate sampling depth for the intended plants.

(B) The soil analysis may include:

i. Soil Texture;

ii. Infiltration rate determined by laboratory test or soil texture infiltration rate table;

iii. pH;

iv. Total Soluble Salts;

v. Sodium;

vi. Percent organic matter; and

vii. Recommendations for preparing, amending and treating the soil.

(2) The project applicant, or designee, shall comply with one of the following:

(A) If significant mass grading is not planned, the soil analysis report shall be submitted to the Department of Community Development and Sustainability for review as part of the Landscape Documentation Package; or

(B) If significant mass grading is planned, the soil analysis report shall be submitted to the Department of Community Development and Sustainability for review as part of the Certificate of Completion.

(3) The soil analysis report shall be made available, in a timely manner, to the professionals preparing the landscape design plans and irrigation design plans to make any necessary adjustments to the design plans.

(4) The project applicant, or designee, shall submit documentation verifying implementation of soil analysis report recommendations to the Department of Community Development and Sustainability with the Certificate of Completion.

Section 40.42.090 Landscape Design Plan.
(a) Landscape Design Criteria. For the efficient use of water, a landscape shall be carefully designed and planned for the intended function of the project. A landscape design plan meeting the following design criteria shall be submitted as part of the Landscape Documentation Package.

(1) Plant Material.

(A) Any plant may be selected for the landscape, providing the Estimated Total Water Use in the landscape area does not exceed the Maximum Applied Water Allowance. To encourage the efficient use of water, the following is highly recommended:

i. Protection and preservation of native species and natural vegetation;

ii. Selection of water-conserving plant and turf species;

iii. Selection of plants based on disease and pest resistance;

iv. Selection of trees based on the City's Master Tree List; and

v. Selection of plants from city, local, and regional landscape program plant lists.

(B) Each hydrozone shall have plant materials with similar water use, with the exception of hydrozones with plants of mixed water use, as specified in Section 40.42.100(a)(2)(D).

(C) Plants shall be selected and planted appropriately based upon their adaptability to the climatic, geologic, and topographical conditions of the project site. To encourage the efficient use of water, the following is highly recommended:

i. Use the Sunset Western Climate Zone System which takes into account temperature, humidity, elevation, terrain, latitude, and varying degrees of continental and marine influence on local climate;

ii. Recognize the horticultural attributes of plants (i.e., mature plant size, invasive surface roots) to minimize damage to property or infrastructure [e.g., buildings, sidewalks, power lines]; and

iii. Consider the solar orientation for plant placement to maximize summer shade and winter solar gain.

(D) Turf is not allowed on slopes greater than 25% where the toe of the slope is adjacent to an impermeable hardscape and where 25% means one foot of vertical elevation change *for every four feet of horizontal length (rise divided by run x 100 = slope percent).*

(E) A landscape design plan for projects in fire-prone areas shall address fire safety and prevention. A defensible space or zone around a building or structure is required per Public Resources Code Section 4291(a) and (b). Avoid fire-prone plant materials and highly flammable mulches.

(F) The use of invasive and/or noxious plant species is strongly discouraged.

(G) The architectural guidelines of a common interest development, which include community apartment projects, condominiums, planned developments, and stock cooperatives, shall not prohibit or include conditions that have the effect of prohibiting the use of low-water use plants as a group.

(2) Water Features.

(A) Recirculating water systems shall be used for water features.

(B) Where available, recycled water shall be used as a source for decorative water features.

(C) Surface area of a water feature shall be included in the high water use hydrozone area of the water budget calculation.

(D) Pool and spa covers are highly recommended.

(3) Mulch and Amendments.

(A) A minimum two inch (2") layer of mulch shall be applied on all exposed soil surfaces of planting areas except in turf areas, creeping or rooting groundcovers, or direct seeding applications where mulch is contraindicated.

(B) Stabilizing mulching products shall be used on slopes.

(C) The mulching portion of the seed/mulch slurry in hydro-seeded applications shall meet the mulching requirement.

(D) Soil amendments shall be incorporated according to recommendations of the soil report and what is appropriate for the plants selected.

(b) Landscape Plan Requirements. The landscape design plan, at a minimum, shall:

(1) Delineate and label each hydrozone by number, letter, or other method;

(2) Identify each hydrozone as low, moderate, high water, or mixed water use. Temporarily irrigated areas of the landscape shall be included in the low water use hydrozone for the water budget calculation;

(3) Identify recreational areas;

(4) Identify areas permanently and solely dedicated to edible plants;

(5) Identify areas irrigated with recycled water;

(6) Identify type of mulch and application depth;

(7) Identify soil amendments, type, and quantity;

(8) Identify type and surface area of water features;

(9) Identify hardscapes (pervious and non-pervious);

(10) Identify location and installation details of any applicable stormwater best management practices that encourage on-site retention and infiltration of stormwater. Stormwater best management practices are encouraged in the landscape design plan and examples include, but are not limited to:

(A) Infiltration beds, swales, and basins that allow water to collect and soak into the ground;

(B) Constructed wetlands and retention ponds that retain water, handle excess flow, and filter pollutants; and

(C) Pervious or porous surfaces (e.g., permeable pavers or blocks, pervious or porous concrete, etc.) that minimize runoff.

(11) Identify any applicable rain harvesting or catchment technologies (e.g., rain gardens, cisterns, etc.);

(12) Contain the following statement: "I have complied with the criteria of the ordinance and applied them for the efficient use of water in the landscape design plan."; and

(13) Bear the signature of a licensed landscape architect, licensed landscape contractor, or any other person authorized to design a landscape.

Section 40.42.100 Irrigation Design Plan.
(a) Irrigation Design Criteria. For the efficient use of water, an irrigation system shall meet all the requirements listed in this section and the manufacturers' recommendations. The irrigation system and its related components shall be planned and designed to allow for proper installation, management, and maintenance. An irrigation design plan meeting the following design criteria shall be submitted as part of the Landscape Documentation Package.

(1) Irrigation System Requirements.

(A) Dedicated landscape water meters are highly recommended on landscape areas smaller than 5,000 square feet to facilitate water management.

(B) Automatic irrigation controllers utilizing either evapotranspiration or soil moisture sensor data shall be required for irrigation scheduling in all irrigation systems.

(C) The irrigation system shall be designed to ensure that the dynamic pressure at each emission device is within the manufacturer's recommended pressure range for optimal performance.

i. If the static pressure is above or below the required dynamic pressure of the irrigation system, pressure-regulating devices such as inline pressure regulators, booster pumps, or other devices shall be installed to meet the required dynamic pressure of the irrigation system.

ii. Static water pressure, dynamic or operating pressure, and flow reading of the water supply shall be measured at the point of connection. These pressure and flow measurements shall be conducted at the design stage. If the measurements are not available at the design stage, the measurements shall be conducted at installation.

(D) Sensors (rain, freeze, wind, etc.), either integral or auxiliary, that suspend or alter irrigation operation during unfavorable weather conditions shall be required on all irrigation systems, as appropriate for local climatic conditions. Irrigation should be avoided during windy or freezing weather or during rain.

(E) Manual shut-off valves (such as a gate valve, ball valve, or butterfly valve) shall be required, as close as possible to the point of connection of the water supply, to minimize water loss in case of an emergency (such as a main line break) or routine repair.

(F) Backflow prevention devices shall be required to protect the water supply from contamination by the irrigation system. A project applicant shall refer to the applicable local agency code (i.e., public health) for additional backflow prevention requirements.

(G) High flow sensors that detect and report high flow conditions created by system damage or malfunction are recommended.

(H) The irrigation system shall be designed to prevent runoff, low head drainage, overspray, or other similar conditions where irrigation water flows onto non-targeted areas, such as adjacent property, non-irrigated areas, hardscapes, roadways, or structures.

(I) Relevant information from the soil management plan, such as soil type and infiltration rate, shall be utilized when designing irrigation systems.

(J) The design of the irrigation system shall conform to the hydrozones of the landscape design plan.

(K) The irrigation system must be designed and installed to meet, at a minimum, the irrigation efficiency criteria as described in Section 40.42.160 regarding the Estimated Total Water Use calculation.

(L) It is highly recommended that the project applicant or local agency inquire with the local water purveyor about peak water operating demands (on the water supply system) or water restrictions that may impact the effectiveness of the irrigation system.

(M) In mulched planting areas, the use of low volume irrigation is required to maximize water infiltration into the root zone.

(N) Sprinkler heads and other emission devices shall have matched precipitation rates, unless otherwise directed by the manufacturer's recommendations.

(O) Head to head coverage is recommended. However, sprinkler spacing shall be designed to achieve the highest possible distribution uniformity using the manufacturer's recommendations.

(P) Swing joints or other riser-protection components are required on all risers subject to damage that are adjacent to high traffic areas.

(Q) Check valves or anti-drain valves are required for all irrigation systems.

(R) Narrow or irregularly shaped areas, including turf, less than eight (8) feet in width in any direction shall be irrigated with subsurface irrigation or low volume irrigation system.

(S) Overhead irrigation shall not be permitted within 24 inches of any non-permeable surface. Allowable irrigation within the setback from non-permeable surfaces may include drip, drip line, or other low flow non-spray technology. The setback area may be planted or unplanted. The surfacing of the setback may be mulch, gravel, or other porous material. These restrictions may be modified if:

i. The landscape area is adjacent to permeable surfacing and no runoff occurs; or

ii. The adjacent non-permeable surfaces are designed and constructed to drain entirely to landscaping; or

iii. The irrigation designer specifies an alternative design or technology, as part of the Landscape Documentation Package and clearly demonstrates strict adherence to irrigation system design criteria. Prevention of overspray and runoff must be confirmed during the irrigation audit.

(T) Slopes greater than 25% shall not be irrigated with an irrigation system with a precipitation rate exceeding 0.75 inches per hour. This restriction may be modified if the landscape designer specifies an alternative design or technology, as part of the Landscape Documentation Package, and clearly demonstrates no runoff or erosion will occur. Prevention of runoff and erosion must be confirmed during the irrigation audit.

(2) Hydrozone.

(A) Each valve shall irrigate a hydrozone with similar site, slope, sun exposure, soil conditions, and plant materials with similar water use.

(B) Sprinkler heads and other emission devices shall be selected based on what is appropriate for the plant type within that hydrozone.

(C) Where feasible, trees shall be placed on separate valves from shrubs, groundcovers, and turf.

(D) Individual hydrozones that mix plants of moderate and low water use, or moderate and high water use, may be allowed if:

i. Plant factor calculation is based on the proportions of the respective plant water uses and their plant factor; or

ii. The plant factor of the higher water using plant is used for calculations.

(E) Individual hydrozones that mix high and low water use plants shall not be permitted.

(F) On the landscape design plan and irrigation design plan, hydrozone areas shall be designated by number, letter, or other designation. On the irrigation design plan, designate the areas irrigated by each valve, and assign a number to each valve. Use this valve number in the Hydrozone Information Table on the city-provided form. This table can also assist with the irrigation audit and programming the controller.

(b) Irrigation Plan Requirements. The irrigation design plan, at a minimum, shall contain:

(1) Location and size of separate water meters for landscape;

(2) Location, type and size of all components of the irrigation system, including controllers, main and lateral lines, valves, sprinkler heads, moisture sensing devices, rain switches, quick couplers, pressure regulators, and backflow prevention devices;

(3) Static water pressure at the point of connection to the public water supply;

(4) Flow rate (gallons per minute), application rate (inches per hour), and design operating pressure (pressure per square inch) for each station;

(5) Recycled water irrigation systems as specified in Section 40.42.170;

(6) The following statement: "I have complied with the criteria of the ordinance and applied them accordingly for the efficient use of water in the irrigation design plan"; and

(7) The signature of a licensed landscape architect, certified irrigation designer, licensed landscape contractor, or any other person authorized to design an irrigation system.

Section 40.42.110 Grading Design Plan.

(a) Grading Plan Requirements. For the efficient use of water, grading of a project site shall be designed to minimize soil erosion, runoff, and water waste. A grading plan shall be submitted as part of the Landscape Documentation Package. A comprehensive grading plan prepared by a civil engineer for other local agency permits satisfies this requirement.

(1) The project applicant shall submit a landscape grading plan that indicates finished configurations and elevations of the landscape area including:

(A) Height of graded slopes;

(B) Drainage patterns;

(C) Pad elevations;

(D) Finish grade; and

(E) Stormwater retention improvements, if applicable.

(2) To prevent excessive erosion and runoff, it is highly recommended that project applicants:

(A) Grade so that all irrigation and normal rainfall remains within property lines and does not drain on to non-permeable hardscapes;

(B) Avoid disruption of natural drainage patterns and undisturbed soil; and

(C) Avoid soil compaction in landscape areas; and

(D) Decompact and break up compacted soil in landscape areas.

(3) The grading design plan shall contain the following statement: "I have complied with the criteria of the ordinance and applied them accordingly for the efficient use of water in the grading design plan" and shall bear the signature of a licensed professional as authorized by law.

Section 40.42.120 Certificate of Completion.

(a) Certificate of Completion Elements. The Certificate of Completion shall include the following six (6) elements in a form determined acceptable to the Director of Community Development and Sustainability:

(1) Project information sheet that contains:

(A) Date;

(B) Project name;

(C) Project applicant name, telephone, and mailing address;

(D) Project address and location; and

(E) Property owner name, telephone, and mailing address;

(2) Certification by either the signer of the landscape design plan, the signer of the irrigation design plan, or the licensed landscape contractor that the landscape project has been installed per the approved Landscape Documentation Package;

(A) Where there have been significant changes made in the field during construction, these "as-built" or record drawings shall be included with the certification;

(3) Irrigation scheduling parameters used to set the controller (see Section 40.42.130);

(4) Landscape and irrigation maintenance schedule (see Section 40.42.140);

(5) Irrigation audit report (see Section 40.42.150); and

(6) Soil analysis report, if not submitted with Landscape Documentation Package, and documentation verifying implementation of soil report recommendations.

(b) Certificate of Completion Submittal. Upon completion of the landscape project and prior to final of the permit or occupancy, the project applicant shall:

(1) Submit the signed Certificate of Completion to the Department of Community Development and Sustainability for review;

(2) Ensure that copies of the approved Certificate of Completion are submitted to the local water purveyor and property owner or his or her designee.

(c) City Review Procedures. Upon submittal of the completed Certificate of Completion, the Department of Community Development and Sustainability shall:

(1) Receive the signed Certificate of Completion from the project applicant;

(2) Upon review of the Certificate of Completion, approve or deny the Certificate of Completion. If the Certificate of Completion is denied, the City of Davis shall not be obligated to issue an occupancy permit and shall provide information to the project applicant regarding reapplication, appeal, or other assistance.

Section 40.42.130 Irrigation Scheduling.
(a) For the efficient use of water, all irrigation schedules shall be developed, managed, and evaluated to utilize the minimum amount of water required to maintain plant health. Irrigation schedules shall meet the following criteria:

(1) Irrigation scheduling shall be regulated by automatic irrigation controllers.

(2) Overhead irrigation shall be scheduled between 8:00 p.m. and 10:00 a.m. unless weather conditions prevent it. If allowable hours of irrigation differ from the local water purveyor, the stricter of the two shall apply. Operation of the irrigation system outside the normal watering window is allowed for auditing and system maintenance.

(3) For implementation of the irrigation schedule, particular attention must be paid to irrigation run times, emission device, flow rate, and current reference evapotranspiration, so that applied water meets the Estimated Total Water Use. Total annual applied water shall be less than or equal to Maximum Applied Water Allowance (MAWA). Actual irrigation schedules shall be regulated by automatic irrigation controllers using current reference evapotranspiration data (e.g., CIMIS) or soil moisture sensor data.

(4) Parameters used to set the automatic controller shall be developed and submitted for each of the following:

(A) The plant establishment period;

(B) The established landscape; and

(C) Temporarily irrigated areas.

(5) Each irrigation schedule shall consider for each station all of the following that apply:

(A) Irrigation interval (days between irrigation);

(B) Irrigation run times (hours or minutes per irrigation event to avoid runoff);

(C) Number of cycle starts required for each irrigation event to avoid runoff;

(D) Amount of applied water scheduled to be applied on a monthly basis;

(E) Application rate setting;

(F) Root depth setting;

(G) Plant type setting;

(H) Soil type;

(I) Slope factor setting;

(J) Shade factor setting; and

(K) Irrigation uniformity or efficiency setting.

Section 40.42.140 Landscape and Irrigation Maintenance Schedule.
(a) Landscapes shall be maintained to ensure water use efficiency. A regular maintenance schedule shall be submitted with the Certificate of Completion.

(b) A regular maintenance schedule shall include, but not be limited to, routine inspection; adjustment and repair of the irrigation system and its components; aerating and dethatching turf areas; replenishing mulch; fertilizing; pruning; weeding in all landscape areas, and removing and obstruction to emission devices. Operation of the irrigation system outside the normal watering window is allowed for auditing and system maintenance.

(c) Repair of all irrigation equipment shall be done with the originally installed components or their equivalents.

(d) A project applicant is encouraged to implement sustainable or environmentally-friendly practices for overall landscape maintenance.

Section 40.42.150 Irrigation Audits.
(a) All landscape irrigation audits shall be conducted by a certified landscape irrigation auditor.

(b) For new construction and rehabilitated landscape projects installed after adoption of this chapter, as described in Section 40.42.020:

(1) The project applicant shall submit an irrigation audit report with the Certificate of Completion to the City of Davis that may include, but is not limited to: inspection, system tune-up, system test with distribution uniformity, reporting overspray or run off that causes overland flow, and preparation of an irrigation schedule.

(2) The City of Davis will maintain a reference list of certified water service auditors. The list shall be provided to project applicants upon request.

(3) The City of Davis may administer programs that may include, but not be limited to, irrigation water use analysis, irrigation audits, and irrigation surveys for compliance with the Maximum Applied Water Allowance.

Section 40.42.160 Irrigation Efficiency.
(a) For the purposes of determining the water calculations, average irrigation efficiency is assumed to be 0.71. Irrigation systems shall be designed, maintained, and managed to meet or exceed an average landscape irrigation efficiency of 0.71.

Section 40.42.170 Recycled Water.
(a) The installation of recycled water irrigation systems shall allow for the current and future use of recycled water, unless a written exemption has been granted as described in Section 40.42.170(b).

(b) Irrigation systems and decorative water features shall use recycled water unless a written exemption has been granted by the local water purveyor stating that recycled water meeting all public health codes and standards is not available and will not be available for the foreseeable future.

(c) All recycled water irrigation systems shall be designed and operated in accordance with all applicable local and State laws.

(d) Landscapes using recycled water are considered Special Landscape Areas. The ET Adjustment Factor for Special Landscape Areas shall not exceed 1.0.

Section 40.42.180 Stormwater Management.
(a) Stormwater management practices minimize runoff and increase infiltration which recharges groundwater and improves water quality. Implementing stormwater best management practices into the landscape and grading design plans to minimize runoff and to increase on-site retention and infiltration are encouraged.

(b) Projects shall comply with applicable city requirements for stormwater best management practices as detailed in the city's stormwater runoff ordinance or equivalent. Measures shall be incorporated and shown in the applicable plans subject to review and approval.

(c) Rain gardens, cisterns, and other landscapes features and practices that increase rainwater capture and create opportunities for infiltration and/or onsite storage are recommended.

Section 40.42.190 Public Education.
(a) The City of Davis or the project developer shall provide information to owners of new, single-family residential homes regarding the design, installation, management, and maintenance of water efficient landscapes in a form determined acceptable to the City.

(b) Model Homes. All model homes that are landscaped shall use signs and written information to demonstrate the principles of water efficient landscapes described in this chapter.

(1) Signs shall be used to identify the model as an example of a water efficient landscape featuring elements such as hydrozones, irrigation equipment, and others that contribute to the overall water efficient theme.

(2) *Information shall be provided about designing, installing, managing, and maintaining water* efficient landscapes.

Section 40.42.200 Effective Precipitation.
(a) *The city may consider Effective Precipitation* (up to a maximum of 25% of annual precipitation) in tracking water use. The following equation may be used to calculate Maximum Applied Water Allowance where Eppt is the Effective Precipitation:

MAWA= (ETo - Eppt) (0.62) [(0.7 x LA) + (0.3 x SLA)].

Section 40.42.210. Fees.
The City of Davis may establish fees for necessary review and inspections related to the requirements of this chapter.

Section 40.42.220. Penalties.
Failure to comply with the requirements of this chapter may result in enforcement and penalties in accordance with Municipal Code Chapter 23.

SECTION 3. PURPOSE.
The purpose of this ordinance is to comply with the Water Conservation in Landscaping Act of 2006, Government Code Sections 65591 et. seq. and to establish standards and procedures that promote the design, installation and management of water efficient landscaping consistent with state requirements.

SECTION 4. FINDINGS.
The City Council of the City of Davis hereby finds:

1. That the Planning Commission held a public hearing on July 28, 2010 to receive comments and consider the ordinance amendments.

2. That the Natural Resources Commission held a public meeting on September 27, 2010 to review and provide comments on the ordinance amendments.

3. That the ordinance amendments are in conformance with the City of Davis General Plan.

4. That the public necessity, convenience and general welfare require the adoption of the proposed ordinance amendments, in that, the ordinance amendments are necessary to comply with state requirements and to implement city policies for water conservation.

5. That the ordinance amendments are exempt from further environmental review pursuant to CEQA Guidelines Section 15307 and 15308 for actions taken by regulatory agencies as authorized by state law to assure the maintenance, restoration, enhancement of natural resources and the protection of the environment..

SECTION 5. EFFECTIVE DATE.
These ordinance amendments shall become effective on and after the thirtieth (30^{th}) day following its adoption.

INTRODUCED on the 9^{th} day of November, 2010, and PASSED AND ADOPTED by the City Council of the City of Davis on this 30^{th} day of November, 2010 by the following vote:

AYES: Greenwald, Krovoza, Souza, Swanson, Saylor

NOES: None

Don Saylor
Mayor

ATTEST:

Zoe S. Mirabile, CMC
City Clerk

Appendix J: Discussion on Upcoming Efficiency Standards

Interactions Among
AB 715 (Laird 2007), SB 407 (Padilla 2009),
and CALGreen Building Standards

Assessing for Provisions of Water Use Efficiency Regulations

Existing law provides for the following:

- requires that all toilets or urinals sold or installed in the state use no more than an average of 1.6 gallons or one gallon per flush, respectively;
- requires that certain disclosures be made upon the transfer of real estate; and
- authorizes water purveyors to adopt and enforce water conservation programs.

These three matters are affected by the regulations AB 715 (Laird 2007), SB 407 (Padilla 2009), (both already chaptered), and the CALGreen Building Standards (waiting formal inclusion in California Building Standards Code - CBSC on January 1, 2011). Between the three regulations, however, there is some degree of confusion or uncertainty regarding what happens when, and how it happens. Specifically, this relates to water efficiency measures, as altered by the regulations' effect on the plumbing code and building standards.

Per the table below ("Toilet and Urinal Fixtures in the California Code"), there are differing standards for toilets and urinals, and differing dates for implementation of high-efficiency models, i.e., HETs and HEUs. In addition, SB 407 and CalGreen address general plumbing fixtures, while AB 715 addresses exclusively toilets and urinals.

AB 715

COVERS: Toilets and Urinals
CHAPTERED AS: Health and Safety Code 17921.3

This law requires that, <u>on or after January 1, 2014, 100% of toilets and urinals</u> (other than blow-out urinals) <u>sold or installed in California be high-efficiency</u> (maximum of 1.28 gallons per flush for high-efficiency toilets – HETs - and 0.5 gallons per flush for high-efficiency urinals - HEUs). (In addition, the law requires that non-water urinals be approved for sale and installation in California.) The law requires that any state agency adopting or proposing building standards for plumbing systems to consider developing building standards that would govern the use of non-water urinals for submission to the CBSC. This law imposes a state-mandated local program, and violation of the State Housing Law is punishable as a misdemeanor. This law addresses exclusively toilets and urinals, and no other residential or commercial plumbing fixtures, fittings, appliances, or equipment.

The challenge with this bill is enforcement. As with all instances where additional inspection and enforcement burdens are placed upon municipalities, there is doubt as to whether either the technical capabilities or the municipal budgets currently exist to take on the added responsibilities associated with these requirements. This can be demonstrated with the lack of full enforcement of *today's* plumbing codes in new commercial construction.

AB 715 contained no provisions related to the retrofit on resale of existing single-family or multi-family homes, nor is there mention of existing commercial. However, by virtue of the 100% requirement relating to sales after January 1, 2014, all commercial and residential renovations involving toilet and/or urinal replacement would be subject to the HET and HEU requirements. As such, the expectation is for natural turnover/replacement to ultimately lead to the replacement of all toilets and urinals throughout the State over a period of time.

The bill also does not address what contractors, plumbers, or installers of the new HETs and HEUs are to do with the fixtures being replaced. Experience suggests that there is a secondary recycling market for the chinaware and other components of the toilets and urinals being removed.

SB 407

COVERS: Toilets, Urinals, Showerheads, Interior Faucets

SB 407 mandates all buildings in California come up to 1992 State plumbing fixture standards at some point in the next decade. This law establishes requirements that residential and commercial property built and available for use on or before January 1, 1994 replace plumbing fixtures that are not water conserving, defined as "noncompliant plumbing fixtures" as follows:

(1) any toilet manufactured to use more than 1.6 gallons of water per flush;
(2) any urinal manufactured to use more than one gallon of water per flush;
(3) any showerhead manufactured to have a flow capacity of more than 2.5 gallons of water per minute; and
(4) any interior faucet that emits more than 2.2 gallons of water per minute.

Conversely, the law defines the category of "water-conserving plumbing fixtures" as fixtures that are compliant with current standards and use water equal to or less than the amounts shown above.

On or before January 1, 2019, all noncompliant plumbing fixtures in multi-family residential and commercial properties must be replaced by the property owner with water-conserving plumbing fixtures. For single-family residential property, the compliance date is January 1, 2017.

Building Alterations & Improvements

In advance of the above dates, the law requires, on and after January 1, 2014, for building alterations/improvements to all residential and commercial property, that water-conserving plumbing fixtures replace all noncompliant plumbing fixtures as a condition for issuance of a certificate of final completion and occupancy or final permit approval by the local building department.

Real Property Sales and Transfers (disclosures)

The law requires, on and after January 1, 2017, that a seller or transferor of single-family residential, disclose to the purchaser or transferee, in writing, the specified requirements for replacing plumbing fixtures and whether the real property includes noncompliant plumbing. For multi-family residential and commercial property, the date is January 1, 2019.

Special Provision: Postponement of Requirements

The law provides that the application of its requirements may be postponed up to one year with respect to a building for which a demolition permit has been issued.

Special Provision: Fixture Operation in Tenant Spaces

Regarding rental or leased properties, the law requires that, on and after January 1, 2019, the water-conserving plumbing fixtures prescribed within the law operate at the manufacturer's rated water consumption at the time that a tenant takes possession.

Special Provision: Local Ordinances

The law permits a city or county or retail water supplier to enact a local ordinance or policy that promotes compliance with the provisions of the law, or that will result in greater water savings than otherwise provided by the law. Any city, county, or city and county that has adopted an ordinance requiring retrofit of noncompliant plumbing fixtures prior to July 1, 2009, is exempt from its requirements so long as the ordinance remains in effect.

Enforcement

Again, however, the complication or barrier to implementation occurs in the enforcement, i.e., how this law will be enforced in the various situations covered in the law. The law does not specify punishment for noncompliance, but only requires that the purchaser or transferee be notified of the noncompliance. The law includes a strong reliance on building inspectors and real estate agents to ensure/enforce that all faucets, showerheads, urinals, and toilets are, in fact, water conserving and operate at the manufacturers' specified standard. As with AB 715, the question remains as to whether either the technical capabilities or the municipal budgets currently exist to take on the added responsibilities at the local level.

Like AB 715, the law does not address what contractors, plumbers, or installers of the new toilets are to do with the replaced fixtures.

CALGreen Building Standards Code

This component is the 11th of 12 parts of the official compilation and publication of the adoptions, amendments and repeal of regulations to California Code of Regulations, Title 24, also referred to as the CBSC. This component is known as the California Green Building Standards Code, and it is intended that it shall also be known as the *CALGreen* Code.

The CBSC is published in its entirety every three years by order of the California Legislature. These building standards have the same force of law, and take effect 180 days after their publication unless otherwise stipulated. There are two non-mandatory appendices to CALGreen that may be adopted locally if an agency chooses to require more stringent conservation. The CBSC applies to all occupancies in the State of California as annotated. A city, county or city and county may establish more restrictive standards reasonably necessary because of local climatic, geological, or topographical conditions. For the purpose of this code, these conditions include local environmental conditions as established by a city, county, or city and county. Findings of the local condition(s) and the adopted local building standard(s) must be filed with the California Building Standards Commission to become effective and may not be effective sooner than the effective date of the most recent edition of the CBSC. Local building standards that were adopted and applicable to previous editions of the CBSC do not apply to the most recent edition without appropriate adoption and the required filing.

Water efficiency requirements begin on page 17 of the CALGreen Code
http://www.hcd.ca.gov/codes/shl/2010_CA_Green_Bldg.pdf

While this is the most thorough of all laws discussed here, it covers ONLY new construction and renovations. It does not cover such areas as property resales, seller disclosures, or product sales. Indoor provisions of CALGreen include: commercial submetering, excess consumption submetering, efficient fixtures, faucet aerators, toilets, urinals, lavatory and metering faucets, multiple showerheads, and non-potable water use systems. Outdoor considerations include: water budgets, landscape submetering, and irrigation design (including rain sensors and weather-based irrigation controllers). There is to be a section on water reuse systems, though it is not yet included within the document.

Mandatory provisions

CalGreen prescriptive indoor provisions for maximum water consumption of plumbing fixtures and fittings are as follows:

Fixture/Fitting	Baseline consumption (Tables 4.303.1 & 5.303.2.2)	High-Efficiency consumption (Tables 4.303.2 & 5.303.2.3)
Water Closets (Toilets) – all types	1.6 gallons per flush	1.28 gallons per flush
Urinals	1.0 gallon per flush	0.5 gallons per flush
Residential showerheads	2.5 gallons per minute	2.0 gallons per minute
Residential lavatory faucets	2.2 gallons per minute	1.5 gallons per minute
Kitchen faucets	2.2 gallons per minute	1.8 gallons per minute
Replacement faucet aerators	2.2 gallons per minute	not specified
Non-residential lavatory faucets	0.5 gallons per minute	0.4 gallons per minute
Metering faucets	0.25 gallons per cycle	0.2 gallons per cycle

The high-efficiency consumption levels shown above represent CalGreen's prescriptive path to compliance.

However, Sections 4.301.1 and 5.303.2 provide that an optional performance path may be chosen instead. That option requires an overall aggregate 20% reduction in indoor water use from a calculated baseline using a set of worksheets provided within the CalGreen document. This trade-off method does not extend to exterior water uses at the building. That is, landscape measures cannot be traded for indoor plumbing measures, and vice-versa.

Mandatory outdoor water use provisions consist of requiring a weather-based or soil moisture-sensing irrigation controller.

Voluntary provisions

In addition to the above mandatory requirements, further efficiencies are available to the jurisdiction or builder through application of two voluntary "tiers". For water use efficiency, tiers are as follows:

Tier 1 requires that all of the mandatory requirements be satisfied PLUS the following:

Residential development (up to 3 stories):

- Kitchen faucet flow rate reduced from 1.8 gallons per minute to 1.5 gallons per minute
- Potable water use for landscape applications be reduced to a quantity that is ≤65% of ETo
- Incorporation of at least one other elective measure from a list of measures provided (including such items as waterless toilet, waterless urinal, low-consumption irrigation system, rainwater capture system, water budgeting, water reuse system)

Non-residential development (including mixed use with some residential):

- Aggregate indoor water use reduction of 30% from the established baseline ***OR*** 30% reduction in individual water use for each of the plumbing fixtures listed above.
- Potable water use for landscape applications be reduced to a quantity that is ≤60% of ETo
- Incorporation of at least one elective measure from a list of measures provided (including such items as clothes washers, commercial and residential dishwashers, ice makers, food steamers, water softeners, dual plumbing, landscape submeters, water budget, potable water elimination from outdoor use, graywater irrigation system)

Tier 2 is more aggressive and requires that all of the mandatory requirements be satisfied PLUS the following:

Residential development (up to 3 stories):

- Kitchen faucet flow rate reduced from 1.8 gallons per minute to 1.5 gallons per minute
- Dishwashers be Energy Star qualified and use no more than 5.8 gallons per cycle
- Potable water use for landscape applications be reduced to a quantity that is ≤60% of ETo

- Incorporation of at least two elective measures from a list of measures provided (including such items as waterless toilet, waterless urinal, low-consumption irrigation system, rainwater capture system, water budgeting, water reuse system)

Non-residential development (including mixed use with some residential):

- Aggregate indoor water use reduction of 35% from the established baseline ***OR*** 35% reduction in individual water use for each of the plumbing fixtures listed above.
- Potable water use for landscape applications be reduced to a quantity that is ≤55% of ETo
- Incorporation of at least three elective measures from a list of measures provided (including such items as clothes washers, commercial and residential dishwashers, ice makers, food steamers, water softeners, dual plumbing, landscape submeters, water budget, potable water elimination from outdoor use, graywater irrigation system)

Conclusion:

After careful reading and assessment of the documents, these laws are not found to be contrary, but simply 'one-up' each other as dates pass and action is taken. The provision in AB 715 that all fixtures sold or installed after January 1, 2014 must be HETs and HEUs (sections 17921.3 (b)(1) and (2)) is primary until January 1, 2014, or until the date on which the California Building Standards Commission includes standards in the CBSC that conform to this section, whichever date is later (section 17921.3 (i)). When the CBSC is updated to conform to the AB 715 legislation (this is a required action by this legislation), it will become the primary plumbing code efficiency provision, a regulation that is, in effect, law.

The efficiency provisions in SB 407 are augmented by those in AB 715 and the CALGreen Code (SB 407 only requires toilet efficiency of 1.6/1.0 gallon per flush for a toilet and urinal versus the high-efficiency provision for 1.28 gallons per flush in AB 715 and CALGreen). The more stringent restrictions in AB 715 and the CALGreen Code will supersede the equipment flow standards included in SB 407. SB 407 requires entities to disclose non-efficient fixtures in real-estate transactions and requires that all toilets in single-family residential, multi-family residential, and commercial buildings have efficient fixtures by January 1, 2017, 2019, and 2019 (respectively). This provision will complement the other regulations, as it rounds out the requirements, including all buildings, whether transfer of ownership occurs or not, and all plumbing fixtures (though this will likely be covered by the update of the CBSC). As noted earlier, the very significant challenge of enforcement remains for all of these laws.

Options for clarifying these incongruencies include rectifying/clarifying legislation. This would be helpful in two cases:

- that of strengthening SB 407 to include some kind of enforcement for existing homes and real estate transactions, as the plumbing code will be enforced on new development; and
- changing the standards listed in SB 407 to those in the CALGreen code at some point in the future.

Toilet and Urinal Fixtures in the California Codes

Condition, Activity, or Event	AB 715 (2007)	SB 407 (2009)	CalGreen
Sale of toilet and urinal fixtures through retail or other outlets	All fixtures sold or installed after Jan 1, 2014 must be HETs or HEUs[3]	Not addressed	Not addressed
Existing[1] single family residential			
Resale	Not addressed	As of Jan 1, 2017, requires written disclosure by Buyer to Seller of non-compliant fixtures in property	Not addressed
Renovation[2]	All fixtures installed after Jan 1, 2014 must be HETs or HEUs[3]	Renovated SFR must be 1.6 max (toilets) or 1.0 max (urinals) on or after Jan 1, 2014 to obtain bldg or occupancy permit	1.28 maximum[3] IF prescriptive path is chosen (per 4.303.1) – Jan 1, 2011
All other SFR	Not addressed	ALL SFR must be 1.6/1.0 max by Jan 1, 2017	
Existing[1] multi-family residential			
Resale	Not addressed	As of Jan 1, 2019, requires written disclosure by Buyer to Seller of non-compliant fixtures in property	Not addressed
Renovation[2]	All fixtures installed after Jan 1, 2014 must be HETs or HEUs[3]	Renovated MFR must be 1.6 max (toilets) or 1.0 max (urinals) on or after Jan 1, 2014 to obtain bldg or occupancy permit	1.28 maximum[3] IF prescriptive path is chosen (per 4.303.1) – Jan 1, 2011
All other MFR	Not addressed	ALL MFR must be 1.6/1.0 max by Jan 1, 2019[6]	
Existing[1] commercial			
Resale	Not addressed	As of Jan 1, 2019, requires written disclosure by Buyer to Seller of non-compliant fixtures in property	Not addressed
Renovation[4]	All fixtures installed after Jan 1, 2014 must be HETs or HEUs[3]	Renovated Comm'l must be 1.6 max (toilets) or 1.0 max (urinals) on or after Jan 1, 2014 to obtain bldg or occupancy permit	1.28 max (toilets) and 0.5 max (urinals)[3] IF prescriptive path is chosen (per 5.303.2) – Jan 1, 2011
All other Commercial	Not addressed	ALL Commercial must be 1.6 max on or after Jan 1, 2019[5]	
New single family residential	All fixtures installed after Jan 1, 2014 must be HETs or HEUs[3]	Not addressed	1.28 max (toilets) and 0.5 max (urinals)[3] IF prescriptive path is chosen (per 4.303.1) – Jan 1, 2011
New multi-family residential		Not addressed	
New commercial		Not addressed	1.28 max (toilets)[3] and 0.5 max (urinals) IF prescriptive path is chosen (per 5.303.2) – Jan 1, 2011

[1] Existing as of the effective date of the provision
[2] Alterations or improvements
[3] Toilet effective flush rate of 1.28 gallons, where dual flush toilets are measured as the average of one full flush and two reduced flushes. Urinal flush rate of 0.5 gallons.
[4] SB407 applies only where building additions increase total building size by more than 10 percent OR for building alterations or improvements, where the total construction cost estimated in the building permit exceeds $150,000
[5] Places continuing responsibility on the owner of rental property to guarantee that the toilet "shall be operating at the manufacturer's rated water consumption at the time that the tenant takes possession."

Appendix K: Executive Summary for End Use Study

Complete copy of final Residential End Use Study can be found at
http://cityofdavis.org/pw/water/

CALIFORNIA SINGLE FAMILY WATER USE EFFICIENCY STUDY

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Sponsored by:
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Amy McNulty, Project Coordinator

Participating Agencies: San Diego County Water Authority, City of San Diego, Los Angeles Department of Water and Power, Las Virgenes Municipal Water District, East Bay Municipal Utility District, City of Davis, San Francisco Public Utilities Commission, City of Redwood City, Sonoma County Water Agency.

Report Date: April 20, 2011

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Disclaimer

All opinions, conclusions and recommendations in this report are those of the principal investigator and research team, and do not necessarily reflect the opinions of any of the sponsors, state officials, participating agencies, reviewers or other persons who may have assisted or participated in this study. The authors apologize and take full responsibility for all mathematical errors, misspellings and grammatical blunders within these pages. Readers are encouraged to point out any of the above to the author by email to bill@aquacraft.com for corrections in later editions of this study or publication of errata.

Author's Preface

This report deals with a simple subject: how water is used in single-family homes in California. Nonetheless, the topic has important consequences for the future of the State of California. The official goal of the State is to reduce per capita water use by 20% by 2020. This report provides useful information and insights as to the technical potential to achieve these goals within the single-family residential water use sector.

The overall period covered by our investigation ranges from 2005 to 2010, and the bulk of the water use data were collected from 2005 through 2008. This study is a bottom-up approach to the subject. Rather than trying to infer customers' water use patterns from gross production data and various other sources such as surveys and census information conducted on whole populations of customers, we have collected highly detailed information at the water meter on random samples of customers chosen from billing databases, with the goal of projecting patterns in the populations from these samples.

We believe that the results of the study shed light both on how California single-family customers are currently using water, how their water use patterns have changed over the ten year period since the Residential End Uses of Water Study, and how future water use patterns might be modified in order to increase the efficiency of use and modify demands to moderate the need for raw water withdrawals form increasingly over-extended supplies. We hope that readers of this report find it of use, and that over time it assists in the common efforts to better manage our natural resources.

Acknowledgments

The research team wishes to express its sincere gratitude for the assistance of all of the people and agencies who supported this effort, and without whom the study never would have been conducted. Specifically, we would like to acknowledge:

Fiona Sanchez and Amy McNulty, of Irvine Ranch Water District, for applying for and managing the grant, and the financial and project related aspects of this study, and acting as liaison between the participating agencies, the California Department of Water Resources, and the Consultants.

The California Department of Water Resources, provider of the Proposition 50 Grant that funded the majority of this study and especially Mr. Baryohay Davidoff, Contract Manager OWUE.

The hundreds of water customers in the participating agencies who consented to allowing their water use data to be included in the study, filled out surveys, and allowed us to data-log their homes and analyze their landscapes. Our thanks go to these persons who shall forever remain nameless in order to protect their privacy.

The participating water agencies who contributed cash, data, in-kind services and moral support to the project:

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Ryan Grisso, North Marin Water District
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Daniel Muelrath, City of Santa Rosa

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Peter Gleick, Matt Heberger and Heather Cooley, Pacific Institute

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Glossary and Conversion Factors

The following table provides the definitions of terms as they are used in this report. These definitions may vary from common usage based on specific terminology for the study.

A	
actual irrigation application	The volume of water estimated as outdoor or irrigation use. Calculated as total annual billed consumption minus best estimate of indoor use (kgal).
AF	Acre-foot - a volume of water that would cover one acre to a depth of one foot, or 325,850 gallons of water. See conversion table below.
AFY	A unit of volumetric rate: acre-feet per year.
ANOVA, Analysis of variance	A mathematical process for separating the variability of a group of observations into assignable causes and setting up various significance tests.[i]
application ratio	The ratio of the actual irrigation application to the theoretical irrigation requirement... Application ratios are key parameters in assessing irrigation use because they indicate at a glance whether a given site is over or under-irrigating.
AWC, average winter consumption	Average winter consumption is an estimate of indoor water use. It can be calculated from average winter water usage in the months of December, January, and February where it is assumed that all usage during that period of time is indoors.
AWWA, American Water Works Association	AWWA provides knowledge, information and advocacy on water resource development, water and wastewater treatment technology, water storage and distribution, and utility management and operations. AWWA is an international nonprofit and educational society and the largest and oldest organization of water professionals in the world. Members represent the full spectrum of the water community: treatment plant operators and managers, scientists, environmentalists, manufacturers, academicians, regulators, and others who hold genuine interest in water supply and public health.

AWWARF, American Water Works Research Foundation	Changed to Water Research Foundation in 2008. The Water Research Foundation is a member-supported, international, nonprofit organization that sponsors research to enable water utilities, public health agencies, and other professionals to provide safe and affordable drinking water to consumers.
B	
BMP, Best Management Practices.	A set of water conservation practices identified, supported and in some cases required by the California Urban Water Conservation Council.
C	
CALFED	Members of the California Water Policy Council and the California Federal Ecosystem Directorate (CALFED) signed the Framework Agreement in 1994. By signing this agreement, participants were committed to processes for: setting water quality standards for the Bay-Delta estuary, developing long-term solutions for the Bay-Delta, and coordinating CVP and SWP operations with endangered species, water quality, and CVPIA requirements. CALFED Ops group is charged with coordinating the operation of the water projects with these requirements.
CCF	A measure of volume: one hundred cubic feet or 748 gallons. Also HCF. See conversion table below.
ccf/yr	An annual measure of volume: one hundred cubic feet, or 748 gallons, per year.
CII	Commercial, institutional and industrial customers.
CIMIS, California Irrigation Management Information System	A network of 120 weather stations found throughout California. Managed by DWR.
confidence interval	For a given statistic calculated for a sample of observations (e.g. the mean), the confidence interval is a range of values around that statistic that are believed to contain, with a certain probability (e.g. 95%) the true value of that statistic (i.e. the population value). This report typically uses a confidence interval of 95%.

Coverage Requirements	Requirements detailing level of implementation of CUWCC BMPs. Coverage requirements may be expressed either in terms of activity levels by water suppliers or as water savings achieved.
Current	The word "current" refers to the study period for this project, which was around 2007. All references to "current" demands or "current" data refer to the study period not the date of reading.
CUWCC, California Urban Water Conservation Council	The California Urban Water Conservation Council was created to increase efficient water use statewide through partnerships among urban water agencies, public interest organizations, and private entities. The Council's goal is to integrate urban water conservation Best Management Practices into the planning and management of California's water resources.
D	
data logging	Collection of flow data from a water meter by use of a portable electronic device that records the number of magnetic pulses generated by the meter on a ten second interval.
DWR, Department of Water Resources	State of California's agency charged with managing water resources and use.
E	
EBMUD, East Bay Municipal Utility District	EBMUD provides drinking water for 1.3 million customers in Alameda and Contra Costa counties. The District's wastewater treatment protects San Francisco Bay and services 640,000 customers.
EnergyStar	ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. The goals of the program are saving money and protecting the environment through energy-efficient products and practices.
EPAct, The Energy Policy Act of 1992	An Act of Congress passed in 1992 with the goal of improving energy efficiency. It also included changes mandating 1.6 gpf toilets.

EPA, Environmental Protection Agency	EPA leads the nation’s environmental science, research, education and assessment efforts. The mission of the Environmental Protection Agency is to protect human health and the environment. Since 1970, EPA has been working for a cleaner, healthier environment for the American people.
EPA Retrofit homes	A group of 96 homes selected from existing single-family homes in Seattle, East Bay MUD and Tampa. Each home was data-logged and surveyed for baseline use, and then retrofit with high-efficiency fixtures and appliance. Post-retrofit data were collected so that the impacts of the retrofits could be determined. These homes are used as benchmarks for high efficincy homes.
ET, Evapo-transpiration	Evapotranspiration (ET), as used in this study, is a measurement of the water requirement of plants. According to CIMIS, Evapotranspiration (ET) is the loss of water to the atmosphere by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues). It is an indicator of how much water your crops, lawn, garden, and trees need for healthy growth and productivity. See reference ET and net ET.
excess use	When the application ratio is greater than 1 there is excess irrigation occurring. Excess irrigation as used in this report is the difference between the actual volume of water applied to the landscape and the theoretical irrigation requirement, with all values less than one set to zero. This represents the sum of all excess use without netting out the deficit use.
Exlanatory variable	A variable used as part of a regression analysis as a parameter to attempt to predict or model another variable. One or more explanatory variabled are commonly used in attempted to predict the value of a single dependent or objective variable. For example household water use was an important dedendent variable in this study, which was related to changes in several explanatory variables such as persons per home, size of home, cost of water, presence of high efficniency fixtures and appliances.
F	
flapper leak	In trace analysis, a periodic leak, often with a flow rate similar to a toilet’s flow rate at a given site.
flow trace data analysis	Process of disaggregating end uses of water for a given meter.

FPD	Flushes per day
FS	field study
G	
gal.	Gallon, a measure of volume. See conversion table below.
GIS analysis	Geographic Information System. GIS is a system of capturing, storing, analyzing and presenting geographic data.
gpd	gallons per day.
gpcd	gallons per capita per day
gpf	gallons per flush.
gph	gallons per hour.
gphd	gallons per household per day
gpm	gallons per minute.
gpsf	gallons per square foot.
gtd	gallons per toilet per day.
H	
HCF, hundred cubic feet	A measure of volume: one hundred cubic feet or 748 gallons. Also CCF. See conversion table.
HET, High Efficiency Toilet	The term refers to toilets designed to flush at 1.28 gpf or less.
High volume, High water use toilet	Toilets designed to flush at volumes greater than 1.6 gpf. Pre-1992 toilets.

I	
irrigated area	Portion of a lot's area that is irrigated. Does not include house footprint, hardscape, etc. Irrigated area is a critical parameter for irrigation analysis. There was a very strong correlation between irrigated area and total lot size demonstrated by the data.
IRWD, Irvine Ranch Water District	Irvine Ranch Water District (IRWD) encompasses approximately 179 square miles and serves the city of Irvine and portions of Costa Mesa, Lake Forest, Newport Beach, Tustin, Santa Ana, Orange and unincorporated Orange County. It is an independent public agency governed by a publicly elected board of directors. Core Services include water treatment and delivery, sewer collection and treatment, water recycling and urban runoff treatment.
K	
Kc (crop co-efficient)	The relative amount of water cool-season turf needs at various times of the year.
keycode	The unique code used to identify each study home. The first two digits of the code identified the agency in which the residence was located. The last three digits identified the specific home.
kgal	Unit of volume equal to 1,000 gallons. See conversion table below.
L	
l, liter	A measure of volume, equal to 0.264 gallons.
LA, landscape area	Portion of a lot area that includes vegetation, ground cover or water surface. May include vegetated areas that are not irrigated. Does not include house footprint, hardscape, etc.
LADWP. Los Angeles Department of Water and Power	Public agency that supplies electricity and water to the City of Los Angeles. Water sources include recycled, imported (MWD) and ground water.
landscape aerial analyses	Utilizing aerial imagery and GIS analysis to identify landscaping features such as likely plant types and corresponding area.

landscape coefficient	The weighted average of crop coefficient for landscape (Kc). Represents the aggregate landscape for a given site. Lower values imply more xeric landscape, while higher values higher water-using landscape.
landscape ratio (LRatio)	This is the ratio of the theoretical irrigation requirement to the reference requirement based on ET_o
"leaks"	Whenever the term "leak" is enclosed in quotes this is intended to remind the reader that these events may include uses that are not actually leaks, but which give the appearance of leaks based on the flow rates, durations and timing patterns.
Leaks and continuous events	Events that are identified as leaks during flow trace analysis. These fall into two categories: small and random events that do not appear to be faucet use due to there small volume, timing and often repetitious nature, and long continuous events that appear to be due to broken valves or leaking toilets. Note that some continuous uses may be due to devices like reverse osmosis systems that are being operated on a continuous basis.
LF, Low flow	Describes toilets, faucets and showerheads that meet the 1992 EPAct requirements
logging	Practice of installing data loggers on customer water meters. Same as data logging.
lot size	Lot size is a measure of the total area attributed to a given study site. Often found from parcel data.
lpf,	liters per flush
LVMWD, Las Virgenes Municipal Water District	Las Virgenes Municipal Water District provides potable water and wastewater treatment to more than 65,000 residents in the cities of Agoura Hills, Calabasas, Hidden Hills, Westlake Village, and unincorporated areas of western Los Angeles County.
M	
mean	A hypothetical estimate of the typical value. For a set of n numbers, add the numbers in the set and divide the sum by n.

median	The middle number in an ordered set of observations. Less influenced by outliers than the mean.
MG	Unit of volume equal to 1,000,000 gallons. See conversion table below.
mgd	millions of gallons per day.
MGY	A unit of volume: million gallons per year.
MOU	Memorandum of Understanding. Especially with respect to the memorandum of understanding that led to the formation of the California Urban Water Conservation Council.
N	
n	number of observations or sample members.
net ET	Equal to Reference ET less effective precipitation. Net ET is a key parameter in analysis and prediction of water use.
NOAA, National Oceanic and Atmospheric Administration	An agency within the Department of Commerce. Focus is on oceans and atmosphere, including weather. Maintains weather stations throughout the United States.
R	
R^2 , coefficient of determination	The proportion of variance in one variable explained by a second variable. It is the square of the correlation coefficient, which is a measure of the strength of association or relationship between two variables.
reference evapo-transpiration (ETo)	ET_o measures the moisture lost from a reference crop (normally cool season grass for urban purposes (inches)) and the soil due to temperature, solar radiation, wind speed, and relative humidity. Precipitation is not included in the measurement of ETo although it does affect several of the parameters in the ET equation such as solar radiation and relative humidity.
Reference requirement	The volume of irrigation water required for a landscape planted exclusively with cool season turf and a 100% efficient irrigation system.

regression	A method for fitting a curve (not necessarily a straight line) through a set of points using some goodness-of-fit criterion.
REUWS homes, Residential End Uses of Water Study homes	This refers to the sample of approximately 1200 single-family homes chosen randomly from the service areas of 12 water providers in 1997. These are considered representative of existing single-family homes from the 1996 time period, prior to widespread implementation of the 1992 Energy Policy Act requirements.
S	
sf	A measure of area, square feet.
single-family home	For purposes of this study, a single-family home refers to a single meter feeding single dwelling unit. Generally detached, but may be attached as in the case of duplexes, triplexes etc, but each unit must be individually metered. Apartements are not included.
standard deviation	An estimate of the average variability (spread) of a set of data measured in the same units of measurement as the original data. It is the square root of the sum of squares divided by the number of values on which the sum of squares is based minus 1. [ii]
standard error	This is the standard deviation of the sampling distribution of a statistic. For a given statistic (e.g. the mean) it tells how much variability there is in this statistic across samples from the same population. Large values, therefore, indicate that a statistic from a given sample may not be an accurate reflection of the population from which the sample came.
T	
Theoretical Irrigation Requirement (TIR)	The volume of water (kgal) needed to meet the calculate requirements of the landscape for a given lot. It is a function of irrigated area, net Eto, landscape ratio, irrigation efficiency.

U	
ULF toilets	Ultra-Low-Flow/ultra-low-flush toilets, which 1992 represented the best efficiency toilets available. When used in this report the term ULF refers to toilets designed for flushing at 1.6 gpf. Currently, ULF toilets are the standard, and HET, or High Efficiency Toilets are the best available devices. The term is clearly out of date, but since it is so widely used and understood to represent 1.6 gpf toilets we continue to use it.
W	
water factor	For clothes washers, this is the ratio of the total average gallons per load to the capacity of the machine in cubic feet. The lower the number the more efficient the machine.
Water Research Foundation	The American Water Works Association research arm. The Water Research Foundation is a member-supported, international, nonprofit organization that sponsors research to enable water utilities, public health agencies, and other professionals to provide safe and affordable drinking water to consumers.
WaterSense	An EPA Partnership Program created to aid water conservation through labeling of water efficient products, services and buildings.

Table of Unit Conversion multipliers

	GAL	CF	CCF	KGAL	AF	MG
GAL	1	0.1337	1.337 x 10-3	1.0 x 10-3	3.069 x 10-6	1.0 x 10-6
CF	7.48	1	0.01	7.48 x 10-3	2.296 x 10-5	7.48 x 10-6
CCF	748	100	1	0.748	2.296 x 10-3	7.48 x 10-4
KGAL	1000	133.7	1.337	1	3.069 x 10-3	1.00 x 10-3
AF	325,851	43,560	435.6	325.852	1	0.326
MG	1,000,000	13,370	133.7	1000	3.069	1

Note: multiply number of units in column 1 by the number in the body of the table to convert to units shown in row 1, for example: 10 MG x 3.069 = 30.69 AF.

CHAPTER 1 – EXECUTIVE SUMMARY

The California Single Family Home Water Use Efficiency Study includes data from many traditional sources such as billing data, survey data, weather data and aerial photo information to analyze the water use patterns of a sample of over 700 single-family homes across ten water agencies throughout the State of California. Detailed flow trace data was obtained from portable data loggers which were attached to the water meters of each of the study homes. These flow traces provided flow readings at ten second intervals from the magnetic pickup, which generate 80-100 pulses per gallon. These highly detailed flow data make it possible to identify individual water use events and to categorize them by their end-use. The flow trace data tell not just how many gallons per day the home used, but how many gallons per day were used for individual end uses such as toilet flushing, clothes washing, dishwashers, showers, irrigation, faucets and leaks. Detailed use information can be pulled from the trace, giving for example, a count of toilet flushes and toilet flush volumes during a logging period. Researchers used flow trace data to determine levels of daily use in the homes and the efficiency of that use. Although the flow trace technique contains marginal error, such as from the mis-categorization of some events, it provides information on end uses-that is not available from any other source. This report summarizes the results of the study which began in 2005 and was completed in 2010. Water use patterns found during the 2007 logging period were analyzed to show how much potential remains for conservation savings from both indoor and outdoor efforts.

The executive summary covers the eight key goals as outlined in the 2004 proposal. This provides readers with a review of the most salient information that covers each of the key project goals. Readers wishing to obtain background information and to learn more about the research methods are referred to Chapters 2, 3 and 5.

Goal 1: To provide information on current water use efficiency by Single Family customers

Assessing the efficiency of water use in single-family homes implies having a standard upon which to base the comparison. The efficiency of the homes can then be described as a numerical value based on the chosen standard. For the single-family homes it is necessary to have two standards: one for indoor use and one for outdoor use.

Determining Efficiency Standards

The standard used in this study for indoor use was the household water use for a home employing best available technology for all fixtures and appliances and with less than 25 gphd of leakage. In effect, the indoor standard was based on the EPA WaterSense specifications for indoor devices. In the report the data from the 2000 study of a group of 100 homes that had been retrofit with high efficiency devices, the EPA Post Retrofit Group, was used as the benchmark for what we referred to as efficient homes. For indoor uses it was possible to have a single number that represented the number of gallons per day of use expected for efficient homes.

While indoor uses are relatively consistent from home to home, outdoor uses are much more variable, and it is really not possible to have a single number that tells how many gallons per year should be used for outdoor purposes. What served the purpose for an outdoor standard were two values referred to in the study as the "application ratio" and the volume of excess use. The application ratio is equal to the ratio of the actual outdoor water use to the theoretical requirement for outdoor use based on the size and type of landscape, the local ET and whether there is a swimming pool present. An application ratio of 1.0 indicates that precisely the correct amount of water is being used outdoors at the home. The volume of excess use is the difference between the actual outdoor use and the theoretical requirement (in Kgal). Using these parameters, an efficient home will have an application ratio of 1.0 or less, and will not have any excess outdoor use.

There were ten water agenies that participated in this study. Together they served a total of 1.3 million single-family customers during the study period. The weighted average annual water use of these homes was 132 Kgal per year or 362 gallons per household per day (gphd). There were a total of 735 homes included in the indoor analysis for this study. Their weighted average indoor water use 134 Kgal/year (367 gphd). Approximately 53% of the annual use appears to be for outdoor use and 47% for indoor uses, based on billing data analysis. Figure 1 shows the indoor outoor split for the homes in the study group.

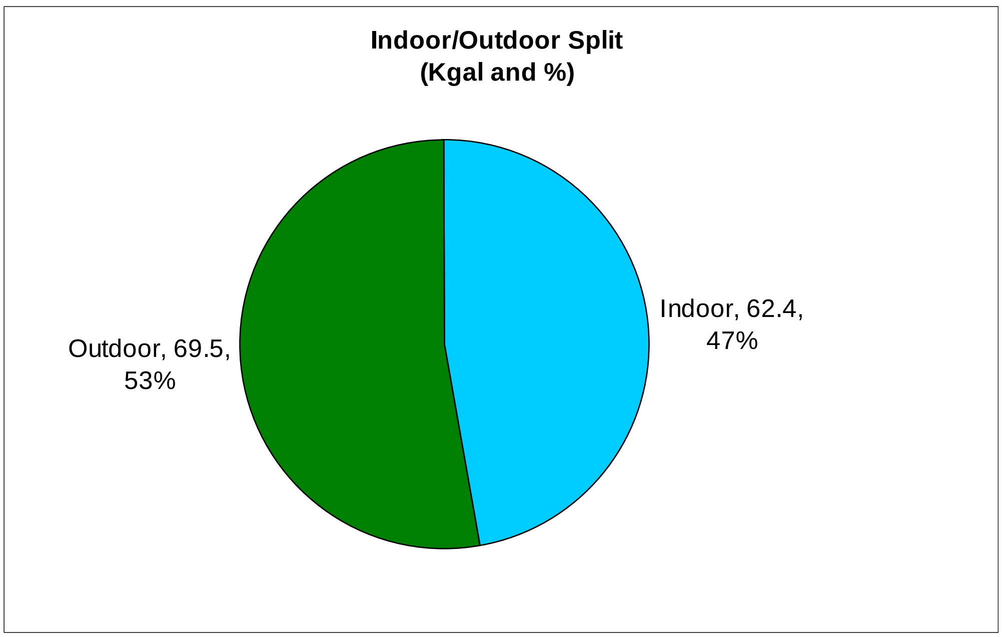


Figure 1: Approximate indoor/outdoor split in logging study group

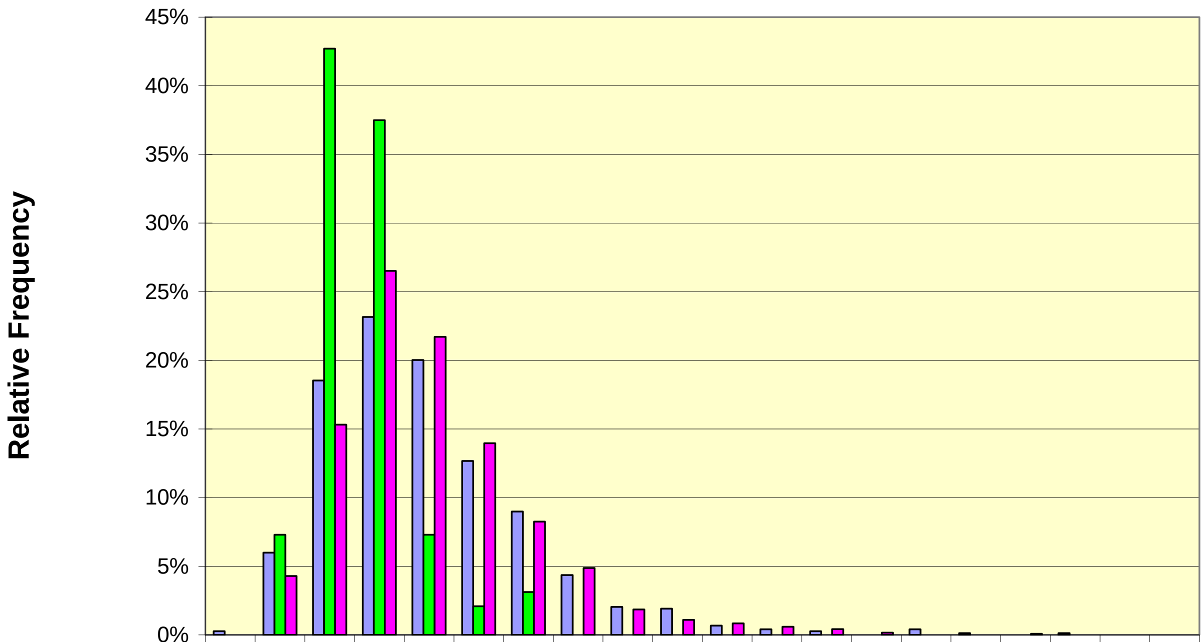
Indoor Efficiencies

When the indoor use (plus leakage) was analyzed from the flow trace data it showed that the indoor use for the households appears to be declining compared to the data obtained from the RUEWS group from 1997, but it is still significantly greater than the benchmark EPA Retrofit

Group. Table 1 shows a comparison of the indoor use of the study group to the two benchmark groups. Figure 1 compares the distribution of indoor use for the three groups. The current California use patterns are much closer to the REUWS benchmark than the EPA Retrofit benchmark.

Table 1: Comparison of average indoor use to benchmarks

Group	Average Indoor Use (gphd)	Percent of REUWS
REUWS (California)	186 ± 10.2	100 %
California SF Home Study	175 ± 8	94%
EPA Post Retrofit Group	107 ± 10.3	57%

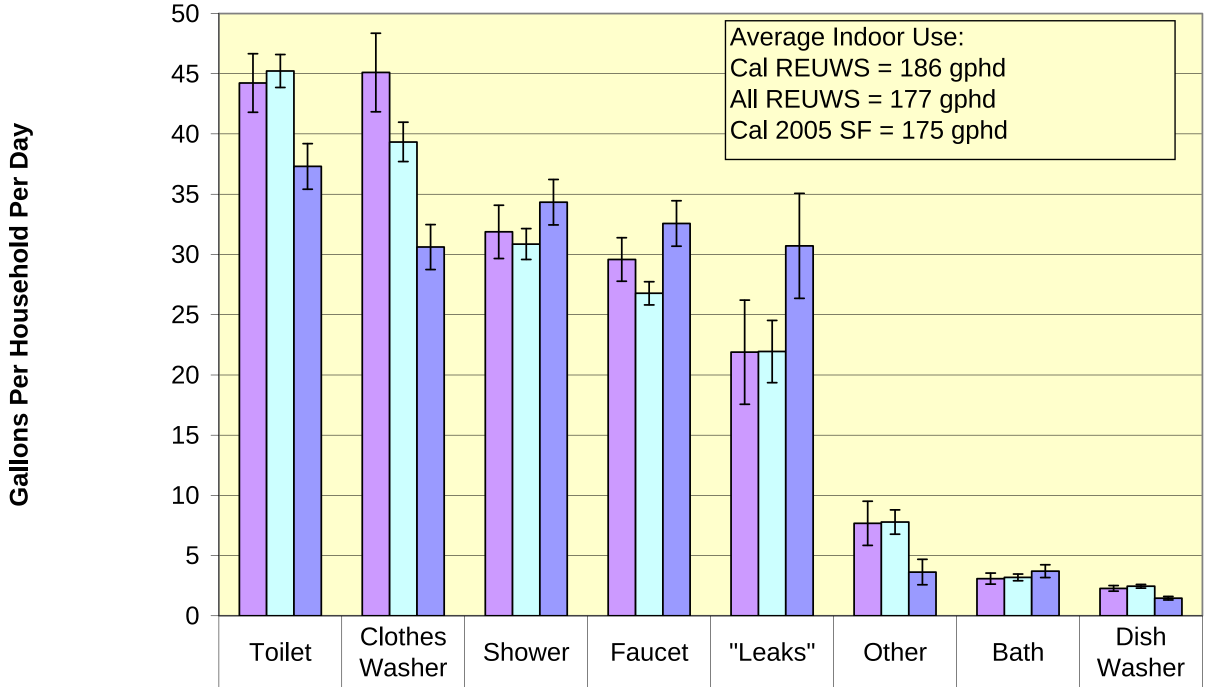


	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	
Cal SF Study	0%	6%	19%	23%	20%	13%	9%	4%	2%	2%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
EPA Retrofit	0%	7%	43%	38%	7%	2%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
REUWS	0%	4%	15%	27%	22%	14%	8%	5%	2%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	

Indoor Water Use (GPD) Comparison

Figure 2: Indoor use histogram for California SF Study sites, REUWS, and EPA Retrofit Homes

When the indoor uses are disaggregated the results are more revealing. The disaggregated data, shown in Figure 3 show that as one would expect that there have been significant reductions in indoor use for toilets and clothes washers in California since 1997. At the same time, the indoor uses attributed to the other categories have stayed the same or increased in a way that has masked the savings from the toilets and clothes washers. This pattern is especially true for events classified as leaks. The analysis showed significantly more long duration or continuous flows that get classified as leaks. These continuous events, which are found in a small number of homes, raise the average volume of water attributed to leaks for the study group from around 22 gphd to 31 gphd. This finding needs further investigation to determine whether these truly are leaks or may be due to devices that actually create a continuous demand for water. This information is important because if the leakage, faucet and shower use were brought down to the levels shown in the REUWS study the average indoor use for the group would have been around 150 gphd, which would have been a significant improvement from the 1997 data.



	Toilet	Clothes Washer	Shower	Faucet	"Leaks"	Other	Bath	Dish Washer
Cal REUWS	44.2	45.1	31.9	29.6	21.9	7.7	3.1	2.3
All REUWS	45.2	39.3	30.9	26.8	21.9	7.8	3.2	2.4
Cal2005SF	37.3	30.6	34.3	32.6	30.7	3.6	3.7	1.5

Figure 3: Comparison of household end-uses

The data show a major improvement in the water use efficiency of toilets. There were a total of 122,869 flushes recorded during the data logging period. The aveage flush volume was 2.76 gallons, and 64% of all flushes were less than 2.75 gallons. The one negative finding on toilets was that apparently many toilets that are designed to meet the ULF standard of 1.6 gpf are flushing at significantly larger volumes. This helps explain why the study found that only 30% of the homes were at average flush volumes of 2 gpf or less, while all of the program data, confirmed by survey data from this study suggest that over 60% of the toilets in the population are ULF or better models.

Figure 4 shows the comparison of the distribution of toilet flush volumes in the California Single Family Homes study and the 1997 REUWS study. This shows a dramatic shift in the bins containing the largest percentage of flushes. In the 1997 sample these were between 3.75 and 4.25 gpf, but as of 2007 they were between 1.25 and 2.25 gpf. As more of the toilets on the right side of the distribution are replaced with high efficiency models the overall demands for toilet flushing will drop well below the current levels, and the percentage of homes meeting the 2.0 gpf efficiency criteria used for this study will increase.

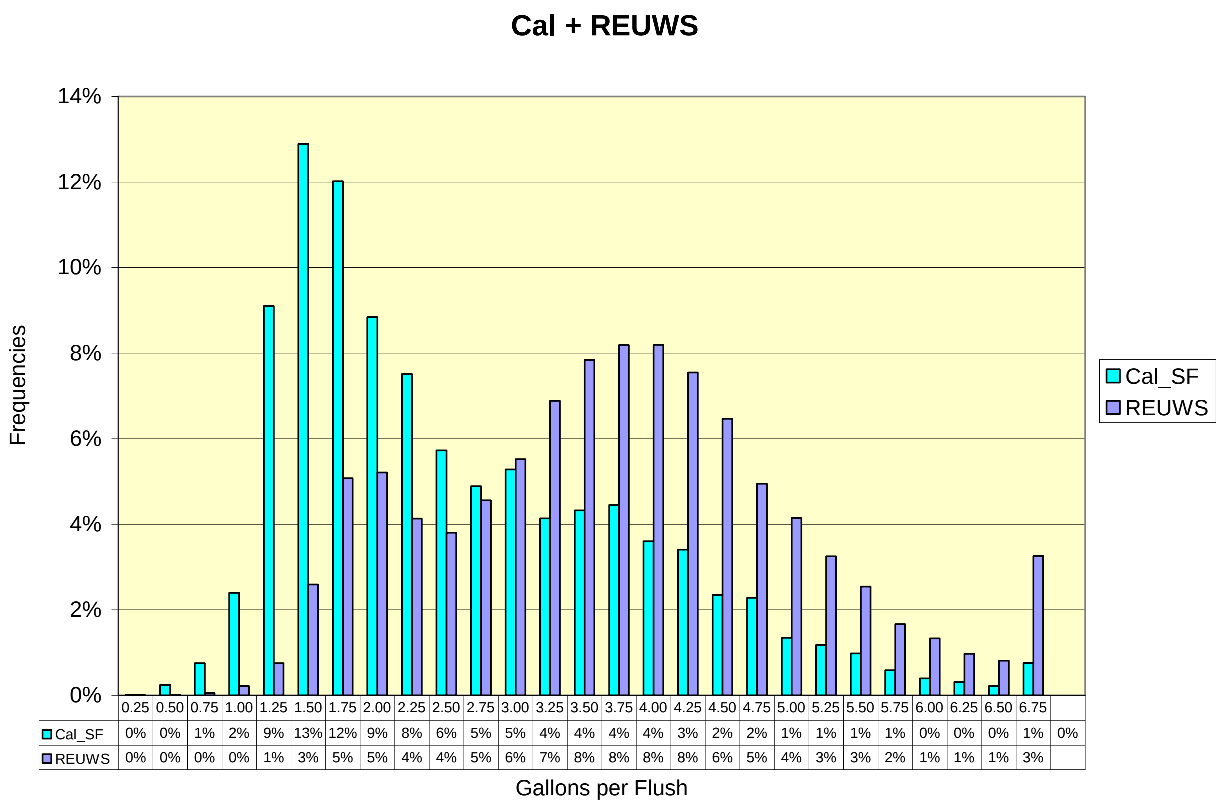
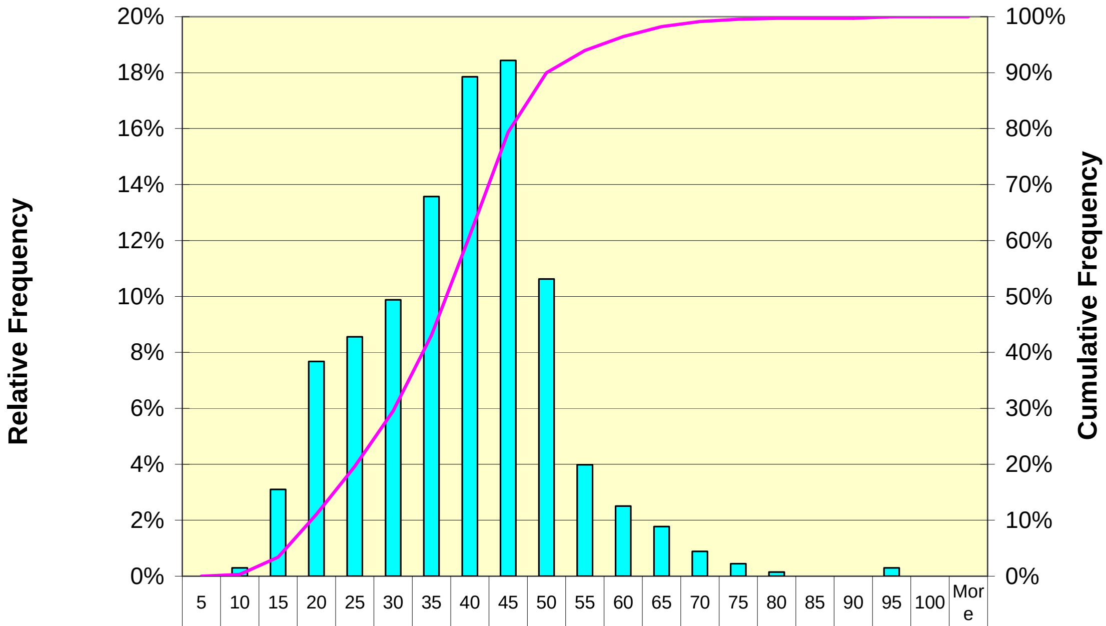


Figure 4: Comparison of toilet flush histograms of California SF Study to REUWS

The distribution of clothes washer load volumes from the data is shown in Figure 5. As of 2007 approximately 30% of homes were using 30 gallons per load or less for clothes washing. At the time of the REUWS only around 1% of the clothes washers used less than 30 gallons per load, so the current data represents a major advance, but the data also show that there is still significant potential for savings in clothes washer use.



	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	More
gal. Per Load	0%	0%	3%	8%	9%	10%	14%	18%	18%	11%	4%	3%	2%	1%	0%	0%	0%	0%	0%	0%	0%
Cum %	0%	0%	3%	11%	20%	29%	43%	61%	79%	90%	94%	96%	98%	99%	100	100	100	100	100	100	100

Gallons per Load of Laundry

Figure 5: Distribution of clothes washer volumes.

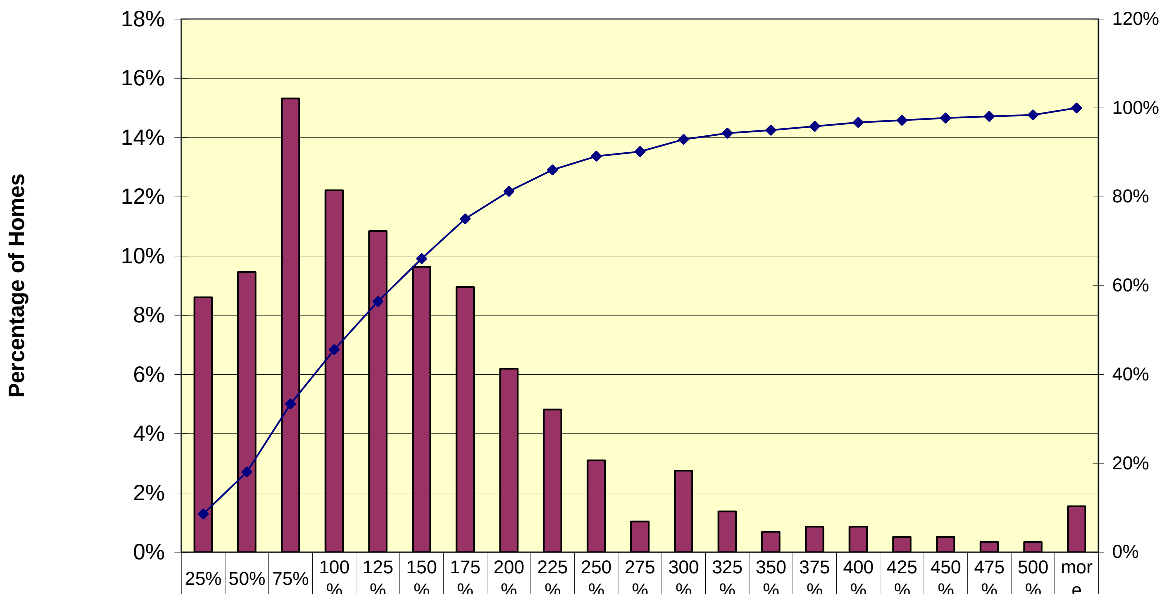
There was little change in shower use between 1997 and 2007. The average gallons per shower was just over 18 gallons (around the same volume that is required to fill up an occupied bath tub), and the duration of showers was just under 9 minutes. Nearly 80% of all showers were flowing at 2.5 gpm or less. Reducing flow rates and durations of showers remain the methods available for conservation in showers. These are the kinds of things that people can do during drought times to gain savings from behavioral changes.

The average leakage rate in the study homes was 31 gphd, while the median rate was 12 gphd. The wide disparity between these values shows that a small group of homes are leaking at very large rates, and this increases the average for the entire study group. By inspection of Figure 45 and Figure 46, one can see how the small number of homes in the larger leakage bins contributes a disproportionate amount of the total leakage in the group. Leakage is complicated by the fact that some events that Trace Wizard categorizes as leaks may be due to devices such as water treatment systems that create a continuous demand for water. The research team does not believe that this occurs very frequently, and that the majority of the long duration events which contribute to the bulk of the leak volumes are in fact due to broken valves or leakage from pools and irrigation systems. Leaks from very short duration event, such as drips or occasional toilet flapper problems usually amount to 10 gpd or less of household demand. The leaks which contribute very large volumes are those that continue for many hours or days. These are the continuous events that need to be better understood so that they can be dealt with appropriately.

The sample group used 33 gpd of water for miscellaneous faucet use. These uses average less than one gallon per use and have average durations of 37 seconds. The average home recorded over 57 faucet events per day. Faucet use represents a category of growing importance as toilets and clothes washers become more efficient. The key to improving the efficiency of faucet use is to decrease the flow rates and the duration of the events. Ideally, one could control faucets without touching the handles, and new devices are coming onto the market which can accommodate this. The easier it is for people to turn faucets on and off the less water will go to waste during tooth brushing, shaving and dish washing.

Outdoor Use Efficiencies

In the study group, only 87% of the homes appeared to be irrigating. This was based on the fact that their lots had no irrigable area, or that their water use showed little or no seasonal use. Only around 54% of the homes which irrigate are doing so to excess. So, overall, the degree of outdoor use efficiency is fairly good. Figure 6 shows the distribution of application ratios in the study homes.



	25%	50%	75%	100 %	125 %	150 %	175 %	200 %	225 %	250 %	275 %	300 %	325 %	350 %	375 %	400 %	425 %	450 %	475 %	500 %	mor e
Relative	9%	9%	15%	12%	11%	10%	9%	6%	5%	3%	1%	3%	1%	1%	1%	1%	1%	1%	0%	0%	2%
Cumulative	9%	18%	33%	46%	56%	66%	75%	81%	86%	89%	90%	93%	94%	95%	96%	97%	97%	98%	98%	98%	100

Figure 6: Distribution of application ratios in study homes.

If we look all of the irrigating homes and compare their average outdoor use volumes to the average theoretical requirement we see that the two values are close to each other. The average annual outdoor use for the group as a whole is 92.7 kgal. The average theoretical irrigation requirement for the group is 89.9 kgal. So, taken as a whole, there is only 2.8 kgal of excess use per lot occurring in the group. Another way of looking at this is that the under-irrigation in the less-than-TIR group just about balances the over-irrigation in the more-than-TIR group. If all irrigators were brought into compliance with their theoretical requirements, then the data indicate that the net result would be little change in overall use.

The fact that the difference between the average outdoor use and the average TIR is small does not mean that there is no potential for irrigation savings. The savings potential is there, but it exists mainly on the lots of customers who are over-irrigating. From the perspective of water conservation the customers who are deficit irrigating need to be set aside and attention needs to be targeted toward the over-irrigators.

The excess use statistics shown in Table 49, in Chapter 7, shows that the average excess use on the lots that are irrigating is approximately 30 kgal per year. Since only 87% of the lots were irrigators, the average excess use for all single-family accounts is estimated at 26.2 kgal per year. Approximately 62% of this excess use is occurring on 18% of the irrigating lots or 15% of all lots. This is critical for water management because it shows that in a typical system the majority of savings from outdoor use will be found from around 15% of the customers.

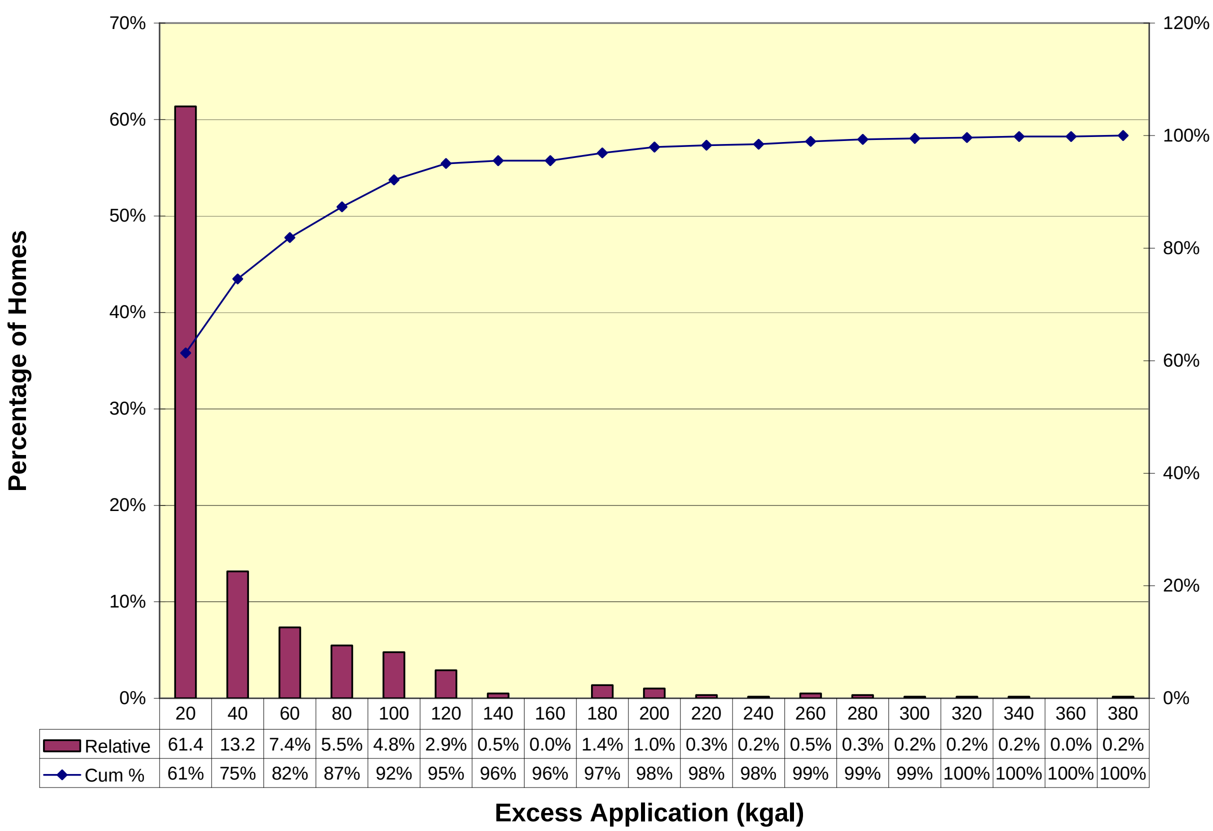


Figure 7: Distribution of excess irrigation by number of accounts

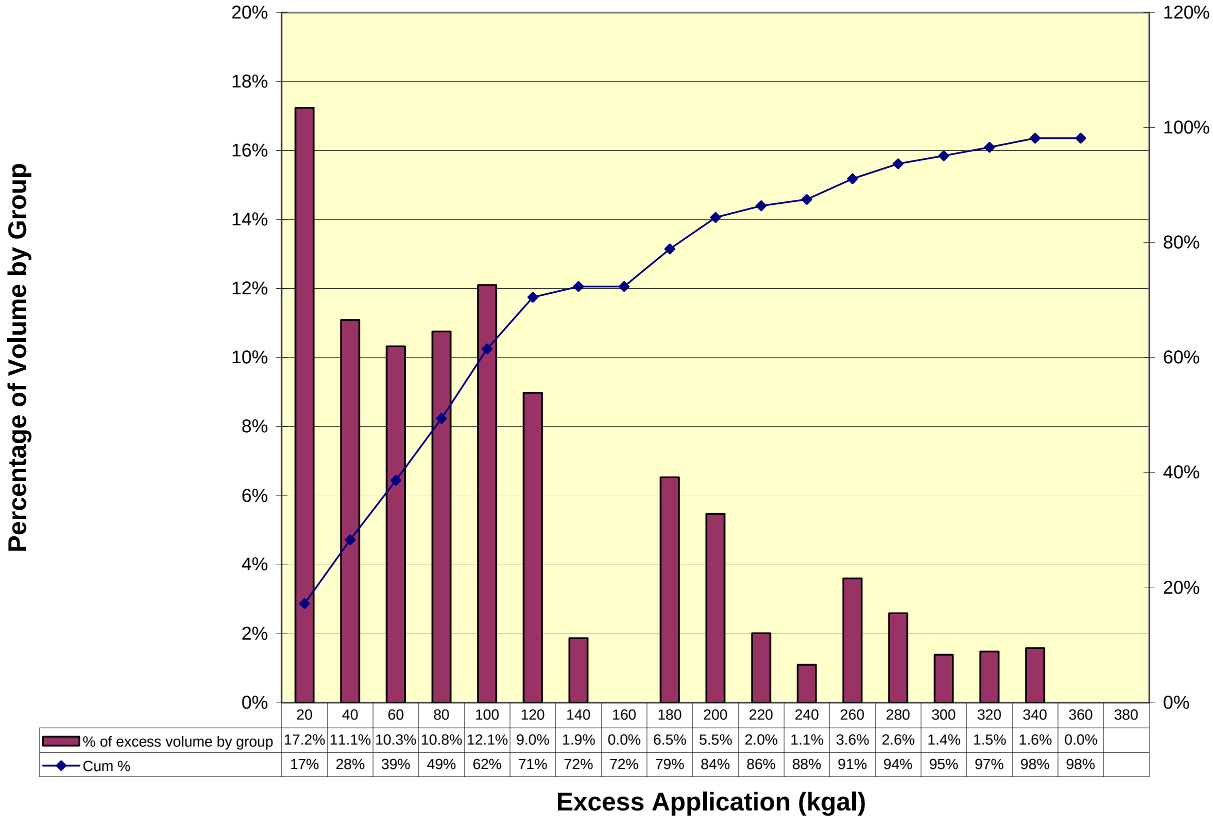


Figure 8: Percent of excess volume attributed to excess use bin

Goal 2: To provide a basis for estimating remaining conservation potential in single-family homes

This question is closely related to determination of the levels of efficiencies. The study used models of indoor and outdoor water use developed from the data collected in the study homes to predict the impact of making specific changes in indoor and outdoor parameters on household water use. These models allow corrections to be made for the variables in the study and present the findings in a normalized manner, and were the chief method for predicting conservation potential in the study homes, and by inference in the state.

For indoor use the data and models (see Table 83, Chapter 9) show that average indoor household water use could be reduced from the 2007 level of 175 gphd to 120 gphd if the following four things could be accomplished:

- The maximum clothes washer volume was 20 gpl
- The volume of water used by miscellaneous faucets could be reduced by 10% (from 2007 levels)
- Leakage could be reduced to a maximum of 25 gphd
- The maximum toilet flush volume could be set at 1.25 gpf

This amounts to a potential of 55 gphd of indoor savings or 20 kgal per year. The report did not discuss precisely how these goals are to be met, and there is no reason that these changes could not be allowed to occur gradually over many years. The key thing is for building codes and regulations to remain in place that require the standards be met in new and remodeled construction. As mentioned elsewhere, the study did not touch on the cost-effectiveness of specific programs aimed at accomplishing these goals.

The study showed that the conservation potential remaining in the system from outdoor uses is significant, and larger than the potential from indoor uses. The data from this study showed that there are three key parameters for modifying outdoor use: the irrigated area, the water demands of plants in the landscape and the percentage of homes in the population that are over-irrigating. Table 87, Chapter 9, shows that according to the outdoor use relationships observed in this study if the average irrigated areas were decreased by 15%, the landscape ratio decreased by 35%, and the percent of over-irrigators reduced from 50% to 20% of the homes it would be possible to reduce outdoor use to an average of 40 kgal per household from its 2007 level of 90 kgal. The low-end estimate is that by simply reducing the rate of over-irrigators and leaving all of the other parameters as is, the outdoor use could be reduced by 28%, saving approximately 0.6 MAF.

In Chapter 10 three levels of potential conservation savings are identified for the single-family sector. The indoor savings potential are based on the end point chosen for indoor household use. In CHAPTER 9, a potential average savings of 20 kgal per home was estimated assuming an indoor use benchmark of 120 gphd. The estimate could be rasied to 30 to 40 kgal per household assuming that benchmarks of 105 gphd could be achieved and more aggressive indoor technologies used. Consequently, we can conceive of three levels of indoor water conservation benchmarks: a low, medium and high level at 20, 30 and 40 kgal per year per home. Total indoor estimates statewide are based on the estimate of 9.5 million single-family households in the state.

Outdoor potential conservation savings have been estimated at a low of 0.6, medium of 0.80 and high of 1.0 MAF. The savings in all three ranges are deemed techically achievable, but would require significant and increasing work over time and innovations in preventing over-irrigation and changes to both irrigated areas and plant types. It is encouraging, however, that the low-end savings would more than achive the desired 20% reduction in use. The practicality of achieving savings in the high range is less clear, and is closely related to the value placed on the saved water (or costs for agencies to develop new supplies as alternatives). Table 2 shows the summary of the estimated potential conservation savings derived from this study. It is worth repeating that what is achievable is a function of the value being placed on the saved water and the costs for program implementation. As water supplies become more constrained, prices typically increase, which may make strategies that are either not or only marginally cost-effective become cost-effective to implement.

Table 2: Summary of projected statewide savings (MAF)

	Baseline	Low	Medium	High
Indoor	2.13	.58	.87	1.16
Outdoor	2.27	.63	.79	1.02
Total	4.4	1.21	1.66	2.18
% of Total		27%	37%	50%

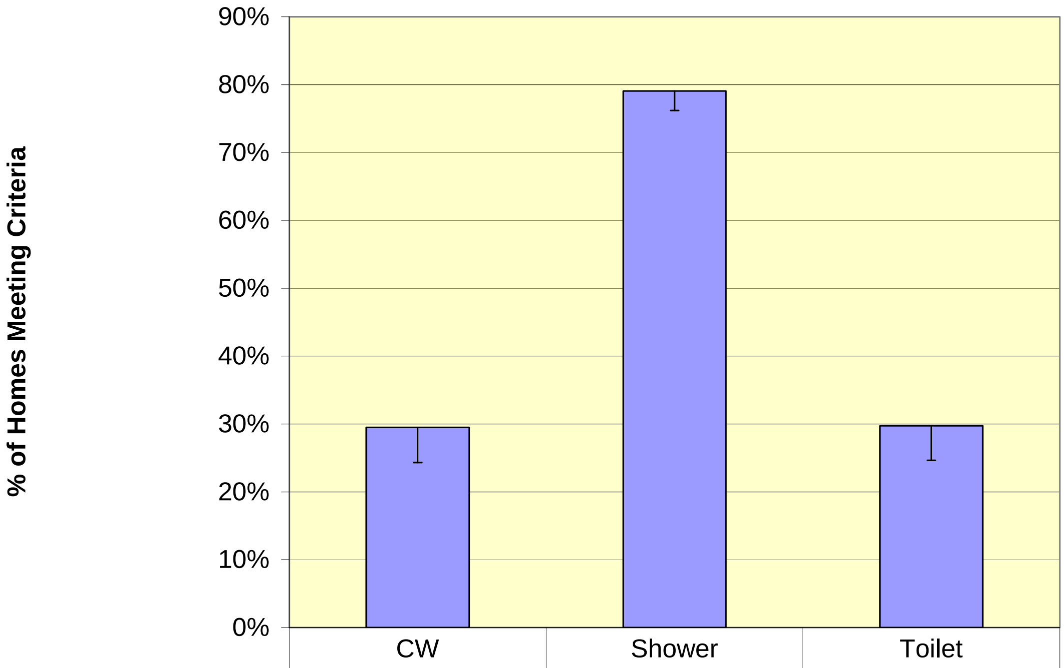
Goal 3: To provide information on the current market penetration of high efficiency fixtures and appliances in single-family homes

There are two aspects of the penetration rates of efficient fixtures and appliances. The first, which was the primary interest of this study, was to determine what percentage of *households* were operating at levels that are consistent with their being equipped with efficient devices, and the second, which was also of interest, was the actual percentage of devices in the market that are *rated* as efficient.

The matter was further complicated by what criteria should be used to classify a fixture as meeting efficiency standards. In the study we looked at the actual performance of the fixtures and appliances in the homes as revealed by their water use on the flow traces. From this perspective a toilet, for example, that flushes at more than a specific level would not be classified as an efficient device irrespective of the actual model installed. For this study we used a cut-off point of 2.0 gpf as the average household flush volume for a home that is totally equipped with 1.6 gpf (ULF) or better design toilets. This represented at 25% margin of error for the toilets. The parameters used for classification of households are shown in Table 3.

Table 3: Metrics used for efficiency determination

Device	Efficiency Criteria
Toilets	Ave gallons per flush < 2.0 gpf
Showers	Ave shower flow rate < 2.5 gpm
Clothes washers	Ave load uses < 30 gal



	CW	Shower	Toilet
% Meeting Criteria	29%	79%	30%

Figure 9 Percentages of homes meeting efficiency criteria for toilets, showers and clothes washers

The results for clothes washers can be interpreted from the perspective of both households and appliances because it is exceedingly rare for a home to have more than one clothes washer. For showers and toilets, however, where there is more than one unit per household the situation is less clear. The efficiency criteria used for the study are set close to the target level for the devices, and therefore a house would need to have exclusively 1.6 gpf toilets or better, and 2.5 gpm showerheads for it to satisfy the criteria. For example, a house with one high volume toilet and one 1.6 gpf toilet would have an average flush volume of more than 2 gpf. There is a considerable amount of discussion of this in Chapter 7 because most agencies believe that they have replaced more than 60% of the toilets in their service areas, yet only 30% of the homes are meeting the efficient toilet criteria. The report concludes that these results are consistent with each other because of two facts: many homes contain mixtures of high volume and ULF or better toilets, and many ULF toilets are flushing at more than 1.6 gallons per flush. The conclusion on toilet penetration was that somewhere between 60% and 70% of the toilets in the single-family residences are probably ULF models or better, and at the same time approximately 30% of the homes have average flush volumes of 2.0 gpf or less.

Goal 4: To provide information on the rate of adoption of high efficiency fixtures and appliances by California homeowners

In 1997, when the REUWS study was published, approximately 1% of the homes had clotheswasher volumes of 30 gallons per load or less, and 10% of the homes had average toilet flushes of 2.0 gpf or less. As of 2007, both devices are showing approximately a 30% household adoption rate. The percent of households with showers at 2.5 gpm was 70% in 1997, and is approximately 80% in 2007.

Device	% of HH in 1997	% of HH in 2007	Change/year
Showers	70	80	1%
Clothes washers	1%	30%	3%
Toilets	10%	30%	2%

The outdoor data from the REUWS study is difficult to compare to that from the California Single Family study since it was from a much broader geographical area. In the REUWS sample 17% of the homes were applying more than the theoretical irrigation requirement, whereas 54% of the homes in this study were. This is simply an interesting comparison, but does not mean that the rate of over-irrigation is going up. The REUWS areas were based on the estimated irrigable areas on the lots rather than the irrigated areas, and they were not based on comparable aerial photos. As such, we can not make any statements about rates of change of irrigation application ratios or excess irrigation amounts from the data obtained for this report.

Goal 5: To provide information in how the BMP's have impacted water use

It is clear that the BMP's have been the major driving force behind water conservation efforts in the State of California since they were adopted in 1991. Most of the agencies in this study are approaching their implementation in a similar manner. It was not possible to detect differences in penetration rates of toilets or clothes washers among agencies with more or less aggressive rebate programs. For example, one agency had a program where toilets woule be replaced on demand for free with just a phone call from the customer. The percentage of homes meeting the toilet criteria in that agency was not significantly different than in the others. All we are able to say from the data in this study is that whatever changes in single-family water use identified in this study have been the results of the combined application of the BMP's. It was not possible to single out individual BMP measures and quantify their impacts separately.

The other fact that the study demonstrated was that water savings obtained in individual categories such as toilets and clothes washers, where there has been measurable reductions, do not necessarily show up on the bottom line as overall household savings because changes in other categories may obscure them. In our case, if the analysis was limited to just billing data it would not have been possible to identify any statistically significant change in the household water use of the homes. It was the analysis of the disaggregated data that showed how individual categories of use had changed that showed that there were in fact significant changes occurring.

Goal 6: To provide baseline demand data for future studies

This study provides a wealth of data on single-family water use circa 2007 which can be used as a baseline for future studies provided those studies collect similar data on end uses. The study showed the annual water use for the single-family customers in the ten participating agencies. It showed the seasonal and non-seasonal water use patterns for each and the broke the indoor uses into individual end uses, which were shown on a household basis. Models of indoor water use

were developed that showed which factors affected water use and the relationships between total indoor use and indoor use by category, to each of the key variables. Future studies can compare water use as it was reported in this study to water use from their own time period. A good example of this type of comparison is found in
Figure 71, Chapter 9, which shows the relationships between indoor use and the number of residents.

The same situation occurs for outdoor use, where information on lot size, irrigated area, landscape coefficienct, application rates and volumes of excess irrigation was tabulated. Models of outdoor use, similar to the indoor use models were developed, which can be used to make meaningful comparisons against future samples of customers.

A key assumption for making future comparisons is that the sample of homes used for this analysis is representative of the single-family homes in the agencies and in the State. We know that the samples chosen from each agency match the water use patterns for their respective populations. We also know that the agencies included in this study represent some of the largest in the state. There is no reason that future analyses in these agencies, using new samples of homes chosen in the same manner, can not provide excellent data on changes in indoor and outdoor use patterns.

Goal 7: To provide information that can be used by California water agencies in updating their Urban Water Management Plans

The degree to which the information presented in this report is useful for preparation of future urban water management plans is a function of how those plans are organized, and how the water use data in them are presented. Water management plans that are based on more disaggregated demand data and which employ estimates of end uses of water will find the information in the report of greatest use. Plans that are based on aggregated demands and overall population estimates will not derive as much benefit.

The types of water management plans that will derive the greatest benefit from the data collected in this report, and from the data collection techniques use for the report, would track at least the following items in their single-family water use accounting:

- Total annual deliveries to single-family accounts
- Winter deliveries (December or January) as a proxy for indoor use
- Number of single-family accounts in system
- Total seasonal and non-seasonal use (derived from annual and winter use)
- Best estimate of population of single-family accounts
- Best estimate of irrigated area in single-family accounts (from samples and GIS data)

These data could be used to generate unit use reports that can be tracked over time and compared to benchmark data. The following unit tracking parameters could be used:

- Annual water use per SF account
- Non-seasonal water use (proxy for indoor use)
    - Annual use

- Gallons per household per day
- Per capita use

- Seasonal use (proxy for outdoor use)
  - Annual use
  - Average application rate (gpsf)
  - Average application depth (in)
  - Application ratio (applied inches/f(ET))

These water management plans are based on measurement and tracking of actual water use that has been normalized in a way that allows it to be compared to efficiency benchmarks. For example, by determining single-family winter water use, one can obtain a fairly good proxy for indoor use. Knowing the household indoor use means this can be compared against benchmarks like the EPA retrofit study group, or against the data from this study. This value should decrease over time if the efficiency of the system is improving. What may have started at 170 gphd would drop over time as new and more efficient fixtures and appliances were installed and hopefully as leakage were controlled better. Tracking the household indoor use in this manner would provide the best data for water management plans. Similar tracking of outdoor use would provide information on which to gauge the improvements in outdoor use efficiency. These types of plans could compliment information on BMP activities and conservation expenditures and confirm their effectiveness.

Goal 8: To provide guidance for allocation of resources by identifying areas with the most promising conservation potential

This report pointed out several items that provide insights into where to most effectively allocate resources for water conservation.

Since the signing of the Memorandum of Understanding in 1991, water conservation efforts have been focused on implementation of the Best Management Practices. These are mainly programs that lend themselves to tracking on the basis of activities performed and fixtures replaced. The most convincing argument for the effectivness of water conservation efforts, however, is one that is backed up by hard data that shows reductions in household water use. This study demonstrated techniques of sampling and data collection that can be used for these approaches. Including detailed analyses of household and per capita water use on representative samples of customers can provide a wealth of information that will compliment the other tracking and evaluation efforts of the agencies. Accounting for toilets and clothes washer rebates provides a primary input on water conservation. It is still somewhat indirect until it can be coupled with demonstrated reductions in household water use for toilet flushing and clothes washing, along with concurrent reductions in the average flush volumes of toilets and load volumes for clothes washer in the homes as of a certain date.

The degree to which both excess use and potential savings are skewed in the population needs to be considered when designing programs. Programs that aim to control leakage or excess irrigation use, for example, should not be targeted to the entire population since most of the leakage and excess irrigation use is associated with a small percentage of the homes. It would be better to design programs that target their effects to just these customers. Water budgets, smart meters, leak detection devices, better customer information systems are all possible exmples of these.

The information on toilets should also be of use for future program design. The data showed two important facts. First, even though there a high percentage of toilets appear to have been replaced with ULF models the percent of homes that are flushing at 2 gpf or less is lagging. Second, the data clearly show that the actual flush volumes of ULF type toilets ranges well above the 1.6 gpf level. If future retrofits are focused on newer high efficiency toilets (those using 1.28 gpf or less), and work continues to replace all of the remaining high volume toilets in the homes upgraded to the high efficiency toilets, the percentage of complying homes will increase rapidly over time and the household water use devoted to toilet flushing will decrease.

The data show that reducing the percentage of homes that over-irrigate is the single most important factor in reducing outdoor use. The report, however, does not support making weather based irrigation controllers mandatory. The data show that these devices would cause irrigation to rise in about as many homes as they would create reductions. The key to controlling outdoor use is to design programs that discourage excess irrigation use while allowing customers who prefer to under-irrigate to continue to do so. This requires targeting over-irrigators, which requires having some sort of estimate of the irrigated areas and outdoor water use for each customer and comparing this information to their actual seasonal use.

The report highlighted the importance of leaks and other unexplained continuous uses in raising average use for the entire population. Rather than have general programs targeted to all customers, the report suggests it would be better to have systems that can alert customers of the existence of a leak-like use pattern so that it can be remedied immediately. In every group of houses that were logged as part of the study there were several that showed these long duration and high volume leak-like events. Having programs in the billing system that detect increases in use and then send a text message, phone call or email to the customer might be considered. Having in-home monitors that read data from the AMR meters directs is another. Having water rates that seriously penalize excess water use would provide an economic incentive for customers to monitor their use.

The report shows the importance of having more detailed information on the customers. It suggests that putting increased resources on better customer information and water use tracking systems would greatly improve the ability to establish better water management programs. As the old saying goes, “you can’t manage what you don’t measure”. Key information that would assist in water management would include: the number of residents in the home, the annual and winter month water consumption, the size of the lot and size of the irrigated area, the local ET for the lot. Such information would be invaluable for planning and evaluation purposes. Systems that provide the customers with real-time information on water use, along with targets for use, enlist the customer as an active partner in water management. Having the customers as partners should greatly enhance the response of the entire system.

Appendix L: Emergency Response Plan Table of Contents

City of Davis
Emergency Response Plan
For
Public Water System Davis/El Macero
PS # 5710001

June 2004

Davis
California

For more information contact:
City of Davis Public Works Department
1717 Fifth Street
Davis, CA 95616

(530) 757-5686
www.cityofdavis.org

City of Davis
Emergency Response Plan Index

City of Davis
Emergency Response Plan
List of Tables

Appendix M: Conceptual Design of Park Improvements

Chestnut Park

Notes on Existing Conditions:

- Multiple pedestrian/bicycle park entries from surrounding neighborhoods, with wide perimeter path (asphalt) around central lawn.
- Perimeter uses: park is fenced around most edges, with residential uses on all sides. Existing vehicular parking is poorly laid out and not immediately accessible to roundhouse or park center. Need for improved bike parking.
- Existing topography adds interest, but blocks safety views from street.
- Signage is poorly located and designed; lack of main park entry or identification of roundhouse from street and entry is on interior park side; opportunity for improved outdoor gathering space at roundhouse.
- Park use areas:
    - Many sports areas are provided: fenced lighted tennis, basketball area, large central informal field games and practice area.
    - Perimeter areas of park offer opportunity for enhanced planting design, reduction of lawn areas, or added aesthetic value.
    - Play area has newly installed playground equipment. Opportunity for added play value with stage and amphitheater, possible BMX or other designed areas using existing grades; nature trails, additional fantasy play features, or other innovative play elements.

Proposed improvements as per Guiding Principles:

Accessibility: Maintain existing accessibility within park area and existing perimeter path. Improve entry signage.

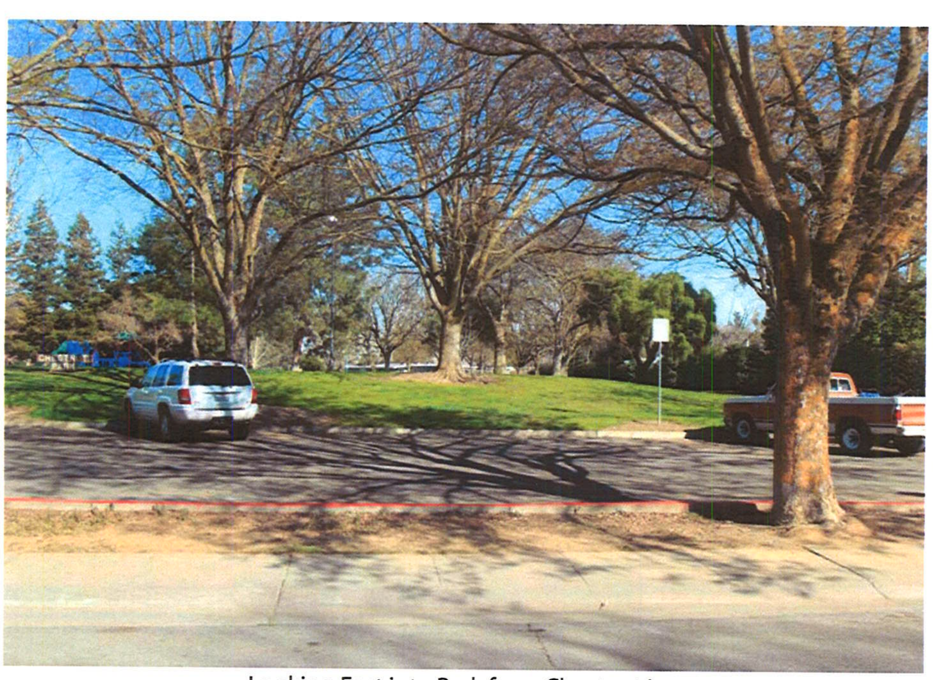
Quality: Add art area, central bike parking, and expanded outdoor space near roundhouse, possibly with covered seating area or enhanced play space. Add amphitheater and steps; add more open visibility toward play area from street.

Sustainability: Keep overall park framework and trees, but add value. Reduce turf area. Use recycled/sustainable materials for park improvements. Retain existing newly installed play structures, but increase play value and address needs of all age groups, including very young (0-2) as well as 2-5, 5-12 and teens. Audit existing irrigation system to ensure water-conserving products and irrigation schedule.

Safety: Add drop off area at roundhouse. Eliminate parking lot, allow street parking.

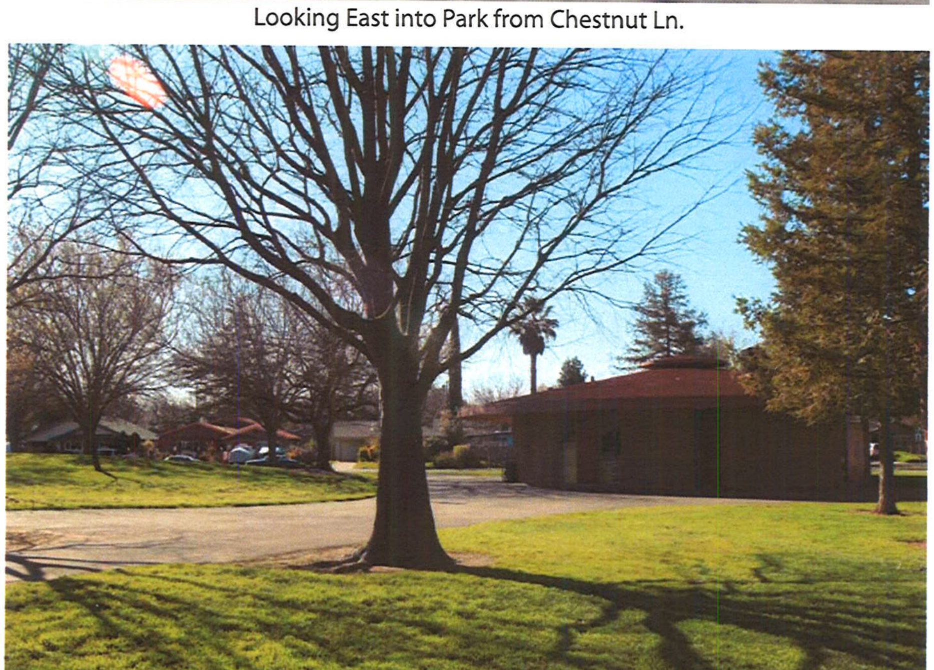
Connectivity: Maintain current access points to park. Add bicycle parking.

Fun: Stage and amphitheater, enhanced indoor/outdoor space, gardens, nature paths, bird-feeding stations, dog amenities.



Looking East into Park from Chestnut Ln.

Looking East, Central Lawn Area



Looking North at Roundhouse

Looking North, Picnic Area and Play Area at Asphault Court Area


Traffic
More...
Map
Satellite
Terrain
Drexel Dr
Cypress Ln
Chestnut Ln
Union Dr
Alice St
Chestnut Park
Georgia Pl
Penny Pl
Snyder Dr
Wahl Way
Pole Line Rd
100 ft
50 m

1 **Community Plaza at Roundhouse**

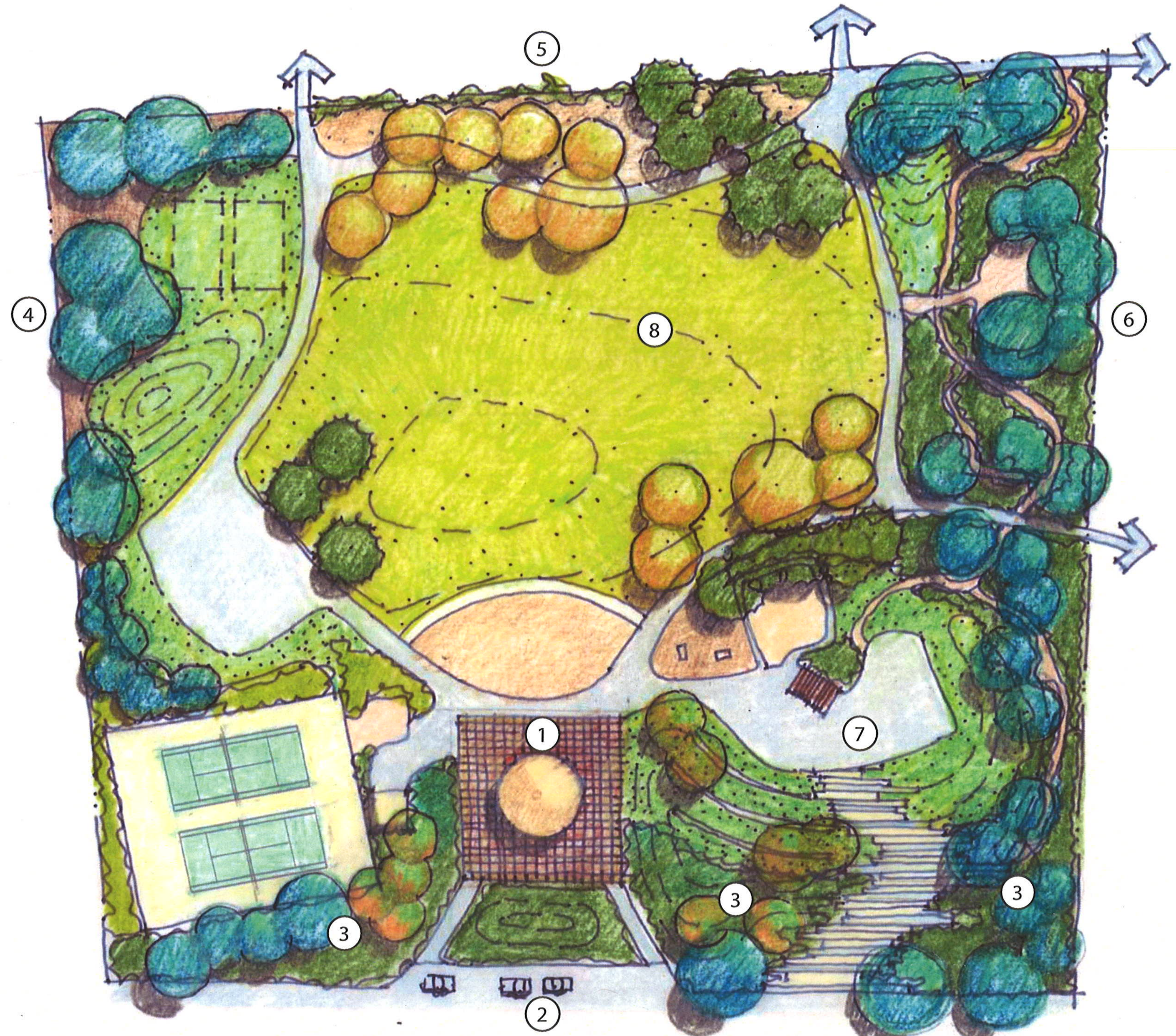
Provide enhanced paved gathering space at Roundhouse for indoor/outdoor activities; identify building entries
(Remove cracked paving and asphalt)
Main park use areas are concentrated near entry and building
Provide new bike parking areas: central bike parking at Roundhouse and single racks throughout park
(Remove all in-ground concrete bike slots)
Park and building entry signage and identity upgrades
Provide permeable paving for flexible use area on east side of Roundhouse (rotating art exhibits, community events, etc.) adjacent to tables and play space

2 **Main Park Entry and Drop-off Area**

Create street drop-off zone with space for up to six waiting cars
Create a 'Field of Flowers' community-adopted planting mound at entry, with plants selected for year-round interest and cutting flowers to be available to the neighborhood
Remove existing off-street parking area and allow on-street parking adjacent to park

3 **Specialty Garden Areas Along the Street**

Provide specialty gardens at street planting areas bossibly including rock gardens, salvia garden, butterfly and hummingbird garden, etc.
Retain existing lawn, reseed and renovate turf
Retain existing perimeter path
Reduce/eliminate all perimeter lawn



4 **North Park Perimeter**

Keep lawn mounds for viewing areas adjacent to basketball and large central lawn; reseed with drought tolerant turf seed
Remove excess lawn under perimeter trees and cover ground surface with mulch
Incorporate bird feeding stations and interpretive signage around perimeter area; possibly add plants with seeds, berries and other wildlife attracting food and shelter

5 **East Park Perimeter**

Change ground surface from lawn to decomposed granite; provide interpretive signage for a variety of soft court games
Provide dog run facilities including waste bags and dog watering amenities (no fencing)

6 **South Park Perimeter**

Remove lawn areas and provide drought-tolerant planting and grasses and/or specialty gardens
Provide pathways through planting areas for strolling and exploring along "nature trails"
Provide benches and/or additional picnic tables under shade of existing trees

7 **Existing Play Structure and Asphalt Court Area**

Retain play apparatus, picnic tables and open asphalt area
Regrade existing lawn mound between play area and street to open views for safety and play/community value; preserve existing trees as much as possible
Create stepped entry and 'amphitheater' seating in existing turf mound facing play area; add performance stage setting for play value and outdoor community use
Replant lawn area with low-maintenance, low-water turf or turf replacement, appropriate to amphitheater use

8 **Central Lawn Area**

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0' 30' 60' 120'

Chestnut Park - Davis, CA
Concept Design

Cedar Park

Notes on Existing Conditions:

- One main central park entry, two side entries, off K Street, none clearly identified; minimal accessibility/ADA issues to be addressed; park is fenced on all sides: 4' chain link fence at street with openings at park center and south end. Opportunity for park identification and entry statement.
- Perimeter uses: Bounded on north end by planting, fence and private residence; west side is bounded by church parking lot—view through fence is unsightly and negatively impacts park; narrow south corner is secondary access point, heavily used; east side is K Street frontage with fence, primary opening in center of street frontage, another secondary opening at north end.
- Existing park is in poor state of maintenance, due primarily to shaded, over-trampled planting and lawn areas. Opportunity for upgraded appearance, incorporation of neighborhood art, improved park aesthetics.
- Park use areas:
  - Existing lawn area at north end is relatively well maintained and is used by neighbors for active play, dog run, picnicking, etc.
  - Horseshoe pit is abandoned and unused. Tot lot, drinking fountain, picnic table and play apparatus areas are relatively newly installed and are used by neighbors, but are not integrated into a cohesive play or picnic/seating space. BBQ, picnic table, drinking fountain are good amenities for this park, but are not located together. This park offers a great opportunity for a better community, multi-generational space or plaza for neighborhood use.
  - Excessive use of lawn in shaded, narrow areas of park causes poorly maintained areas that are unattractive. This is an opportunity for improving sustainability by reducing lawn and incorporating different materials.
- Most accessibility/ADA issues are addressed as per 2008 inventory.
- In summary, this is an appreciated neighborhood space with opportunities to improve sustainability, fun/diversity of uses and park identity.

Proposed improvements as per Guiding Principles:

Accessibility: Provide entry identification and signage at main entry with vertical elements, color and interest. Maintain existing accessibility within park area.

Quality: Change materials in poorly maintained areas; provide high quality neighborhood gathering space to replace unconnected use areas in center of park near main entry.

Sustainability: Reduce turf area. Use recycled/sustainable materials for park improvements. Acknowledgement of recycled materials in playground equipment is a good educational opportunity, but remove or place sign in more appropriate yet still conspicuous location. Retain existing newly installed play structures, but increase play value and address needs of all age groups, including very young (0-2) and teens. Audit existing irrigation system to ensure water-conserving products and irrigation schedule. Select drought-tolerant, easily maintained plants to add color and interest.

Safety*:* Maintain perimeter fencing, but improve appearance with planting and/or materials used. Add lighting to entry structure and picnic gathering space to enhance lighting provided by two street lights (one on K Street and one at parking lot.

Connectivity*:* Maintain current access points to park, but provide walkway through park, connecting various uses and entries. As a neighborhood mini-park there is no need to add bicycle parking, as most users walk to site.

Fun: Consider addition of sand and water play, fantasy play, bocce, limited dog facilities, colorful elements and other park additions. Introduce more attractive layout of paths, planting, paving and other park elements.

Innovation: Introduce art and opportunities for neighborhood interaction, such as a place for impromptu performances, integrating multigenerational uses such as benches and tables adjacent to children's play spaces and throughout the park area, or an 'adopt-a-birdhouse' garden (an opportunity for an annual art project in the neighborhood), for example.

Diversity: Even within this small park, offer uses that respond to the needs of diverse users, as shown on proposed plan and park program. Provide a space that can continue to be used as it is now by neighbors, as well as opportunities to be used for special occasions, such as celebrations, neighborhood barbecues, etc. Provide for multi-generational activities, active and passive uses, and provide visual interest from the street.

North End of Park

Looking East, Panoramic along K Street

South End of Park

Traffic
More...
Map
Satellite
Terrain
Colgate Dr
Duke Dr
L St
K St
Cedar Park
700
1300
600
©2009 Google - Imagery ©2009 City of Davis, Map data ©2009 Tele Atlas - Terms of Use
50 ft
20 m

① Community Plaza

- Park Entry Trellis with Signage & Park Identity
- Paved gathering space with movable chairs
- Trellis columns with vines connecting play areas
- Wide concrete steps into existing play area
- Small permanent tables scattered through central area (game/picnic tables, including wheel-chair accessible locations)
- Keep existing drinking fountains
- Add lighting

② Enhanced Play Areas

- Retain existing play structures and concrete edging
- Move small structure to north near others
- New colorful play surfacing and mounds in selected areas
- Boulders and 'hopping' stones to connect two areas

North Area:

- Add fantasy play wall with windows and mounds
- New steps act as seating/transition to plaza
- Adequate space for bocce in DG paving

South Area:

- Create sand and water play area
- Manually operated jets
- Sculpted play forms such as animals in metal or concrete

③ Lawn Play Area

- Replace turf with 'No-Mow Lawn'
- Provide pathway around perimeter of lawn area

④ Park Entries and Circulation

- Main entry on K Street at center of park
- Secondary entries at north and south ends
- Provide circulation throughout park with DG paving (remove turf areas)

⑤ Park Perimeter

- Add 'Art Walls' with ceramic murals (artist or neighborhood creation)
- Retain low chain link fence on K Street; plant with vines and/or add decorative metal sculptures within fence for color, interest and screening
- New 6' screen fence or vine plantings between art walls on east side
- Community-tended garden space at south end

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0' 10' 20' 40'

Cedar Park - Davis, CA
Concept Design

West Manor Park

Notes on Existing Conditions:

- Multiple pedestrian/bicycle park entries from surrounding neighborhoods, with wide perimeter path (asphalt) around central lawn. Park is used by pedestrians and bicyclists as a direct connecting point for circulation through West Davis areas that are not connected by roads.
- Perimeter uses: park is fenced around most edges, with residential uses on all sides, including rental apartments and single family homes, as well as a community center with pool and Montessori preschool (south side). Extensive parking is available immediately off-site (at community center); an additional sixteen spaces on-site in small lot to the north provide the opportunity to reduce vehicular parking.
- Visibility/neighborhood connection: Park is not clearly visible from surrounding streets, as it is primarily interior, with access from cul-de-sacs and ped/bike paths. Additional upgraded signage would help identify park.
- Park use areas:
  - Many sports areas are provided: fenced roller hockey, fenced tennis, full court basketball, softball/baseball backstop, central informal grass area for field games and practice (overlapping with softball). One large area is asphalt with no current active uses.
  - Existing lawn area in park provides active play space/sports and has value as such. Perimeter areas of park offer opportunity for enhanced planting design, demonstration gardens or added aesthetic value.
  - Existing group picnic area has twelve concrete tables, four metal barbecues and one large masonry barbecue pit. Ample space exists within the group picnic area to enhance the landscape and uses, including possible art or other focal point, integration with the play area, nighttime use, consolidating picnic table layout, etc.
  - Play area has newly installed playground equipment. Opportunity for added play value with more innovative play elements.
  - Park has existing restroom and two drinking fountains.
- Most accessibility/ADA issues are addressed as per 2008 inventory.

Proposed Improvements as per Guiding Principles:

Accessibility: Maintain existing accessibility within park area and existing perimeter path. Improve entry signage and park image/identity.

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Quality: Add play value with adventure play amenities, including tree canopy walk, dry/wet stream play feature, and interactive play elements. Add shade structure near sports fields/paved courts. Add interpretation/education kiosk for community outreach and interpretive information about park storm drainage/retention on site, plant selections, trike/bike training area, et.

Sustainability: Keep overall park framework and trees, but add value. Reduce turf area. Increase on-site water retention. Adapt existing storm drainage system for overflow in heavy storms only and with goal of 100% capture of water on-site by design of bioswales, rainwater harvesting, increased permeable surfaces, etc. Use recycled/sustainable materials for park improvements. Retain existing newly installed play structures, but increase play value and address needs of all children's age groups. Audit existing irrigation system to ensure water-conserving products and irrigation schedule. Select drought-tolerant, easily maintained plants in new planting areas to add color and interest; provide plant labels and interpretative info at kiosk.

***Safety**:* Add lighting at shaded seating structure, in trees at picnic gathering space, and in treehouse/tree walk. Provide 'Bicycle Safety Training' course for bike/trike use and education with striped lanes, traffic signage (stop, yield, bike lane, etc.) and interpretive materials; extend to park perimeter path and create public outreach info for City-wide awareness of training ground availability as a destination use.

***Connectivity**:* Maintain current access points to park; improve identity and signage. Add bicycle parking near picnic area and hard courts.

Fun: Consider addition of zero entry spray park, appealing to a wide range of children's—and adults—ages. Add sand and water play, fantasy play, interactive elements, color and other amenities to existing children's play area. Introduce more attractive layout of planting, paving and other park elements.

Innovation: Treehouse and tree walk. Incorporate natural drainage course doubling as both water retention on-site and added play value. Provide education and interpretive kiosk for water conservation, bicycle safety training, plant selections (drought tolerance, grasses, hummingbird/butterfly), etc.

Diversity: Provide a park design that can continue to be used as it is now by neighbors, as well as providing elements that make it a destination park for residents from other areas. Provide increased opportunities for use for special occasions such as celebrations, barbeques, birthday parties, neighborhood gatherings, etc., starting with availability of existing group picnicking and babeque. Provide for multi-generational activities, active and passive uses.


Salem St
West
Manor Park
Cumberland Pl
Brandywine Pl
2900
50 ft
20 m
Traffic
More...
Map
Satellite
Terrain
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① **Park Entry and Parking Area**

Park Entry with signage and identity elements

Reduce number of parking spaces and asphalt to six including accessible space

Provide 'quiet zone' such as walled hammock room

Bicycle Safety Course: Provide striping for bicycle/tricycle safety training in parking lot and/or on basketball court; provide signage and striping on perimeter path for destination bike training

② **Enhanced Group Picnic Area**

Retain existing trees and picnic tables

Integrate children's play and picnic with adventure play

Renovate and upgrade large and individual barbecues

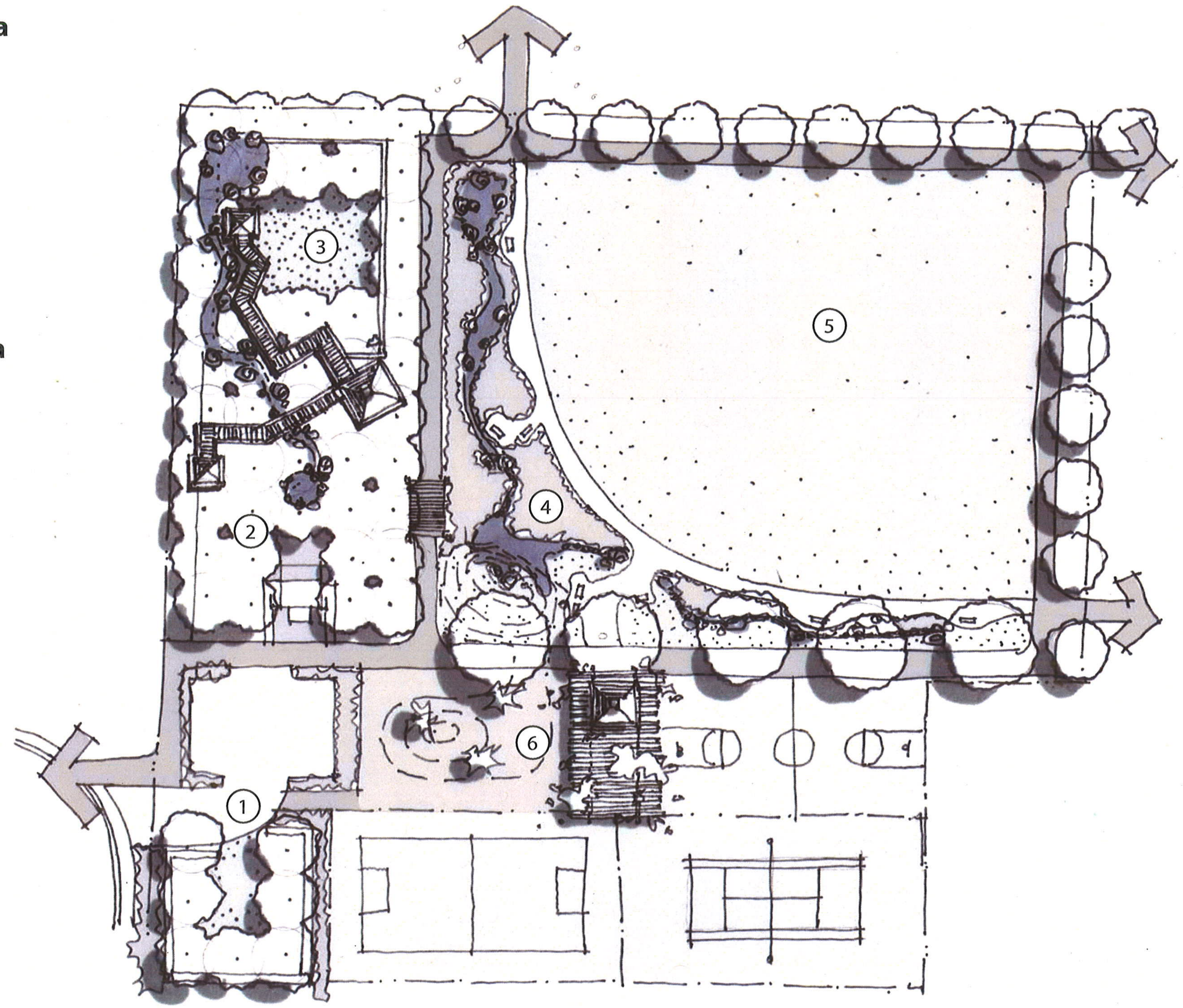
Retain park restroom building

③ **Enhanced Children's Play Environment**

Retain existing play structure, concrete edging two sides

Add 'Tree Walk' platforms and towers, with accessible elements, rope bridges and overlooks, lighting

Create dry creekbed as part of storm drainage improvements: use for overflow drainage, sand and water play area, boulders and plantings for nature exploration



④ **Remove 30-35% of Lawn Area**

Establish goal of 100% water capture/ retention on site: redesign storm drainage for surface flow and percolation, bioswale grading/ planting, dry creekbed, use existing system

Provide pond/wetland planting, bridge in perimeter path

Add decomposed granite path at lawn edge with benches

Provide low mound for hill rolling and viewing soft playcourt/sprayground area

Non-mowed native or fescue grasses in bioswale area

⑤ **Lawn Play Area**

Retain turf and backstop for active play/sports

Retain perimeter asphalt pathway

⑥ **Hard Court Area**

Retain full court basketball, tennis and roller hockey courts

Remove ball court asphalt, replace with permeable material

Consider mounded zero entry spray park

Provide shaded seating under trellis with vines; provide interpretive kiosk with information regarding storm drainage redesign and bioswale, bicycle training course, plant selections, drought tolerance, low maintenance

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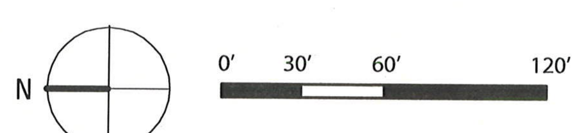

West Manor Park - Davis, CA
Concept Design