Appendix E

Details of Commercial Water Use and Potential Savings, by Sector

Office Buildings
(SIC codes 60–64, 67, 73, 81, 87, and 90)

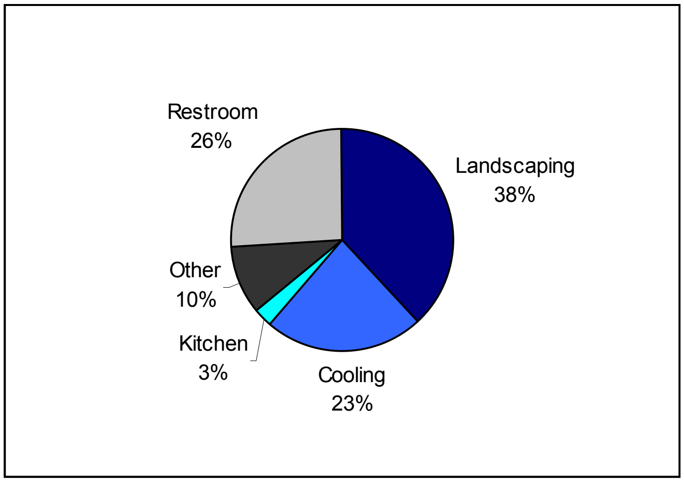
Offices buildings house a wide variety of companies ranging from insurance brokers to law offices. Although the types of offices differ, their employees are usually engaged in similar activities and can therefore be aggregated under one category. We did not, however, include SIC code 65 (real estate) or SIC code 86 (membership organizations) in our analysis, because the GEDs estimated were unreasonably high; indicating problems with either the data or the categorization. For example, we suspect that SIC code 65 includes multi-family housing in addition to real estate offices because it includes in its description "apartment building operators," and rental offices are often located within apartment complexes, where water is used for residential purposes.

Table E-1
Employment and Water Use in Office Buildings (2000)

Sub-industry	SIC code	Gallons per Employee Day (GED)[1,2]	Employees	Annual Use, Thousand Acre-Feet (TAF)
Depository	60	58	198,500	7.9
Non-Depository	61	135	84,700	7.9
Security, Broker	62	176	75,100	9.1
Insurance	63	169	136,300	15.9
Insurance	64	129	83,400	7.4
Holding/Investment	67	176	39,680	4.8
Business	73	129	1,350,530	120.1
Legal	81	99	123,204	8.4
Engineering	87	113	472,069	36.7
Government	90	136	1,279,745	120.3
Office Buildings Total		**127 (average)**	**3,843,303**	**338.5**

[1] Based on a 225-day year.
[1] Note that the GED coefficients estimated for 1995 were decreased by 20% to obtain the GED coefficients for 2000 for the commercial sector. See the write-up on correcting GED Estimates for 2000 in the report.

Figure E-1
Water Use, by End Use, in Office Buildings



Source: Calculated from MWD audit data of selected office buildings (MWD 2002).

Comparison of GED-derived Estimate to Modeled Water Use

We modeled water use in office buildings, using published estimates of restroom visits by employees, irrigated turf area, cooling requirements etc. We compared our GED-derived estimate of water use per employee to that predicted by the model Table E-2. The end-use calculations in the GED-derived estimate are from Figure E-1 and the model's assumptions are derived from the end use data in Appendix D.

Table E-2
Modeled Water Use in Office Buildings (2000)

End Use	Unit	Rate	Number	Modeled Water Use (GED)	GED-derived (GED)
Toilets[1]					
Employee use	gpf	3.00	2.60 flushes/day	7.8	
Visitor use	gpf	3.00	0.33 flushes/day	1.0	
Urinals[1]					
Employee use	gpf	1.60	1.25 flushes/day	2.0	
Visitor use	gpf	1.60	0.17 flushes/day	0.3	
Faucets[1]					
Employee use	gpf	0.11	3.85 flushes/day	0.4	
Visitor use	gpf	0.11	0.50 flushes/day	0.1	
Total restroom				11.6	33.0
Cooling	gal/sq ft/day	0.07[2]	350[3] sq.ft/employee	23.3	29.2
Landscaping	gal/sq ft	0.08[4]	547[5] sq. ft/employee	20.7	48.3
Kitchen	gal/meal	10.1[6]	0.33 meals/employee/day	3.3	3.8
Other				12.7	12.7
Total				**72**	**127**

[1] See Appendix D.

[2] Two case studies estimated 15 and 34 gal/sq ft./year. The average is about 25 gal/sq.ft/year. We estimate that only 60 percent of office buildings have cooling towers so this works out to 15 gal/sq ft/year on average or 0.07 gal/sq ft/day (Dziegielewski et al. 2000).
[3] Statistical average of 67 office buildings (Dziegielewski et al. 2000).
[4] See Appendix D.
[5] MWD 2002.
[6] See Appendix D.

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) to our GED-derived estimates of end use, we estimated potential water savings (shown in Table E-3).

Table E-3
Potential Water Savings in Office Buildings (2000)

End Use	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	High	Best	Low	High	Best
Landscaping	128.6	38%	53%	50%	48.3	68.0	64.2
Restroom	88.0	49%	49%	49%	43.4	43.4	43.4
Cooling	77.9	9%	41%	26%	7.4	32.3	20.0
Kitchen	10.2	20%	20%	20%	2.0	2.0	2.0
Other	33.9	0%	25%	10%	0.0	8.5	3.4
Total	**338.5**	**30%**	**46%**	**39%**	**101.1**	**154.1**	**133.0**

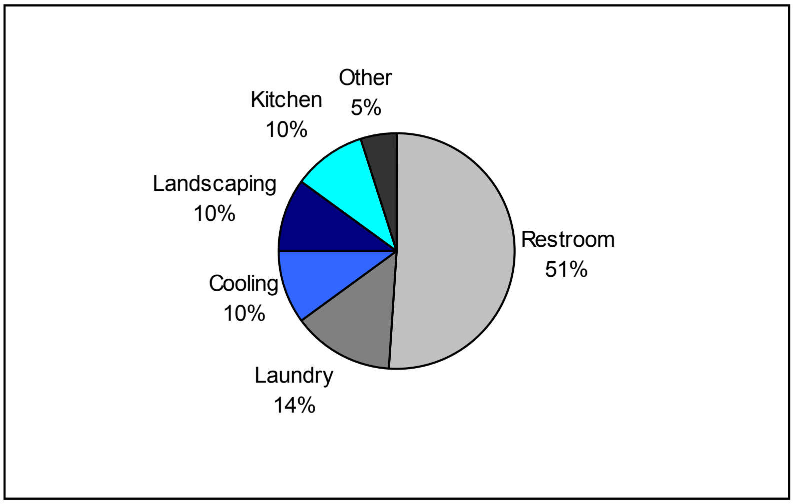
Hotels (SIC codes 701 and 704)

Sub-industries under SIC code 70 include hotels, motels, rooming and boarding houses, recreational vehicle parks, camp sites, and a variety of other types of lodging establishments. Because the literature focuses primarily on water use in hotels, motels, and bed and breakfasts (SIC codes 701 and 704), we limited our focus to these three types of lodging establishments, which we refer to collectively as hotels.

Table E-4
Employment and Water Use in the Hotel Industry (2000)

Industry	SIC codes	GED	Employees	Annual Use (TAF)
Hotels	701,704	240	182,640	30.3

Figure E-2
Water Use, by End Use, in the Hotel Industry



Source: Calculated from MWD audit data of 93 hotels (MWD 2002).

Comparison of GED-derived Estimate to Modeled Water Use

We modeled the water use in hotels, using published estimates of restroom visits, showers, faucet use by guests and employees, irrigated turf area, cooling requirements etc. We converted our GED-derived estimate of water use per employee into water use per occupied room per day and then compared it to that predicted by the water use model. The end use calculations in the GED-derived estimate are from Figure E-2 and the model's assumptions are based on the end use data in Appendix D and a study of water use in the hotel industry (Redlin and deRoos 1990).

Table E-5
Modeled Water Use in Hotels (2000)

		Typical Use/Occupied Room/Day			
	Measurement Unit	**Rate/Unit**	**Number of Units**	**Water Use (gal/day)**	**GED-derived Use (gal/day)**
Showers[1]	gal/minute	2.2	16.0	35.2	
Faucets[1]	gal/minute	1.3	0.4	0.6	
Toilets[1]	gal/flush	3.0	4.0	12.0	
Laundry[2]	gal/lb.	2.5	8.0[3]	20.0	
Kitchen	gal/meal	7.6[4]	2.2[5]	17.0	
Icemakers	gal/meal	0.5[6]	2.2[5]	1.1	
Misc.	gal			25.0	

INDOOR				**111.0**	
Cooling[7]	gal/CDD	5.6	1.4	8.0	
COOLING				**8.0**	
Irrigation[8]	gal/sq. ft.	0.2	50.0	10.0	
Pool				0.5	
OUTDOOR				**10.5**	
TOTAL				**130**	**117[9]**

[1] See Appendix D.
[2] See Appendix D.
[3] Pounds/occupied room/day of laundry is obtained from the average of the 12 hotels in Redlin and de Roos (1990). Eighty-nine percent of hotels have in-house laundries (Redlin and de Roos 1990).
[4] Average gal/meal is obtained from the restaurant sector. Seventy-six percent of hotels have restaurants (Redlin and de Roos 1990).
[5] Meals/occupied room (Redlin and de Roos 1990)
[6] 0.5 lbs/meal * 1 gal/lb : lbs/meal taken from 1994 ASHRAE Refrigeration Handbook, 1 gal/lb estimated from Pike 1995.
[7] Nearly 50 percent of the hotels surveyed in Redlin and de Roos (1990) had central cooling. Average annual Cooling Degree Days (CDD) in California was 1035. Therefore Cooling Degrees per day = 1035*50%/365 = 1.4 gal/CDD obtained from Redlin and de Roos (1990).
[8] See Appendix D.
[9] We used information on the total number of occupied hotel rooms and total water used by the hotel sector in 2000. When we divided 2000 water use (30.3 TAF) by 350,000 rooms times the average occupancy rate for the year (66%), the water use/occupied room/day was about 117 gallons.

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) to our GED-derived estimates of water use, we estimated potential water savings (shown in Table E-6).

Table E-6
Potential Water Savings in the Hotel Industry (2000)

End Use	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	**High**	**Best**	**Low**	**High**	**Best**
Restrooms	16.7	31%	31%	31%	5.3	5.3	5.3
Laundry	4.2	42%	66%	54%	1.8	2.8	2.3
Cooling	3.0	9%	41%	26%	0.3	1.3	0.8
Landscaping	3.0	47%	53%	50%	1.1	1.6	1.5
Kitchen	2.4	20%	20%	20%	0.5	0.5	0.5
Other	0.9	0%	0%	0%	0.0	0.0	0.0
Total Savings	**30.3**	**30%**	**38%**	**34%**	**9.0**	**11.4**	**10.3**

Golf Courses (SIC code 7992)

SIC code 79 includes various recreational establishments such as theaters, amusement parks, movie studios, and golf courses. Because water use in these industries varies tremendously, we included only golf courses (SIC code 7992), which comprise a very water intensive sub-industry, in our analysis. Indeed, in 2000, there were nearly 900 golf courses in the state, covering close to 89,000 acres (Horton, 2002), and using 342 TAF of water annually.

Table E-7
Employment and Water Use at Golf Courses (2000)

Industry	**SIC**	**GED**	**Employees**	**Annual Use (TAF)**
Golf Courses	7992	7,718	34,100	341.8[1]

[1] Freshwater comprised 229 AF of 2000 use and the remaining water was reclaimed water (California State Water Resources Control Board 2002).

Although we do not know the exact breakdown of water use at golf courses, we do know that water is used primarily for landscaping. Without published data, we assumed that 95 percent of golf course water use is used for irrigating turf while the remaining 5 percent is used in restrooms, kitchens, and cooling, which we consolidated as "other." Golf courses tend to use high amounts of reclaimed water in addition to self-supplied and agency-supplied water.[1]

Comparison of GED-derived Estimate to Modeled Water Use

Since landscaping comprises nearly all of a golf course's water use and little or no information was available on restroom, kitchen, or cooling uses, we modeled only the irrigation component to crosscheck our GED-derived estimate. First, we totaled the number and acreage of golf courses by hydrological region and then applied what we know about turf water use in different regions to these acreages to determine total water use in 2000.[2]

[1] According to the National Golf Foundation, in 1998, about 33% of the water supply to golf courses in Region 8 (which includes So Cal, W.AZ and So NV) was supplied from reclaimed water. This percentage was assumed to apply to California. The rest of the water supply to golf courses was from freshwater sources: lakes and streams (22%), wells (32%), public supply(9%), and other (5%). (Thompson, 2002).

Table E-8
Modeled Irrigation Water Use at Golf Courses

Hydrologic Region	Percentage Golf Acreage[1]	Acreage 2000[2]	EV Ratio w.r.t Central Coast[3]	Annual Water Use (AF/Acre)	Modeled Total Irrig. Use (TAF)	GED-derived Estimate of Total Use (TAF)
North Coast	3%	2,945	1.01	2.02	**5.9**	
San Francisco	15%	13,394	1.26	2.52	**33.8**	
Central Coast	7%	6,126	1.00	2.00	**12.3**	
South Coast	46%	41,012	1.37	2.74	**112.4**	
Tulare Lake	5%	4,082	1.80	3.60	**14.7**	
San Joaquin	6%	5,687	1.80	3.60	**20.5**	
Sacramento River	13%	11,211	1.80	3.60	**40.4**	
North Lahontan	1%	544	1.56	3.12	**1.7**	
South Lahontan	4%	3,412	2.08	4.16	**14.2**	
Colorado River	0%	360	2.53	5.06	**1.8**	
Total Irrigation		**88,773**			**258**	**324.6**
Total All End Uses						**341.8**

[1] The number of golf courses was reported by county and we translated this into hydrologic region (California Golf Owners Association 2002). We then converted the number of golf courses in each region into a percentage of the state's total golf course acreage.
[2] The total acreage of golf courses was reported by the California Golf Owners Association (2002) and then distributed among regions based on the percentage of golf courses in each region.
[3] see Appendix D.

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) to our GED-derived estimates of water use, we estimated potential water savings (shown in Table E-9).

Table E-9
Potential Water Savings at Golf Courses (2000)

End Use	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	**High**	**Best**	**Low**	**High**	**Best**
Irrigation (Freshwater)	211.9[1]	26%	100%	39%	60.1	211.9[2]	88.7
Irrigation (Reclaimed)	112.8[1]	0%	0%	0%	0	0	0
Other	17.1	0%	0%	0%	0	0	0
Total	**341.8**	**26%**	**100%**	**39%**	**55.6**	**82.1xx**	**211.9xx**

[1] According to the National Golf Foundation, in 1998, about 33% of the water supply to golf courses in Region 8 (which includes So Cal, W.AZ and So NV) was supplied from reclaimed water. (Thompson, 2002)
[2] The low and best estimates coincide with the findings in Appendix D while the high estimate includes potential freshwater savings if all freshwater currently used in golf course irrigation (229 AF/year) was replaced with reclaimed water.

Hospitals (SIC code 806)

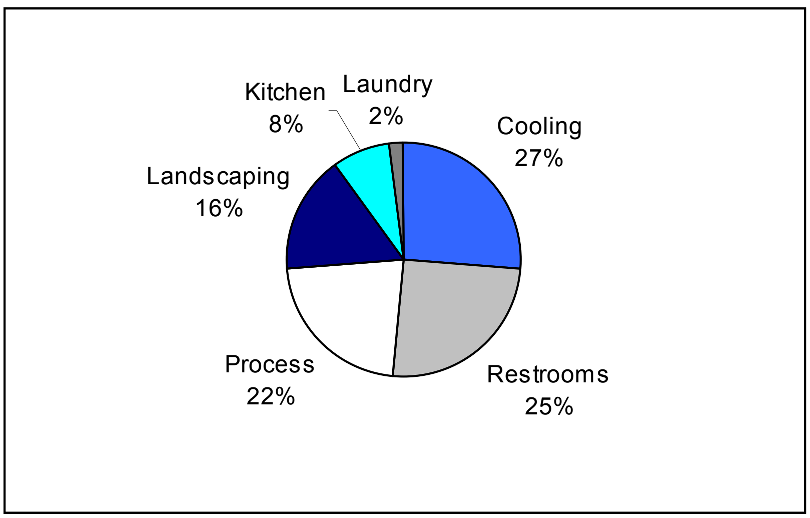
Hospitals are classified under SIC code 80, which also includes physicians' offices (SIC codes 801, 802, and 804), nursing homes and special care facilities (SIC code 805), laboratories and dental clinics (SIC code 807), and outpatient clinics and blood banks (SIC codes 808 and 809). Because the water use in these facilities varies considerably, we focused solely on hospitals (SIC code 806), which are the largest single sub-industry in SIC code 80. Table E-10 and Figure E-3 show water use in hospitals by end-use.

Table E-10
Employment and Water Use in the Hospital Industry (2000)

Industry	SIC code	GED[1,2]	Employees	Annual Use (TAF)
Hospitals	806	124	428,450	36.7

[1] Based on a 225-day year.
[2] Note that the GED coefficients estimated for 1995, were decreased by 20% to obtain the GED coefficients for 2000 for the commercial sector.

Figure E-3
Water Use, by End Use, in the Hospitals



Source: Calculated from MWD audit data of regional hospitals (MWD 2002).

Process Water Description

Hospitals use process water to operate the following equipment:

- X-ray machines (as part of the film development process);
- Steam sterilizers (for sterilizing equipment);
- Washers;
- Autoclaves (for sterilizing equipment);
- Laboratories;
- Boilers;
- Vacuum pumps (for sterilizing environments); and

- Other, misc. processes.

Potential Process Water Savings

Table E-11
Potential Process Water Savings in the Hospital Industry (2000)

Sub-end Use	Water Conservation Measure	Sub-end Use (x) [1]	Technology Savings (c)	Penetration Rate (p)	Conservation Potential (s) [2]
		(percent)			
X-ray	Recirculating x-ray machines[3]	22%	90%[3]	5%[4]	90%
Steam sterilizers	Replace steam sterilizers with ozone based ones; recirculate water where replacement is not possible	23%	70%[5]	50%[6]	65%
Washers	None				
Autoclave	None				
Laboratories	Improve efficiency of reverse osmosis units; install ultrasonically controlled sinks; retrofit sterilizers	1%	20%	30%[6]	20%
Boilers	Recycle boiler condensate	1%	50%	85%[6]	50%
Vacuum pumps	Replace with oil-ring pumps	4%	100%[7]	95%[8]	100%
Other			0%	50%	30%
Total			**52%**		

[1] Estimated from data in three case studies (B&V 1991 (c&d), MWD 1996, B&M, 1995).
[2] Percent Savings Potential = Savings * (1-Penetration)/ (1- Savings*Penetration Rate)
[3] Water Saver/Plus TM units can save 98 percent of water used for x-ray machines (CUWCC 2001). Because this technology is relatively new, only a handful of machines have been retrofitted and we assumed that 95 percent of x-ray machines in California are yet to be replaced.
[4] Estimated from data in CUWCC (2001).
[5] The typical conservation recommendations for sterilizers include installing auto-shutoff valves, running the sterilizer or autoclave with full loads only, and recycling steam condensate and non-contact cooling water from sterilizers as make-up water in cooling towers or boilers. These conservation measures could result in savings up to 60 percent (LADWP 1991). However, more recently a few hospitals have replaced steam sterilization with chemical-based sterilizers, saving both water and energy. Almost 70 percent of a hospital's sterilizing needs can be met without steam (Scaramelli and Cohen 2002).
[6] Estimate based on how many years the technology has been around
[7] Converting from water ring pumps to oil ring pumps eliminate water use altogether. Where steam must be used, recirculation is increasingly becoming common (Scaramelli and Cohen 2002).
[8] Oil-ring vacuum pumps currently dominate 80 percent of the market, about 17 percent are oil-less, and roughly 3 percent are still water-ring pumps (Britain 2002).

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) and Table E-11 to our GED-derived estimates of water use, we estimated potential water savings (shown in Table E-12).

Table E-12
Potential Water Savings in the Hospital Industry (2000)

End Use	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	**High**	**Best**	**Low**	**High**	**Best**
Cooling	9.6	9%	41%	26%	0.9	4.0	2.5
Restrooms	9.2	47%	47%	47%	4.3	4.3	4.3
Process	8.1	39%	57%	52%	3.1	4.6	4.2
Landscaping	5.9	38%	53%	50%	2.2	3.1	2.9
Kitchen	2.9	20%	20%	20%	0.6	0.6	0.6
Laundry	0.7	42%	42%	42%	0.3	0.3	0.3
	36.7	**31%**	**46%**	**40%**	**11.4**	**16.8**	**14.8**

Laundries (SIC code 721)

SIC code 721 consists of a range of facilities that include carpet and upholstery cleaners, large linen rental companies, and a variety of laundries, including industrial laundries that clean rags used to wipe inks and solvents off equipment. We include all laundries except SIC code 7215, coin laundries. Table E-13 shows employment and gallons per employee per day coefficients. Figure E-4 shows laundry end-use estimates. As expected, most water use in this industry goes to washing clothes, though about 15% goes to other end uses.

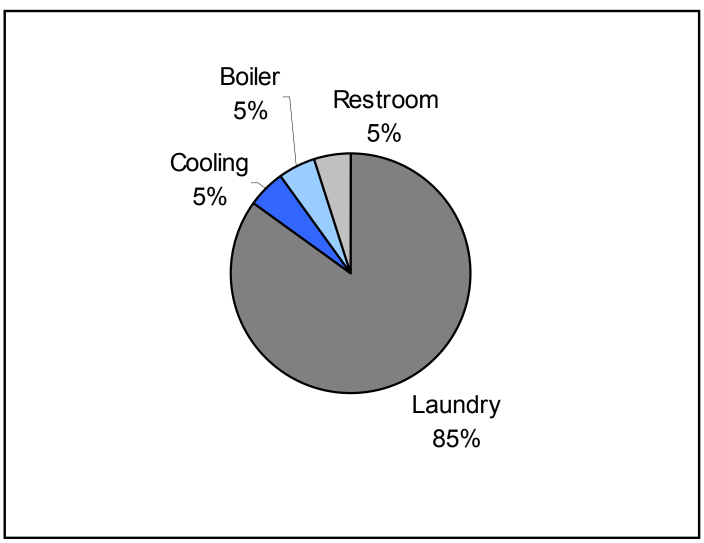
Table E-13
Employment and Water Use in the Laundry Industry (2000)

Sub-industry	SIC code	GED[1,2]	Employees	Annual Use (TAF)
Dry cleaning & laundry	7216	981	21,410	14.5
Linen supply	7213	977	7,860	5.3
Carpet & upholstery	7217	984	5,890	4.0
Industrial launderers	7218	981	9,150	6.2
Total	**49,965**		**44,310**	**30.0**

[1] Based on a 225-day year.
[2] Note that the GED coefficients estimated for 1995, were decreased by 20% to obtain the GED coefficients for 2000 for the commercial sector.

In the laundry industry, water is used primarily to remove soil and odors from textiles through laundering and very little water (<15 percent) is used for other purposes.

Figure E-4
Water Use, by End Use, in the Laundry Industry



Source: Based on average of two laundry case studies (AWWARF 2000)

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) to our GED-derived estimates of water use, we estimated potential water savings (as shown in Table E-14).

Table E-14
Potential Water Savings in the Industrial Laundry Industry (2000)

	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
End Use		**Low**	**High**	**Best**	**Low**	**High**	**Best**
Laundry	25.5	42%	66%	54%	10.8	16.9	13.8
Cooling	1.5	9%	41%	26%	0.1	0.6	0.4
Boiler[1]	1.5	0%	25%	10%	0.0	0.4	0.2
Restroom	1.5	34%	34%	34%	0.5	0.5	0.5
Total	**30.0**	**38%**	**61%**	**49%**	**11.4**	**18.4**	**14.8**

[1] Assumed Range

Restaurants (SIC code 58)

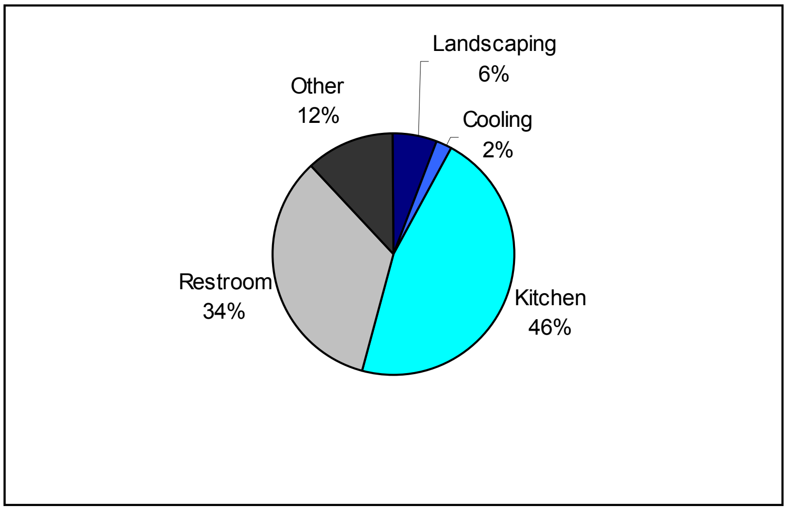
Water is used in restaurants primarily for kitchen purposes, such as washing dishes, making ice, and preparing food (see Appendix D for a description of these uses). A significant amount of water is also used for restrooms. Table E-15 and Figure E-5 provide our estimates of total water use in the restaurant industry by end use.

Table E-15
Employment and Water Use in the Restaurant Industry (2000)

Industry	**SIC code**	**GED[1,2]**	**Employees**	**Annual Use (TAF)**
Restaurants	58	265	890,600	163.0

[1] Based on a 225-day year.
[2] Note that the GED coefficients estimated for 1995, were decreased by 20% to obtain the GED coefficients for 2000 for the commercial sector.

Figure E-5
Water Use, by End Use, in the Restaurant Industry



Source: Calculated from MWD audit data of 89 restaurants (MWD 2002).

Comparison of GED-derived Estimate to Modeled Water Use

We modeled water use in restaurants using published estimates of restroom visits by employees and customers, irrigated turf area, cooling requirements, dishwashing water use etc. We converted our GED-derived estimate of water use per employee into water use per meal and then compared it to that predicted by the water use model. To convert the GED-derived estimate, we first divided the amount of water used in the restaurant sector in 2000 by the number of meals eaten to calculate the average gallons/meal/day.

Because the number of meals eaten at California restaurants per day was not available, we estimated this number with two different methods (see Tables E-16 and E-17).

Table E-16
Number of Meals Served in California (2000), Method One

Data	**Source**	**Value (2000)**
A) Employees in California	US Census Bureau	895,000
B) Meals/employee/day	Average of restaurants[1]	15
C) Total meals/day in California	A*B	13,500,000
D) Percentage of drive-through meals	Restaurant USA	18%
E) Take out meals/day	C*D	2,400,000
F) Sit down meals/day	C-E	11,100,000

[1] Average of data from several case studies (LADWP, 1991 (a & b), MWD, 1992, MWRA, 1990)

Table E-17
Number of Meals Served in California (2000), Method Two

Data	Source	Value (2000)
A) Population in California in 2000	US Census Bureau	33,800,000
B) Meals eaten out/week	Restaurant USA	4.2
C) Total meals/day in California	A*B/7	18,200,000
D) Fraction of meals eaten at cafeterias (not in SIC code 58)	Fraction of establishments not included in SIC code 58	25%[1]
E) Meals in SIC code 58	C*(1-D)	13,700,000
F) Percentage of drive-through meals	Restaurant USA	18%
G) Number of drive-through meals	D*E	2,500,000
H) Sit-down meals/day in restaurants	D-F	11,200,000

[1] We used the number of establishments (74,000) published by the California Restaurants Association (www.calrest.org). The number listed under SIC code 58 (57,000), is about 77 percent of the total restaurants.

To model the water use in a medium-sized restaurant, we considered a food establishment with 25 employees and 60 seats. The meal turnover industry average of 5 meals/seat/day (or 250 meals/day) (LADWP, 1991 (a & b), MWD, 1992, MWRA, 1990) was applied to end-use data from Appendix D.

Table E-18
Modeled Daily Water Use in Restaurants (2000)

Water End Use	Volume[1]	Times Per Day[1]	Use Gal/Day	Use Gal/Meal/Day	Use Efficient Gal/Meal/Day[2]
Dishwasher					
Pre-rinse nozzles	2.5 gpm	60 min	150	0.6	0.40
Pot and pan sink	40 gal	3 sinks * 2 fills[3]	300	1.20	1.20
Garbage disposal	4.5 gpm	30 min	135	0.54	0.20
Dishwasher	2.4 gal/rack	0.5 racks/meal, 70 percent capacity[4]	429	1.71	0.79
Restrooms[5]					
Employee use restrooms	2.8 gal/visit	25 employees * 4.6 visits/day gal/day	322	1.3	0.72
Customer use restrooms	2.7 gal/visit	250 customers *50 percent of customers	338	1.4	0.79
Food Prep					
Preparation sink	15 gal	2 fills/day	30	0.12	0.12
Water used in food	0.5 gal/meal	250 meals/day	125	0.50	0.50
Icemaker					
Ice maker	1 gal/lb[6]	1.5 lb/meal[7]*250 meals	338	1.5	1.2
General Sanitation					
Floor wash	12 gal/clean	3 cleans[8]	36	0.14	0.14
Other[9]	30 gal		125	0.50	0.50
Miscellaneous	100 gal		100	0.40	0.40
Total			**25,607**	**9.91**	**6.96**

[1] Volume and use were estimated from data in several case studies (LADWP, 1991 (a & b), MWD, 1992, MWRA, 1990), except where otherwise noted.
[2] See Appendix D
[3] Three pot sinks of 50 gallons capacity are filled and emptied twice daily.
[4] The amount of dishes generated was assumed to be 2.5 racks/guest (Bohlig 2002).
[5] See Appendix D.

[6] Ice used per meal was about 1.5 lbs and icemaker water use of 1 gal/lb was assumed (note that one gallon of water produces only one pound of ice because, during the process, several gallons are lost to bleed-off.
[7] ASHRAE 1994
[8] Assuming the restaurant uses about 25 gallons each time it cleans the floor and counters and it does this twice daily.
[9] The restaurant uses 100 gallons daily in other uses including laundry and landscaping (about 5 percent of total use). The restaurant does not have a cooling tower.

Our comparison of the GED-derived and modeled estimates is shown in Table E-19 below.

Table E-19
Comparison of Estimates of Water Use in a Typical Restaurant

	GED-derived (gallons/meal)	Model 1 (typical use)	Model 2 (efficient use)
Total	12.9[1]	9.9	7.0

[1] Using 163 TAF in 2000 for SIC code 58 and dividing this by the number of meals per day and then by 365 days in a year, we got about 12.9 gal/meal.

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) to our GED-derived estimates of water use, we estimated potential water savings (shown in Table E-20).

Table E-20
Potential Water Savings in the Restaurant Industry (2000)

	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
End Use		**Low**	**High**	**Best**	**Low**	**High**	**Best**
Landscaping[1]	9.8	38%	53%	50%	3.7	5.2	4.9
Cooling	3.3	9%	41%	26%	0.3	1.4	0.8
Kitchen	75.0	20%	20%	20%	14.9	14.9	14.9
Restrooms	55.4	46%	46%	46%	25.2	25.2	25.2
Other[2]	19.6	0%	25%	10%	0.0	4.9	2.0
Total	**163.0**	**27%**	**32%**	**29%**	**44.0**	**51.5**	**47.7**

[1] Based on our modeled landscaping use, we assumed that about 18 TAF, or 4 percent, of total restaurant use is used for landscaping. The remaining 13 TAF, or 6 percent, of the other/landscaping category was used for other purposes. See Appendix D for more information on landscaping.
[2] Range assumed

Retail Stores (SIC codes 53, 54, 55, 56, 57, 59)

Retail stores include grocery stores, department stores, gas stations, and non-store retailers (i.e., retailers who work from home). In 2000, there were nearly 800,000 retail stores in the state. Due to known differences in water use, we categorize retail establishments as grocery stores or "miscellaneous retail" stores. These are shown in Table E-21 and Figure E-6 and Figure E-7.

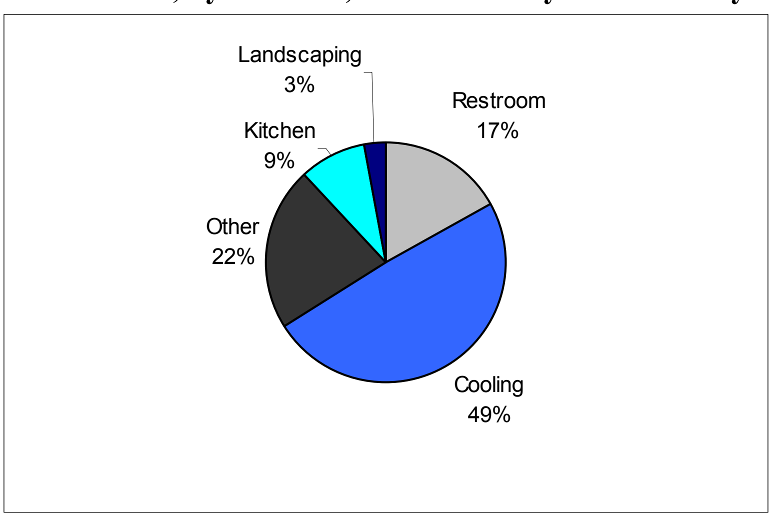
Table E-21
Employment and Water Use in the Retail Industry (2000)

Sub-industry	SIC code	GED[1,2]	Employees	Annual Use (TAF)
Grocery	540	170	293,224	34.5
Misc. Retail	53,55,56,57,59	152	1,128,210	118.1
Total			**1,421,434**	**153.0**

[1] Based on a 225-day year.
[2] Note that the GED coefficients estimated for 1995, were decreased by 20% to obtain the GED coefficients for 2000 for the commercial sector.

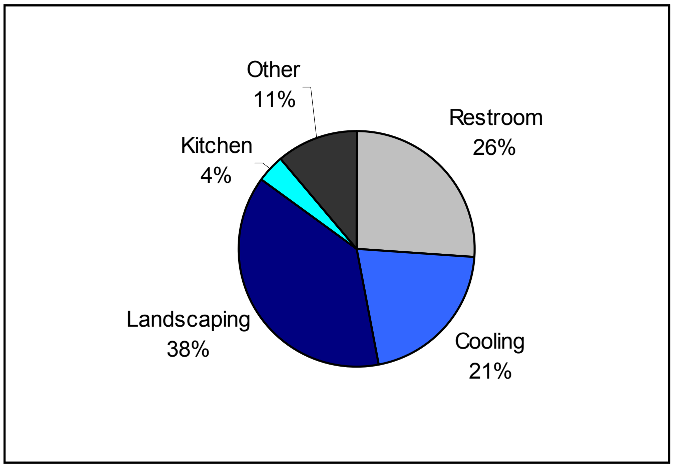
Retail stores use water in kitchens and restrooms and for cooling and irrigation. Although no process water is typically used in the Retail industry, water use varies considerably among the different types of retail stores. For example, grocery stores use water more intensively than other retail stores because they have sinks and dishwashing nozzles in meat and deli departments, misters to keep produce moist, and ice makers. In contrast, department and other retail stores use water mostly for restrooms and space cooling.

Figure E-6
Water Use, by End Use, in the Grocery Sub-industry



Source: Calculated from MWD audit data of 45 grocery stores (MWD 2002).

Figure E-7
Water Use, by End Use, in Misc. Retail Sub-industries



Source: Calculated from MWD audit data of 38 miscellaneous retail stores (MWD 2002).

Comparison of GED-derived Estimate to Modeled Water Use

We could not create a complete model of typical water use because of data insufficiency on kitchen and cooling water use in retail establishments. However, we did compare our GED-derived estimates to some of the various end uses that were calculated in Appendix D, as shown in Table E-22.

Table E-22
Comparison of Estimates of Annual Water Use in the Retail Industry

End Use	Modeled End Use	GED-derived Use
	(TAF)	
Kitchen	n/a	7.8
Restrooms	22.5	36.6
Cooling	n/a	41.7
Landscaping	33.7	45.9
Other	n/a	20.6
Total		**153**

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) to our GED-derived estimates of water use, we estimated potential water savings (shown in Table E-23).

Table E-23
Potential Water Savings in Grocery Stores (2000)

Grocery End Use	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	High	Best	Low	High	Best
Restroom	5.9	51%	51%	51%	3.0	3.0	3.0
Cooling	16.9	9%	41%	26%	1.6	7.0	4.3
Landscaping	1.0	38%	53%	50%	0.4	0.5	0.5
Other	7.6	0%	25%	10%	0.0	1.9	0.8
Kitchen	3.1	20%	20%	20%	0.6	0.6	0.6
Total	**34.5**	**16%**	**38%**	**27%**	**5.6**	**13.1**	**9.2**

Table E-24
Potential Water Savings in the Other Retail Stores (2000)

Misc. Retail End Use	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	High	Best	Low	High	Best
Restroom	30.7	44%	51%	51%	51%	15.7	15.7
Cooling	24.8	7%	9%	41%	26%	2.4	10.3
Landscaping	44.9	47%	38%	53%	50%	16.9	23.7
Other	13.0	0%	0%	25%	10%	0.0	3.2
Kitchen	4.7	20%	20%	20%	20%	0.9	0.9
Total	**118.1**	**28%**	**43%**	**37%**	**33.2**	**50.9**	**43.4**

Schools (SIC codes 8219, 9382)

There are 8,330 public and 4,370 private schools in California, including elementary, middle, high, continuing, and vocational schools. Total enrollment (public and private) was 4.73 million in elementary and middle schools, 1.85 million in high schools, and 2.20 million in other[3] types of schools (CDE 2002, California Postsecondary Education Commission 2002).

Table E-25
Employment and Water Use in Schools (2000)

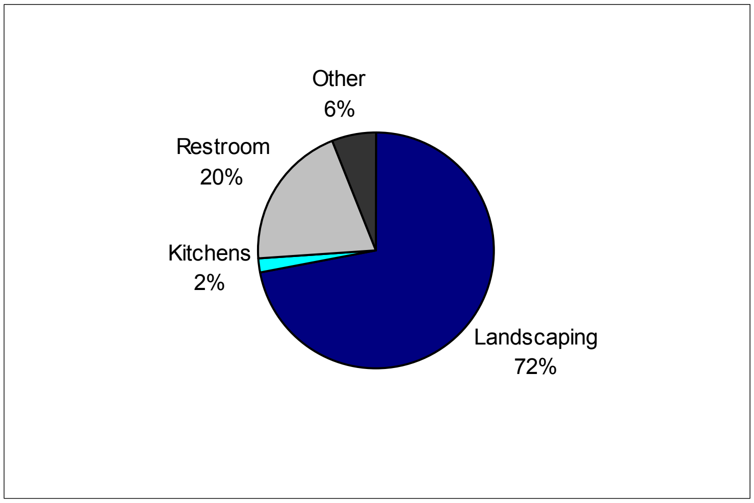
Sub-industry	SIC	GED[1,2]	Employees	Annual Use (TAF)
K-12		308	1,009,130	214.6
Other		190	280,200	36.7
Total			**1,289,300**	**251.3**

[1] Based on a 225-day year.
[2] Note that the GED coefficients estimated for 1995, were decreased by 20% to obtain the GED coefficients for 2000 for the commercial sector.

Although most schools use water for restrooms, cooling and heating, irrigation, and kitchens, the percentage of water consumption devoted to different end uses varies among schools. The most significant difference appears to result from the large use of irrigation water in schools with athletic fields. High schools generally have more irrigated athletic field area per student than elementary schools or other types of schools. Because the end use percentages can vary greatly among the different types of schools, we analyzed water use in elementary/middle schools, high schools, and other schools separately (see Figures E-8 and E-9).[4]

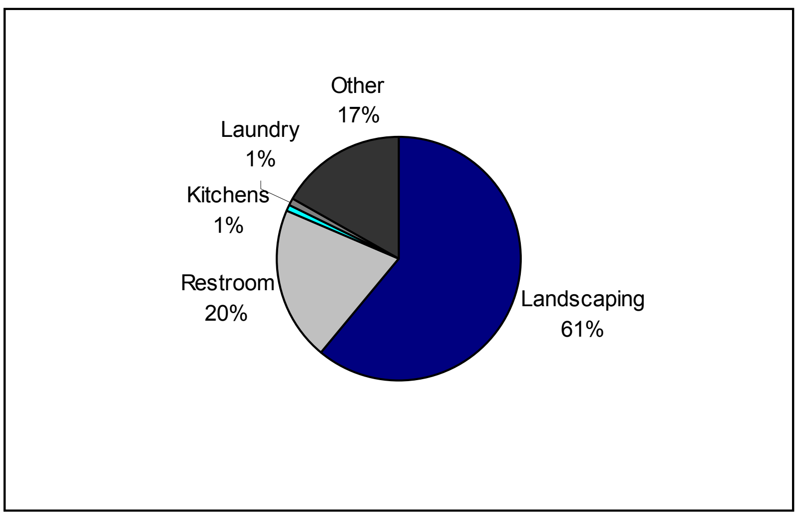
[3] Other types of schools, as referred to herein, include colleges, universities, trade schools, and other non-K-12 schools.
[4] In some cases we had enough data to also analyze elementary and high schools separately.

Figure E-8
Water Use, by End Use, in K-12 Schools



Source: Calculated from MWD audit data of 149 schools (MWD 2002).

Figure E-9
Water Use, by End Use, Other Schools



Source: Calculated from MWD audit data of selected non-K-12 schools (MWD 2002).

Comparison of GED-derived Estimate to Modeled Water Use

We modeled water use in schools using published estimates of restroom visits by students and staff, irrigated turf area, cooling requirements, etc. We converted our GED-derived estimate of water use per employee into water use per student per day and then compared it to that predicted by the water use model. The end use calculations in the GED-derived estimate are from Figures E-8 and E-9 and the model's assumptions are derived from the end-use data in Appendix D. Table E-26 shows the results.

Table E-26
Modeled Water Use per Student

End Uses	Unit Measuring Area or Volume of Use	Area or Volume	Unit Measuring Frequency of Use	Frequency of Use	Total gal/ student/ day
Elementary and Middle Schools					
Irrigation[1]	irrigated acres/student	0.004	gal/acre/school day	varies	24.3
Toilet[2]	gpf	3.00	visits/day	2.11	6.3
Urinal[3]	gpf	1.60	visits/day	1.01	1.6
Faucet Use[4]	gpf	0.11	flushes/day	3.12	0.3
Kitchen	gal/meal	9.91[5]	meals/day/student	0.4[6]	4.0
Other[7]					2.0
Total					**38.5**
High Schools					
Irrigation[1]	irrigated acres/student	0.008	gal/acre/school day	varies	55.6
Toilet[2]	gpf	3.00	visits/day	2.11	6.3
Urinal[3]	gpf	1.60	visits/day	1.01	1.6
Faucet Use[4]	gpf	0.11	flushes/day	3.12	0.3
Kitchen	gal/meal	9.91[5]	meals/day/student	0.4[6]	4.0
Other[7]					4.0
Total					**71.8**
Other Schools					
Irrigation	irrigated acres/student	0.002	gal/acre/school day	varies	6.9
Toilet[8]	gpf	3.00	visits/day	1.03	3.1
Urinal[9]	gpf	1.60	visits/day	0.39	0.6
Faucet Use	gpf	0.11	min/day	0.96	0.1
Kitchen	gal/meal	9.91	meals/day/student	0.4	4.0
Other					1.0
Total					**15.7**

1

2 Assuming that each K-12 student and staff uses the toilet 1.95 times per day (see Appendix D) and a student-staff ratio of about 11.8 (based on student enrollment obtained from the Educational Demographics Office (2002) and employment data from California Employment Development Department (2002), we calculated 2.11 daily toilet visits per K-12 student.

3 Assuming that each K-12 student and staff uses urinals 0.94 times per day (see Appendix D) and a student-staff ratio of about 11.8 (Based on Student Enrollment obtained from the Educational Demographics Office (2002) and Employment Data from California Employment Development Department (2002)), we calculated 1.01 daily urinal visits per student.

4 Faucet use was based on the number of daily toilet and urinal flushes reported above.

5 Average gal/meal was obtained from the model in Appendix D.

6 The USDA estimated that there were about 489 million school meals served in 2000 (about 2.7 million meals per day). The total enrollment in California's public and private schools is about 6.6 million, implying about 40 percent of students have cafeteria meals.

7 Other use is estimated at 5 percent of total use and includes cooling, pools, etc.

8 Assuming that each non K-12 student uses the toilet 0.86 times per day and staff uses the toilet 1.95 times per day and a student-staff ratio of 11.8, we calculated 1.03 daily visits per non K-12 student.

9 Assuming that each non K-12 student uses urinals 0.31 times per day and staff uses them 0.94 times per day and a student-staff ratio of 11.8, we calculated 0.39 daily visits per student.

Table E-27
Comparison of Estimates of Water Use in Typical Schools

	GED-Based Estimate[1]	Modeled Estimate
	(gal/student/day)	
Elementary and middle schools	48.1	38.5
High schools	87.4	71.8
Other schools	30.5	15.8

[1] Based on the assumption that elementary and middle school students use 55 percent of the water used by high schools students (see Table E-26), we converted elementary and middle students into 2.60 million "additional" high school students. We then divided total K-12 water use (215 TAF) by the number of high school students plus the "additional" high school students to yield 87.43 gallons/high school student/school day. Then, we took 55 percent of the high school use in gal/student/day to get gallons/K-8 student/day. For gallons/other student/day, we divided total other use by the number of other students and then by the number of school days.

Estimate of Potential Savings

By applying the conservation potential calculated in the end-use studies (see Appendix D) to our GED-derived estimates of water use, we estimated potential water savings (shown in Table E-28 and E-29).

Table E-28
Potential Water Savings in K-12 Schools (2000)

K-12 End Uses	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	High	Best	Low	High	Best
Landscaping	154.5	38%	53%	50%	58.1	81.6	77.1
Kitchens	4.3	20%	20%	20%	0.9	0.9	0.9
Restroom	42.9	45%	45%	45%	19.4	19.4	19.4
Other	12.9	0%	25%	10%	0.0	3.2	1.3
Total K-12	**214.6**	**36%**	**49%**	**46%**	**78.3**	**105.1**	**98.6**

Table E-29
Potential Water Savings in Other Schools (2000)

Other Schools End Uses	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	High	Best	Low	High	Best
Landscaping	26.4	38%	53%	50%	9.9	14.0	13.2
Kitchens	8.8	45%	45%	45%	4.0	4.0	4.0
Restroom	0.4	20%	20%	20%	0.1	0.1	0.1
Laundry	0.4	42%	66%	54%	0.2	0.2	0.2
Other	0.7	0%	25%	10%	0.0	0.2	0.1
Total Higher and Special-Ed.	**36.7**	**39%**	**50%**	**48%**	**14.1**	**18.4**	**17.5**