Special Issue
Water issues of interest to the Southern California turfgrass industries are featured. Water demand, supply, conservation budgeting (BMP 5), and recycled water are discussed.

UNIVERSITY OF CALIFORNIA, RIVERSIDE TURFGRASS RESEARCH PROGRAM
Better Turf Thru Agronomics
UCRTRAC Newsletter, August 1999

California Water Demand Snapshot

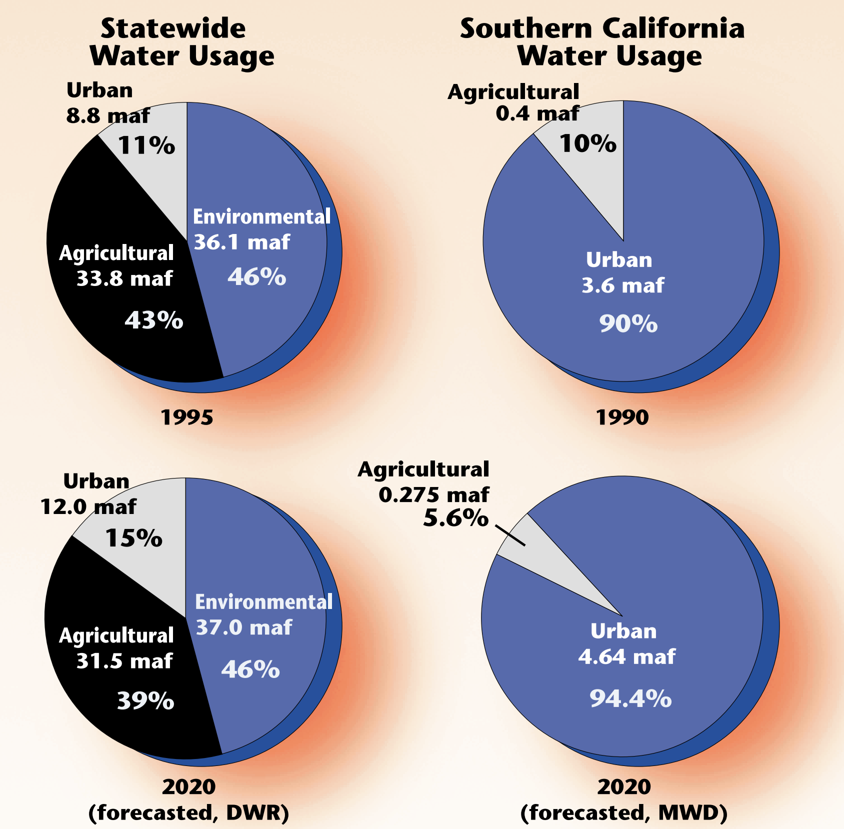

Fig. 1. Southern California water usage differs markedly from statewide usage now and in the future. The MWD and its 27 member agencies serve 95% of the DWR's South Coast Hydrologic Region. maf = million acre-feet. Sources: Statewide -- California Water Plan Update, Bulletin 160-98, Department of Water Resources (DWR, Jan. 1998). Southern California -- Integrated Water Resources Plan (IRP), Report. No. 1107, Metropolitan Water District of Southern California, (MWD, March 1996).

The Department of Water Resources (DWR) subdivides statewide water demand into three broad categories -- urban, agricultural, and environmental. The Metropolitan Water District of Southern California (MWD) subdivides water demand in its service area into two broad categories, urban and agricultural.

For both the MWD and the DWR, urban water demand consists primarily of single-family and multifamily residential, commercial, institutional, and industrial demand (Fig. 2). To make reliable, regional, urban water demand projections, the MWD uses an econometric model known as MWD-MAIN, which factors in urban demographic and economic trends. MWD-MAIN is based on the national state-of-the-art model, IWR-MAIN. The agricultural sector includes farm crops and the nursery industry, the state's third largest farm product in gross value.

The DWR quantified environmental water use for the first time in 1993 in Bulletin 160-93. This water sector is primarily the result of legislative and regulatory processes. Thus, DWR's Bulletin 160-98 says forecasting of this sector is "speculative." Environmental water includes dedicated flows in state and federal wild and scenic rivers, water needs of managed freshwater wildlife areas, instream flow requirements specified in water rights permits, court actions, and other administrative documents, and Bay-Delta outflows required by the State Water Resources Control Board water rights actions.

The water demand picture in Southern California is top heavy with urban demand, compared to the statewide picture (Fig. 1). Statewide, urban water demand was 11% of the total in 1995 according to the Department of Water Resources (DWR) and is forecasted to increase to 15% by 2020; whereas, in Southern California, urban demand was 90% of the total in 1990 and is projected to increase to 94.4% by 2020, according to the Metropolitan Water District of Southern California (MWD).

Water usage in Southern California is projected by the MWD to increase to 4.9 million acre-feet (maf) by 2020, representing about 6% of the statewide total forecasted by the DWR (80.5 maf), even though more than half of the state's population lives in the region. Agricultural water demand in Southern California is projected to decrease from 10% in 1990 to 5.6% in 2020, according to the MWD.

Urban Water Use By Sector in MWD's Southern California Service Area

The MWD's *Integrated Water Resources Plan* (IRP) subdivides urban water use in the region into sectors, showing that single and multiple family residences together consume two-thirds of the urban water used in Southern California (Fig. 2). Residential demand is subdivided further into water used indoors (sinks, toilets, tubs and showers) and water used outdoors, which is primarily for landscape irrigation. A detailed discussion of outdoor urban water use in the region is provided on page 2.

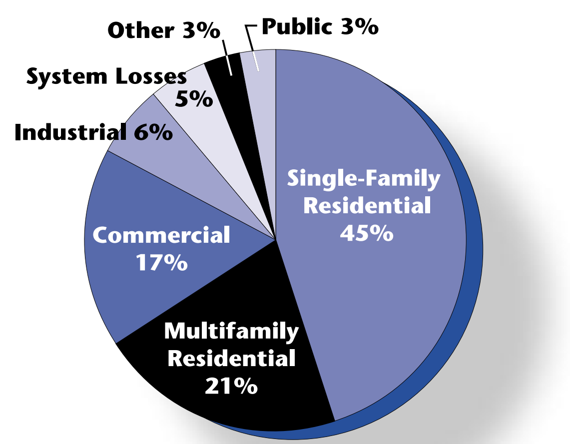

Fig. 2. Urban water use by sector in Southern California. Residential demand accounts for two-thirds of the total urban demand in the region. Source: IRP, MWD Report No. 1107, March 1996.

How Much Water Is Used for Landscape Irrigation in Urban Southern California?

It's not a simple question. According to MWD planners, a precise answer requires a survey of all water retailers in the region.

Large Turfed Areas. Here's why it's difficult to get a reliable number for how much water is used to irrigate large turfed areas in the region, such as golf courses, sod farms, school athletic fields, parks, median strips, and cemeteries: Since MWD is the primary wholesaler for the region, its 27 member agencies, which comprise 14 cities, 12 municipal water districts, and 1 county water authority, determine the water billing classification of turfed areas in their reporting to the MWD. MWD's *commercial sector* includes irrigation of golf courses and sod farms only if water retailers bill at the commercial rate. If a golf course uses recycled water, its water usage is not reported in MWD's commercial sector. Recycled water sold to CALTRANS for median strips is not included in MWD data. Water usage by a sod farm may be reported in the agricultural sector, if a member agency has a special agricultural rate available to the sod producer.

Residential Lawns. The MWD publishes pertinent statistics on outdoor water use by the urban residential sector. Single-family residences consume almost two times as much water outdoors (35%) as multifamily households (18%, Table 1).

Preliminary results from a national study sponsored by the American Water Works Association Research Foundation of residential water use by single-family homes show different consumption patterns from the MWD's IRP: The mean annual outdoor:indoor water split for all cities (12 study sites across North America) was 59% outdoor:41% indoor. At two study sites in Southern California (San Diego and Walnut), the mean annual outdoor:indoor water split was 63-64% outdoor and 36-37% indoor, just the opposite of the usage reported in the IRP (Table 1), which may indicate the variation in outdoor water use among water agencies and districts.

Differences in outdoor irrigation practices, such as deficit irrigation of the landscape in certain districts, inefficiencies in older irrigation systems, and variable quality in irrigation programming could account for some of the discrepancies in the findings, said Jurgen Gramckow, Managing Partner, Southland Sod Farms.

Based on our interactions with clientele in the landscape industry, we believe that the *regional* outdoor:indoor water split is closer to 50:50 on an annual basis, said Dennis Pittenger, UC Extension Area Environmental Horticulture Specialist, Central Coast and South Region. The disparity in published findings underscores the need for additional research, he said. Climate, socioeconomic and demographic factors, and attitudes about conservation influence regional outdoor usage patterns, he said. Multifamily residential housing is projected to grow faster than single-family dwellings, up 17.8% from 1990 levels by the year 2000 (Table 1), which means demand for landscape irrigation water will not increase as rapidly as when single-family housing growth sets the pace. Offsetting this trend is the fact that residential growth is projected to be more rapid in inland regions

Table 1. MWD Service Area Urban Water Use

Sector	Avg. Daily Water Use[a] Per Household or Establishment	% Annual Use Indoor	% Annual Use Outdoor	Total No. in MWD[a] (Millions) 1990	2000
	----------Historical Average----------				
Single Family Residential	465 gal	65	35	2.85	3.18
Multifamily Residential	265 gal	82	18	2.25	2.65
Commercial/ Institutional	1,480 gal	71	29	0.345	
Industrial	5,600 gal	80	20	NR[b]	
Public	NR[b]	NR[b]	NR[b]	NR[b]	

Source: Integrated Water Resources Plan (IRP), MWD Report No. 1107, March 1996. [a]The IRP cites the Southern California Association of Governments (SCAG) and the San Diego Association of Governments (SANDAG) for these data. [b]Not reported. One acre-foot is about 326,000 gallons.

Please see ***LANDSCAPE IRRIGATION****, page 6*

Best Management Practice 5 (BMP 5) Mandates ET_O-based Water Use Budgets at CII Sites

Recent revisions to the ***Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California,*** governed by the California Urban Water Conservation Council (CUWCC), are favorable to the green industry. Urban best management practice 5 (BMP 5), ***Large Landscape Conservation Programs and Incentives,*** set the maximum allowable irrigation water applied annually up to 1.0 ET_O per square foot of landscape area for accounts with dedicated irrigation meters at commercial, industrial, and institutional (**CII**) sites.

ET_O, known as "reference" evapotranspiration, approximates the water use of a 4- to 6-inch tall, healthy cool-season grass. (Water use by plants consists primarily of two components, soil evaporation [E] and plant transpiration [T], hence the term 'evapotranspiration'.)

Agencies that signed the MOU prior to Dec. 31, 1997, were required to implement BMP 5 no later than July 1, 1999.

BMP 5 allows local water agencies discretion: They may use an *adjustment factor* that reduces the water budget (a defined allotment of water) to an amount less than 100% ET_O. Agencies can provide water budgets to CII accounts for informational purposes only or can link them to water pricing strategies.

At each billing cycle, water agencies must notify CII accounts with dedicated irrigation meters of their actual consumption and its relationship to the water use budget.

According to BMP 5, CII landscape sites also include multifamily residential sites with dedicated irrigation meters (homeowners' associations).

For CII accounts with mixed-use meters or no meters, BMP 5 requires water agencies to conduct water use surveys (audits) and to offer conservation measures specified in the MOU.

The first reporting period to CUWCC, composed of MOU signatories, is July 1, 2001. CUWCC is responsible for monitoring implementation of BMPs and reporting progress to the State Water Resources Control Board (SWRCB). Nearly 250 water agencies, public interest groups, and environmentalists have signed the MOU since 1991.

The ***BMP 5 Handbook: A Guide to Implementing Large Landscape Conservation Programs as Specified in Best Management Practice 5*** will be available from the CUWCC in September 1999.

Water Savings Projections

Landscaping programs in MWD's service area are projected to account for 10 to 11% of total water conservation savings (Table 2).

Please see ***BMP 5****, page 3*

Table 2. Current and Projected Water Demand in Southern California with Conservation Measures Implemented

	1990 Obs.[a]	Projected (Normal Weather) 2000	2010	2020
	----------------million acre-feet-------------			
Water Demand with Conservation				
Urban Demand (Municipal & Industrial)	3.600	3.660	4.168	4.644
Agricultural Demand	0.400	0.330	0.295	0.275
Total Demand	4.000	3.990	4.463	4.919
Water Conservation (BMPs) Savings				
1980 to 1990 Programs	0.250	0.250	0.250	0.250
Landscaping Programs		0.050	0.076	0.097
1990 Plumbing Codes and Ordinances		0.089	0.157	0.235
Plumbing Retrofit Programs		0.080	0.185	0.203
Commercial/Industrial Programs		0.014	0.027	0.045
Leak Detection/Repair		0.017	0.043	0.052
Public Education and Information		NR[b]	NR[b]	NR[b]
Total Savings	0.250	0.500	0.738	0.882

Source: IRP, MWD Report No. 1107, March 1996. Adapted from Table 2-5 and data in text. [a]1990 had above-normal water demand because it was a hot/dry year. [b]NR=not reported.

BMP 5, *continued from page 2*

When conservation BMPs are fully implemented, MWD projects future per capita water use will be reduced by 15%, held down to 190 gallons of water per person consumed daily (gpcd), despite inland growth and expected increases in the standard of living.

UCR Research: Practical Methods to Conserve Irrigation Water

UCR research on turf plant factors (K_c, Table 3) by Vic Gibeault, Extension Environmental Horticulture Specialist, and his colleagues can be combined with historical or real-time ET_o data to facilitate the water budgeting required by BMP 5 and to conserve irrigation water. Using ET_o and K_c, the irrigation need of a turfgrass stand can be calculated according to equation (1):

$$\text{Irrigation water required} = (ET_o \times K_c)/DU = ET_{turf}/DU \quad (1)$$

where K_c is the turf plant factor (crop coefficient); DU is the distribution uniformity, a measure of how efficiently an irrigation system applies water to a crop surface; and ET_{turf} is the actual water used by the turf. As DU decreases, more irrigation water will be required, although the actual water used by the turf (ET_{turf}) is unchanged. ET_{turf}/DU determines the actual irrigation requirement. Many urban turfgrass sites have an irrigation DU ranging from 50 to 70%, with more water savings being realized as the DU increases.

An optimally efficient irrigation system coupled with frequent controller program updates based on K_c and local ET conserves water. In Table 3, K_c are reported on a monthly, quarterly, semi-annual, and annual basis to allow for periodic irrigation programming or planning. Quarterly historical ET_o for 16 cities in Southern California are reported in Table 4. Real-time ET_o can be obtained from CIMIS (California Irrigation Management Information System) by calling 1-800-92CIMIS or by computer using the website address

http://wwwdpla.water.ca.gov/cgi-bin/cimis/cimis/hq/main.pl

Southern California landscapes planted to cool-season grasses in inland areas that seek good turf quality will have physiological water needs greater than 1.0 ET_o in

Please see ***BMP 5,*** *page 4*

What BMP 5 Means to End Users

BMP 5 does not require differentiation of plant materials in the water budget process when agencies assign water use budgets to their customers. In its simplest form, developing a water budget for a site requires two basic inputs: landscape area and weather data (real-time ET_o). The definition of landscape area chosen (all non-hardscape area or area of irrigated plant material) is a key decision for each water agency in assigning water budgets. BMP 5 presents new challenges to water conservation coordinators. Alternative methods to measure landscape area and simple-to-complex equations to calculate water budgets are discussed in the CUWCC's BMP 5 Handbook.

Table 3. Turf Crop Coefficients (K_c) in Southern California

Cool-Season Turfgrass

Month	Monthly	Quarterly	SemiA	Annually
Jan.	.61			
Feb.	64	.67	.68	
March	.75			
April	1.04			
May	.95	.96		
June	.88		.90	.80
July	.94			
Aug.	.86	.85		
Sept.	.74			
Oct.	.75			
Nov.	.69	.68	.68	
Dec.	.60			

Warm-Season Turfgrass

Month	Monthly	Quarterly	SemiA	Annually
Jan.	.55			
Feb.	.54	.62	.55	
March	.76			
April	.72			
May	.79	.73		
June	.68		.71	.60
July	.71			
Aug.	.71	.68		
Sept.	.62			
Oct.	.54			
Nov.	.58	.56	.55	
Dec.	.55			

Table 4. Quarterly Historical ET_o in Inches Per Month

City	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
Bakersfield	2.1	6.3	7.1	2.0
Barstow	4.0	9.9	10.3	3.7
Beaumont	2.6	5.9	7.2	2.7
El Centro	4.0	9.7	9.8	3.8
Escondido	2.9	5.4	6.2	2.8
Fallbrook	2.9	5.4	6.2	2.8
Long Beach	2.8	4.3	4.7	2.6
Los Angeles	2.9	5.3	5.7	2.9
Palm Springs	3.6	8.0	9.0	3.4
Pasadena	2.8	5.3	6.5	2.9
Riverside	3.0	5.8	7.2	2.9
San Bernardino	2.8	5.7	7.1	2.9
San Diego	2.8	4.5	4.8	2.6
Santa Ana	2.9	4.8	5.7	2.7
29 Palms	4.0	9.7	9.8	3.8
Victorville	3.4	8.7	9.5	3.3

BMP 5, *continued from page 3*

April through September when quarterly K_{cs} are 0.96 and 0.85, respectively, unless DUs are 96% and 85%, respectively (Eq. [1], Table 3). In the fall and winter, when quarterly K_{cs} are 0.68 and 0.67, respectively (Table 3), which are less than the annual average of 0.80, irrigation water needs of cool-season turf will be equal to or less than 1.0 ET_o, if DUs are equal to or greater than 68% and 67%, respectively.

Water Banking

The efficacy of seasonal carryover, also known as water banking (allocating landscape irrigation water on an annualized basis), which accounts for reduced physiological demand for water in the winter and excess demand in the summer, is currently being evaluated by Robert Green, UCR Turfgrass Research Agronomist.

BMP 5 has no express provision for water banking; however, the Otay Water District in San Diego has implemented *annualized* water budget allocations based on 100% ET_o. Their water efficient landscape irrigation ordinance has been in effect since June 1992. In Otay, unused water (up to 12 inches) is banked to avoid incurring overuse penalties during hot spells, establishment of new plantings, fertilization procedures, or irrigation system failures resulting in unanticipated usage.

The statewide Model Water Efficient Landscape Ordinance was added to Title 23 of the California Code of Regulations in response to the requirements of the 1990 Water Conservation in Landscaping Act (AB 325). The ordinance set 0.8 ET_o as a water use goal and applied to all new and rehabilitated landscapes (more than 2,500 sq. ft) for public agency projects and private development projects that required a permit and all developer-installed landscaping in single-family and multifamily residential projects. In contrast, BMP 5 applies to all CII landscapes. The California Urban Water Agencies are conducting a survey to assess the adoption, implementation, and enforcement of AB 325, said Byron Buck, Executive Director. Results are expected by early next year.

The Water Supply in Southern California

MWD planners predict future water supply in the region will fall short of urban demand without development of new water resources and increased conservation savings. In dry years, supply decreases below normal and demand increases above normal; thus, the MWD says that development of a reliable plan to meet the future water needs for the region must "provide an accurate assessment of the existing firm supplies available during dry years" (Table 5). The IRP defines a **'dry year'** as a "statistical measurement that accounts for the fact that Metropolitan and its member agencies receive water from hydrologically diverse and geographically widespread areas in the state and the western United States."

Without development of additional water sources, MWD planners estimated in the IRP, the most recent, published MWD projections, that total existing firm supplies available to the region during a 'dry year' are about 3.2 maf for the next 20 years, which falls significantly short of projected urban and agricultural water demand in normal weather (3.99 - 4.92 maf, Table 2). Comparing the total regional water supplies projected to be available in a dry year in 2000, 2010, and 2020 (Table 5)

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Table 5. Regional Water Supplies Available in a Dry Year

Water Source	2000	2010	2020
	---------million acre-feet---------		
Locally Developed Supplies			
Local Production[a]	1.43	1.48	1.53
Water Recycling[b]	0.27	0.36	0.45
Groundwater Recovery	0.04	0.05	0.05
Local Groundwater Storage Production[c]	0.25	0.30	0.33
Metropolitan's Regional Supplies			
Colorado River Aqueduct (CRA)	1.20	1.20	1.20
State Water Project (SWP)	0.75	0.97	1.35
MWD Storage & Water Transfers	0.34	0.49	0.46
Total Supply with Conservation BMPs[d]	4.28	4.85	5.37

Source: IRP, MWD Report No. 1107, March 1996. Adapted from Table 3-11. [a]Includes groundwater and surface production and imported supplies from the LAA. [b]Does not include upstream Santa Ana recharge, which is included in local production. [c]Represents annual production, not total storage capacity, which is about 1.0 maf. [d]Represents retail water demands under hot and dry weather conditions, assuming full implementation of conservation BMPs.

Urban Water Supply Costs

The current retail cost of water in MWD's service area is about $620/af, slightly above the national average of $600/af, which compares favorably to other urban centers (Fig. 3). MWD's cost analysis indicates that the region's average retail cost for water will increase from its current level to about $1,000/af by 2010 and to $1,250/af in 2020, an average increase of less than 2 percent annually in constant dollars, according to the IRP.

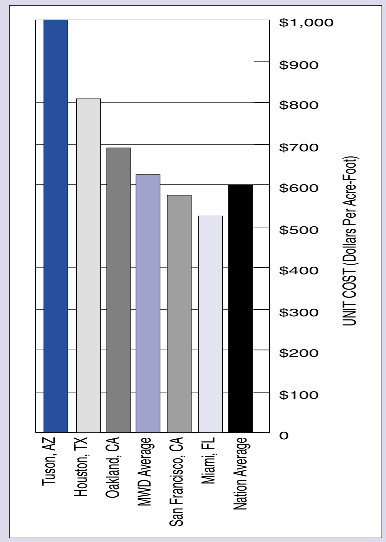

Fig. 3. Comparison of average urban water supply costs. Source: IRP, MWD Report No. 1107, March 1996 (based on Ernst & Young water rates survey, 1994).

Quality of Regional Water Supplies

According to the MWD, the total dissolved solids (TDS) of the Colorado River Aqueduct (CRA) supply "currently averages 650 mg/L and is expected to increase to about 700 mg/L, even with planned salinity control measures for the Colorado River. The State Water Project (SWP) supply, by comparison, has a TDS of about 350 mg/L. Blending CRA and SWP water improves the overall TDS for Metropolitan's member agencies..." According to the DWR, SWP supplies contain disinfection by-product precursors, from bromides in seawater and from organics in Sacramento-San Joaquin Delta soils.

Usage of Reclaimed Water for Landscape Irrigation

Statewide, 57,000 af of reclaimed water is used for landscape irrigation in California, which represents about 16% of the total reclaimed water used (Table 6). Approximately 354,000 af is reclaimed per year statewide. Both the total amount of wastewater discharged and the amount of wastewater being reclaimed continue to increase. Recent estimates of the percentage of wastewater recycled statewide range from 8 to 12%.

The California Water Code mandates municipal wastewater reclamation and reuse, also known by the term 'water recycling' in California. The Code states that no person or public agency shall use water suitable for potable domestic use for nonpotable uses, including, but not limited to, golf courses, cemeteries, highway landscaped areas, and industrial uses, if reclaimed water is available at reasonable cost and meets all of the conditions and quality standards set forth in the Code. The Office of Water Recycling at the California State Water Resources Control Board (SWRCB) continuously updates its database of reclaimed water usage statewide. Large water reclamation projects (>1,500 af/yr) use about 80% of the reclaimed water, said Lynn Johnson, Chief, Office of Water Recycling, SWRCB.

Microbial Considerations. Association of microbial-mediated illness from turfed areas irrigated with reclaimed water, such as golf courses, school playgrounds, parks, cemeteries, and freeway medians, is a *potential* health concern for persons employed in landscape irrigation, due to the risk of potential exposure to microbial pathogens via contact with plant surfaces wetted by reclaimed water and via exposure to pathogens in aerosols that result from spray irrigation, said Marylynn Yates, UCR Environmental Microbiologist and Groundwater Quality Specialist. The potential exposure risk extends to persons engaged in recreation on turf irrigated with reclaimed water, such as golfers and children, who may be in contact with plant surfaces irrigated with reclaimed water. Despite these potential risks, no cases of illness have been reported to date from such exposure, Yates said.

Quality Considerations. It is reasonable to exempt putting greens from specific requirements to use recycled water, said Robert Green, UCR Turfgrass Research Agronomist. Roughs and fairways may be able to handle unpredictable spikes in chlorine and other problem ions in recycled water, but putting greens cannot. Compromised water quality has too detrimental an effect on putting green turf quality, he said. Superintendents can lose their jobs over putting greens that are not up to par, even if compromised water quality is the precipitating cause, Green said. Putting greens comprise a small percentage (2-3 acres) of the entire turfed area on a golf course and are insignificant with respect to the quantity of water consumed.

Table 6. Reclaimed Water Usage in California By Sector

Category of Use	Percent	af/yr (Thousands)	Specific Types of Use
Agricultural Irrigation	48.3%	171	Food crops, sod farms, nurseries, fodder crops, fiber crops, seed crops, silviculture
Landscape Irrigation	16.1%	57	Golf courses, parks, playgrounds, school grounds, cemeteries, greenbelts, roadway rights-of-way
Groundwater Recharge	12.7%	45	Aquifer recharge, salt water intrusion control, ground subsidence control
Wildlife Habitat	6.5%	23	Wildlife habitat, miscellaneous enhancements
Recreational Impoundments	6.2%	22	Boating, fishing, duck hunting
Industrial Use	5.1%	18	Cooling, boiler feed, stack scrubbing, process water
Other	5.1%	18	Other/mixed applications

Source: Lynn Johnson, Chief, Office of Water Recycling, California SWRCB (personal communication), 2/99. Updates of these data, which were updated in 1/99, are intended to be put on the SWRCB website later this year.

WATER SUPPLY, *continued from page 4*

with projected demand (Table 2), it is evident that water planners forecast that demand in the MWD service area can be met in dry years without shortfall, if conservation BMPs are fully implemented and a resource mix of local and regional water supplies are fully developed.

Using historical averages over recent normal, wet, and dry years, the MWD quantified in its IRP recent supply sources totaling 3.9 maf annually: local ground-water basins and surface production have supplied 1.36 maf (34% of total supply) in the region; local water recycling and ground-water recovery have averaged 0.15 maf (4%); and imported water from the Los Angeles Aqueduct (LAA), Colorado River Aqueduct (CRA), and State Water Project (SWP) have averaged 2.39 maf (62%).

Methods To Increase Supply

Storage

Developing water storage for emergencies or seasonal and regulatory adjustments, or for carryover to prepare for drought reduces the potential for water shortages. Emergency storage is important because the region's imported water supply travels through three aqueducts that all cross the San Andreas fault. Seasonal or regulatory storage may be required to match monthly and weekly patterns of demand and supply (Table 2).

MWD's Eastside Reservoir Project near Hemet in Riverside County, to be completed this year, is strategically located for imported water storage and has a total design capacity of 0.8 maf. Together, the Eastside Reservoir and local groundwater basins can provide the region with about 2.3 maf of storage for emergencies and drought protection, based on storage modeling results.

Development

The water supply can increase from additional development of local ground-water and surface production, local water recycling and groundwater recovery projects, and imported supplies from the LAA, the CRA, and the SWP as well as voluntary transfers of entitlement water from the agricultural community, which can be conveyed from the Central Valley via the California Aqueduct for urban use in MWD's service area.

Incentives

Credits for conservation investments and water banking policies add incentive to increase supply. A proposal to use vacant capacity in Colorado River reservoirs for water banking would permit MWD and other Colorado River users to store water for later use and would provide incentives for investment in conservation programs.

Please see **WATER SUPPLY**, *page 6*

Water Recycling Criteria in California

California was the first state to adopt water reclamation and reuse standards to protect public health. Total coliform bacteria levels are used as disinfection performance standards in California. The total coliform limits and the treatment required depend on the type of nonpotable end use of the reclaimed water (Table 7). Irrigation of open-access landscape areas has stricter limits (2.2/100 mL) than irrigation of sod farms and restricted access golf courses (23/100 mL, Table 7). The complete current Recycling Criteria are available at *http://www.dhs.ca.gov/ps/ddwem/publications/lawbook.htm*

California's Water Recycling Criteria, which are currently being revised, were adopted in 1978 as wastewater reclamation criteria by the Department of Health Services (DHS), which has authority and responsibility under California law to establish health-related standards for water reclamation and reuse. The Water Code provides for 9 California Regional Water Quality Control Boards (RWQCB). Local health agencies have independent authority and may impose requirements more stringent than those specified by the California DHS or RWQCB. California and Florida have the most comprehensive reuse criteria based on a water's end use.

Table 7. California Treatment and Quality Criteria for Nonpotable Uses of Reclaimed Water

Types of Use	Total Coliform Limits[a]	Treatment Required
Irrigation of orchards[b], vineyards[b]; fodder, fiber, seed crops; food crops that undergo commercial pathogen-destroying processing; flushing sanitary sewers	No Limit Established	Secondary
Irrigation of landscape areas[c], sod farms/ornamental nursery stock; pasture for milking animals; cleaning roads; commercial cooling water (no mist created); nonstructural fire fighting	23/100 mL	Secondary + disinfection
Surface irrigation of food crops; restricted landscape impoundments	2.2/100 mL	Secondary + disinfection
Irrigation of food crops[d] and open access landscape areas[e]; toilet and urinal flushing; industrial process water; snow making; structural fire fighting; industrial cooling (mist created)	2.2/100 mL	Secondary + disinfection, coagulation[f], filtration[g]

[a]Based on running 7-day median. [b]No contact between reclaimed water and edible portion of crop. [c]Restricted-access golf courses, cemeteries, freeway landscaping, and other controlled-access landscaped areas. [d]Contact between reclaimed water and edible portion of crop; includes edible root crops. [e]Unrestricted-access golf courses, parks, playgrounds, schoolyards, residential landscaping, other uncontrolled-access landscaped areas. [f]Not required if the turbidity of the influent to the filters does not exceed 5 nephelometric turbidity units (NTU) more an 5% of the time. [g]Turbidity of filtered effluent cannot exceed a daily average of 2 NTU.

*Table 7 is adapted and modified from Crook, J. 1998. Water Reclamation and Reuse Criteria. In: T. Asano (ed.), **Wastewater Reclamation and Reuse** (Volume 10 of the Water Quality Management Library), Technomic Publishing Co., Inc, Lancaster, PA. Additional sources for Table 7: Bob Hultquist, P.E., Chief, Technical Operations Section, Drinking Water Program, California DHS (personal communication), 2/99; Draft Water Recycling Criteria, California DHS, 9/98.*

LANDSCAPE IRRIGATION, *continued from page 2*

where outdoor water demand is higher due to climate. If it is assumed that historical usage patterns, the number of residential dwellings, and the split between indoor:outdoor water use reported in the MWD's IRP are valid (Table 1), then these data could be used to calculate an estimate of total outdoor annual use in 1990 and in 2000 by the residential sector: Outdoor water use by single family and multifamily residences is estimated to have been 0.64 maf in 1990 and to be 0.72 maf next year, which means residential urban outdoor water demand in the region (primarily for landscape irrigation) exceeded agricultural sector demand in 1990 (0.40 maf, Table 2) by 60% and would be estimated to exceed agricultural sector demand next year (0.33 maf, Table 2) by more than 100%.

These comparisons point to urban growth and increasing urban demand for landscape irrigation water in Southern California, which differs from the statewide picture (Fig. 1). The results of the North American residential end use water study cited on page 2 indicate that estimates of regional outdoor water use based on the MWD's IRP may be low, since much higher water percentages were found to be used outdoors by single family homes.

WATER SUPPLY, *continued from page 5*

Precipitation and Runoff: Differences Between Southern California and the State

Average annual precipitation in the South Coast Hydrologic Region is 18.4 inches per year, 20% below the state average of 23 inches per year. On average, 75% of the state's annual precipitation falls between November and March; 50% of it usually occurs between December and February. About 65% of the state's precipitation is lost to ET. The remaining 35% (71 maf) comprises the state's average annual runoff, some of which is developed for urban and agricultural use, but much of which "maintains healthy ecosystems in California's rivers, estuarine systems, and wetlands," according to the DWR. In 1983, an El Nino year, the all-time highest annual runoff was recorded, 135 maf. The all-time annual low of 15 maf occurred in 1977. Average annual runoff in the South Coast Hydrologic Region is 1.2 maf, a small fraction of the statewide total.

Better Turf Thru Agronomics is prepared for the delegates and membership of the University of California, Riverside Turfgrass Research Advisory Committee (UCRTRAC). UCRTRAC provides a formal linkage between the University of California and the turfgrass industries in Southern California. Member organizations are the Southern California Golf Association; California Golf Course Superintendents Association (GCSA); GCSA of Southern California; San Diego GCSA; Hi-Lo Desert GCSA; California Sod Producers Association; Southern California Section, Professional Golfers Association; Southern California Turfgrass Council; Southern California Turfgrass Foundation; United States Golf Association; and UCR. The intent of the newsletter is to present summaries of turfgrass research results and topical information of interest to the Southern California turfgrass industries. When UCRTRAC was established in 1996, delegates identified 11 research and educational needs, including the need for unbiased, specific issue analysis reports and for accessible, user-friendly research and education reports; thus, this special edition of the newsletter about water issues was prepared to address these needs. The newsletter is written by Deborah Silva and edited by Dr. Vic Gibeault, UCR Cooperative Extension Environmental Horticulture Specialist, and Dr. Robert Green, UCR Turfgrass Research Agronomist, and designed by Jack Van Hise, UCR Printing and Reprographics.