

# **RESULTS, CHALLENGES, AND FUTURE APPROACHES TO CALIFORNIA'S MUNICIPAL WASTEWATER RECYCLING SURVEY**

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## **Introduction**

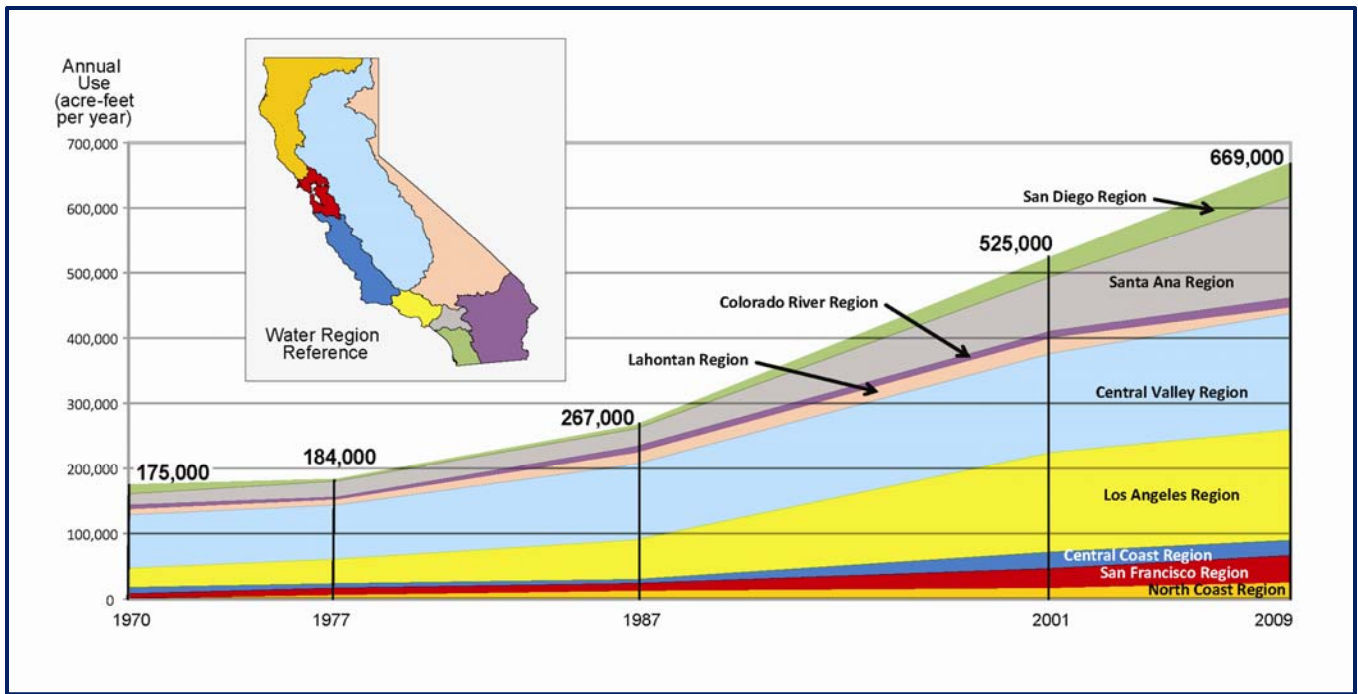
The 2009 Municipal Wastewater Recycling Survey (2009 Survey), recently completed by California's State Water Resources Control Board (State Water Board) and the California Department of Water Resources (DWR), indicates that the amount of municipal wastewater recycled for a beneficial use is increasing in most regions of the state (Figure 1). The 669,000 acre-feet of recycled municipal wastewater shown for 2009 in Figure 1 represents an increasing diversity in beneficial uses (Figure 2) and approximately 13 percent of the estimated 5 million acre-feet per year of treated municipal wastewater produced in California (DWR 2003), the most current available summary of California's total treated wastewater production.

## **Background**

Municipal wastewater has been reused in California since the late 1800s. In this drought-prone state's earliest recycled water applications, farms located near urban areas used effluent from municipal wastewater treatment plants. Anecdotally, farmers even gave cities easements for sewer mains in exchange for the right to pump untreated wastewater to irrigate their crops. As a result of public health concerns expressed as early as 1907, the first state health regulations governing reuse of municipal wastewater were adopted in 1918. By 1910, 35 sites were using recycled water for agriculture purposes. San Francisco's Golden Gate Park, which initially used raw sewage for irrigation water, later added a septic tank because of complaints from nearby residents. From 1932 to 1978, the McQueen Treatment Plant, the first documented California treatment facility dedicated to treating recycled water (RMC Water and Environment 2009), supplied recycled water in Golden Gate Park<sup>1</sup>. In 1952, 107 communities were using recycled water for agricultural and landscape irrigation in California. Following a national initiative to upgrade and improve the level of wastewater treatment in the 1970s, the diversity of recycled water uses has increased and now includes landscape, agricultural, and golf course irrigation; commercial and industrial applications; environmental enhancement; and groundwater recharge (Ongerth and Jopling 1977).

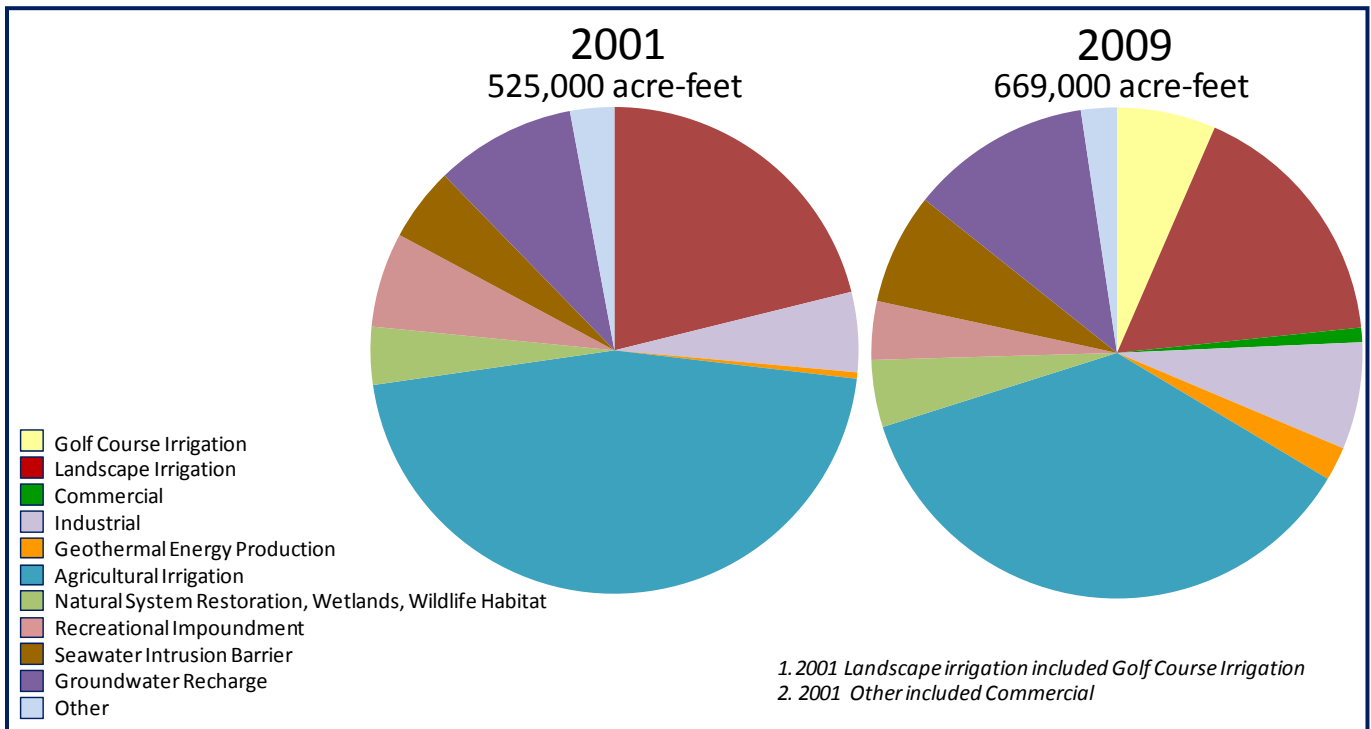
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<sup>1</sup> The plant subsequently was decommissioned. The San Francisco Public Utilities Commission is currently planning to construct a new facility to provide recycled water to Golden Gate Park again.



**Figure 1. Historic<sup>2,3</sup> Increase in Recycling of Municipal Wastewater by Regional Water Quality Control Board.**

Total municipal wastewater recycled for beneficial purposes for the major historic statewide surveys.



**Figure 2. Beneficial Use Comparison of the 2001 and 2009 Municipal Wastewater Recycling Survey Results.**

Changes in beneficial uses between the 2001 and 2009 surveys.

<sup>2</sup> The 2001 Municipal Wastewater Recycling Survey was not released in report form. For additional information on the findings of the 2001 Survey, please contact Daman Badyal at dbadyal@waterboards.ca.gov.

<sup>3</sup> The 1987 Survey report (State Water Board 1990) included the data from the earlier surveys.

Periodic surveys<sup>4</sup> of recycled water use have been conducted to support the statewide water resource planning and public health protection obligations of various state agencies. Surveys have been conducted in various years by the State Water Board, DWR, the California Department of Public Health (DPH), and the WaterReuse Foundation on behalf of the state. Statewide surveys conducted since 1970 have categorized and quantified the annual volume of recycled water beneficially used throughout the state.

### ***Recycled Water Definition***

“Recycled water” is defined in the Water Code as wastewater treated to a quality suitable for beneficial use. The Water Code definition does not designate the source of the wastewater. The 2009 Survey only included treated wastewater originating in whole or in part from a domestic source and directly used in a beneficial manner. Highly treated wastewater directly discharged to a water body for disposal was not included. Additionally, the term recycled water does not indicate a certain level of treatment, only the fact that it is wastewater that has been treated and beneficially reused. The motivation for a project is not a factor in this definition; beneficial reuse can occur in projects intended primarily to treat and dispose of wastewater or to meet water supply needs.

### ***System Definition***

When the 1987 Survey and earlier surveys were conducted, the majority of recycled water projects were implemented by a single agency, which distributed the water directly to retail customers. During the 2009 Survey, 8 percent of the systems summarized in Table 1 involved multiple agencies, but this group represented 44 percent of the total municipal wastewater recycling in the state. This interagency involvement could entail:

- One agency providing treated wastewater to another agency for treatment to recycled water standards appropriate to its planned end uses
- One agency producing the recycled water and another distributing it
- Multiple agencies involved in wholesaling or retailing water from a single treatment facility
- A wholesaler or retailer providing a higher level of treatment to a portion of its recycled water for higher-end uses

Furthermore, many agencies have recycled water capabilities at multiple plants. Therefore, in this paper, the term “system” refers to all of the physical facilities associated with a particular entry or line item in the survey. Each line item may represent multiple treatment plants, agencies, or conveyance components.

### ***Recycled Water Implementation and Regulation***

Recycled water projects are implemented and managed on a local or regional level, depending on the needs of the local water and wastewater agencies. They may be implemented by a single entity that generates and supplies its own recycled water either for use on its own property or directly to its own retail customers, or implemented by a regional or cooperative group developing a shared project to generate, wholesale, convey, or retail recycled water. Regional and cooperative projects are commonly planned, funded, and implemented through integrated regional water management (IRWM) planning processes.

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<sup>4</sup> Comprehensive surveys of municipal wastewater recycling were conducted in 1970, 1977, 1987, and 2001 and are referred to the 1970 Survey, etc. Partial updates were conducted in some interim years, but these data were generally not published.

Recycled water is regulated within California through permits issued by nine regional water quality control boards (regional water boards), which are branches of the State Water Board. Regional data for the 2009 Survey presented in this paper are summarized by the jurisdictional areas of the regional water boards. Additional contributions to regulating and managing recycled water in California are provided by DPH, which adopts uniform recycled water criteria for non-potable and potable recycled water projects and provides recommendations for recycled water project permits; and by DWR, which evaluates the use of and plans for potential future uses of recycled water through the preparation of the California Water Plan.

### ***2009 Survey Approach***

The 2009 Survey was conducted by contacting water and wastewater agencies by e-mail and direct phone calls. Responders provided their information by completing data forms online, by phone, or by e-mail. Information was collected about where recycled water was obtained, where it was distributed, and end uses. Agencies were very helpful when contacted and almost always provided the requested information in this voluntary survey.

This survey focused only on intentional direct reuse — where recycled water was delivered directly to customers for non-potable reuse or for planned indirect potable reuse by seawater intrusion barriers or groundwater recharge basins.

In cases where a recycled water system involved multiple agencies in the supply, treatment, distribution, or wholesale or retail sale of recycled water, every effort was made to avoid duplication. In-plant use at a wastewater treatment plant, such as for wash-down and other uses, was considered part of treatment plant operations and was not counted as recycled water.

An important distinction made during collection of the survey data was disposal versus recycling. Every wastewater facility in California treats its wastewater to the requirements established by each facility's permits and then either discharges its treated wastewater or provides it as recycled water for a use appropriate to its treatment. Whether the water is considered recycled or disposed (or both) is based on whether the treated wastewater supports a beneficial purpose. Although recycled water is currently promoted as a water supply, reuse of effluent historically has been a cost-effective means of disposal. Often, application of effluent onto land is intended mainly as a means of disposal, even though there are beneficial uses occurring, such as pasturing of animals or harvesting hay crops. Effluent for disposal meets the conditions of "recycled water" if the wastewater is treated and beneficially reused. The 2009 Survey included projects nominally classified as disposal if reuse was directly occurring. This is distinguished from wastewater disposal that does not include a direct benefit, such as putting the treated wastewater into disposal ponds that are not permitted for groundwater recharge, releasing it into an adjacent river, or dispersing it onto a spray field without any crop harvest or pasturing. If the treated water was considered to be disposed without direct benefit from the disposal, then it was not included in the survey. During completion of the 2009 Survey, this distinction was often misunderstood by survey respondents and was a key challenge.

There can be post-disposal benefits resulting from release of treated wastewater into the environment. In some cases, agencies indicated that downstream users reused their water or that the groundwater basin was recharged by the stream or disposal ponds. Because these beneficial uses were incidental after the discharge or disposal of the effluent, they were not included in the survey, although it is acknowledged that they may be indirect benefits.

### ***California Code of Regulations Title 22***

Title 22<sup>5</sup> of the California Code of Regulations, which contains standards and uses for recycled water from a municipal source, identifies multiple levels of recycled wastewater treatment and appropriate uses for each treatment level. For each beneficial use category in the survey, all levels of Title 22 wastewater recycling were included but were not differentiated. For example, agricultural irrigation can occur with undisinfected secondary water for certain types of crops (fodder crops, non-food-bearing trees, sod farms, etc.), disinfected secondary water<sup>6</sup> (crops where the edible portion is above ground and does not contact the recycled water, pasture for animals producing milk, etc.), or tertiary level recycled water (food crops where the recycled water comes into contact with the edible portion of a food crop eaten raw). Each of these recycled water treatment levels and uses were grouped together as “agricultural irrigation.”

## **Discussion of 2009 Survey Findings**

Recycling of municipal wastewater occurs throughout California (Figure 3). Only seven of the state’s 58 counties do not have identified recycling. In general, the highest countywide volumes of recycled water occur in parts of the state where local water resources are strained, population densities are high, or wastewater disposal is problematic.

### ***Extent of Use***

Table 1 summarizes by region and beneficial use the 210 recycling systems identified in the 2009 Survey<sup>7</sup>. The systems ranged in annual volume from less than 50 acre-feet to more than 86,000 acre-feet in 2009. This shows that California agencies and communities are able to implement effective recycling systems at all size ranges. More than 70 additional municipalities and agencies are involved in these systems and are identified on the State Water Board website.

Of the 210 systems, 15 produced and beneficially reused more than 10,000 acre-feet each in 2009. These 15 systems cumulatively produced 447,000 acre-feet, or two-thirds of the 2009 Survey total of 669,000 acre-feet. The 195 systems with a 2009 production of less than 10,000 acre-feet each demonstrate that small projects are implementable and that there is extensive opportunity for expanding recycled water use with better integration into statewide water management.

The majority of the state’s recycled water use is in Southern California. Sixty percent of the state’s recycling occurs south of the Tehachapi Mountains, which is consistent with the proportion of overall statewide water use. Considering the Sacramento-San Joaquin River Delta and the effort for water users within and south of the Delta to reduce dependency on water supplies conveyed through the Delta, 92 percent of the state’s use of recycled water occurs within and south of the Delta.

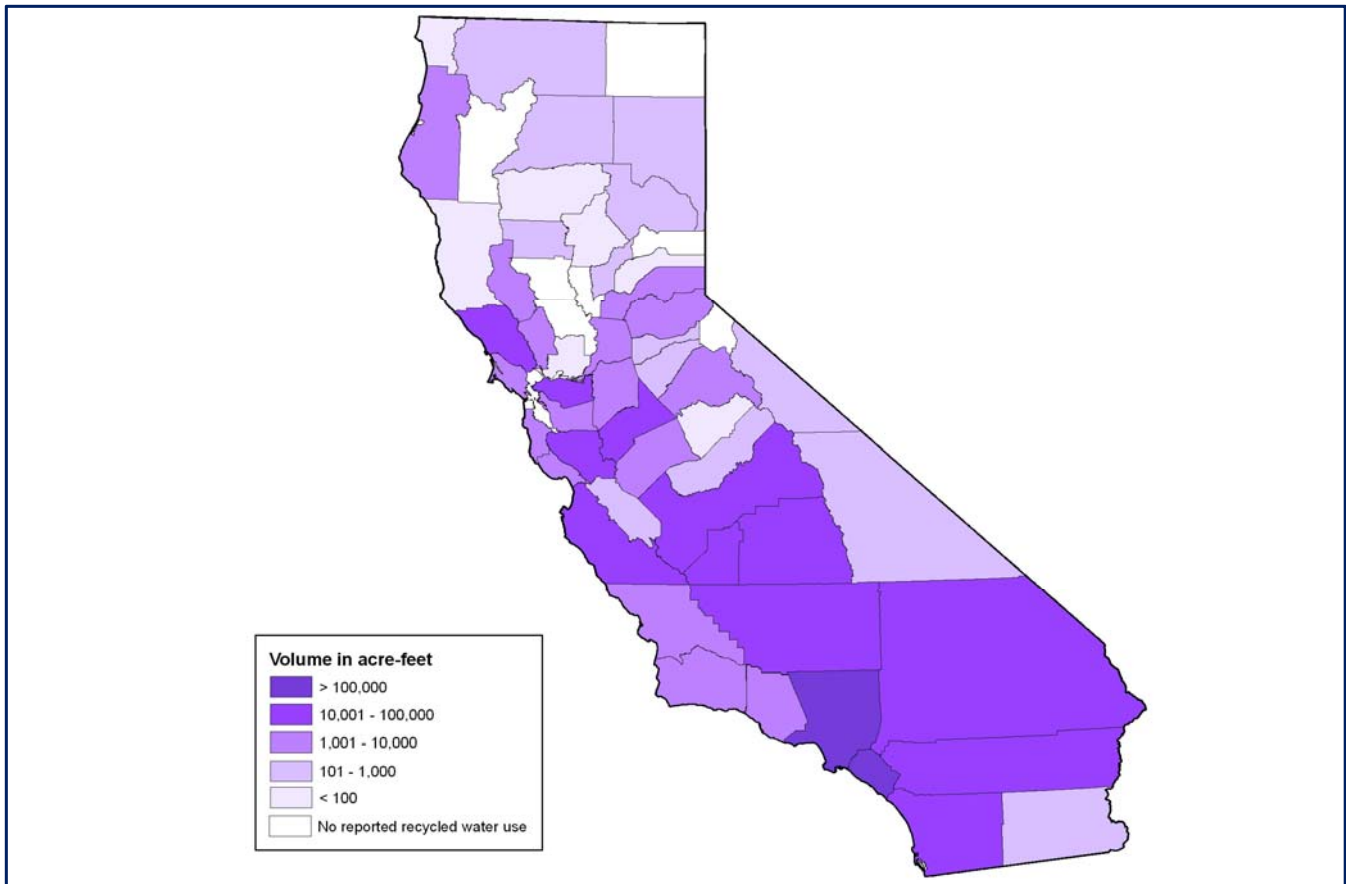
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<sup>5</sup> The California regulations that contain the criteria for the levels of treatment and the appropriate uses for recycled water (California Code of Regulations Title 22, sections 60301-60355). The regulations cover secondary, tertiary, and advanced treatment levels.

<sup>6</sup> Water that meets either the 2.2 or 23 coliform per 100 milliliters bacteriological results, as specified in California Code of Regulations Title 22, sections 60301.220 and 60301.225.

<sup>7</sup> The full listing of the 210 systems is on the State Water Board website at:

[http://www.waterboards.ca.gov/water\\_issues/programs/grants\\_loans/water\\_recycling/munirec.shtml](http://www.waterboards.ca.gov/water_issues/programs/grants_loans/water_recycling/munirec.shtml).



**Figure 3. Total 2009 Recycled Water by County.**  
Units in acre-feet per year.

***Agricultural versus Urban Uses***

Recycled water beneficial uses vary considerably around the state (Figure 4, Table 1). In the Central Valley, 85 percent of the recycled water used is for agricultural irrigation. Most of this use occurs in the San Joaquin Valley, where wastewater disposal can be a challenge and water resources limited because of groundwater overdraft or delivery constraints from Delta flow restrictions. Lower-quality wastewater (secondary treatment) can be a more reliable water source than groundwater or surface water and, in some cases, can reduce crop fertilizer needs. Recycled water can also be conveyed cost-effectively by existing irrigation canals. Outside the Central Valley, agricultural reuse accounts for only 20 percent of recycled water.

The component of recycled water as a percent of urban water use also varies throughout the state, as evaluated by region (Table 2). The percentage of urban recycling<sup>8</sup> within total urban use ranges from 1 percent in the Central Coast and Central Valley regions to 7 percent in the urban South Coast region (Ventura to San Diego counties — the Los Angeles, Santa Ana, and San Diego regional boards shown in Figure 4).

<sup>8</sup> Urban recycling for this report is defined as total recycled water minus agricultural irrigation and geothermal use.

**Table 1. 2009 Recycled Water Beneficial Uses by Region.**

Range of Project Size: # of Systems <sup>a</sup> :	Regional Water Board									Beneficial Use Total
	1	2	3	4	5	6	7	8	9	
	12 - 19,077	11 - 10,702	11 - 11,814	23 - 86,185	9 - 34,497	10 - 4,803	172 - 7,565	<50 - 67,613	41 - 13,102	
	14	33	20	16 <sup>b</sup>	82	13	6	10	25	
Beneficial Use										
Golf Course Irrigation	564	6,062	2,133	8,062	3,750	856	10,088	5,754	6,363	43,632
Landscape Irrigation	632	9,210	2,262	25,622	3,143	7,043	1,636	29,391	33,611	112,550
Agricultural irrigation	8,675	5,387	18,598	18,169	150,735	1,892	1,627	35,826	3,613	244,522
Commerical	0	114	0	5,310	654	0	0	291	13	6,382
Industrial	0	8,658	265	25,672	9,296	0	0	2,721	525	47,137
Geothermal Energy Production	12,665	0	0	0	2,274	0	0	0	0	14,939
Seawater Intrusion Barrier	0	0	0	11,003	0	0	0	37,749	280	49,032
Groundwater Recharge	0	0	0	42,626	5,134	0	0	31,954	0	79,714
Recreational Impoundment	0	0	0	19,920	0	0	420	5,498	0	25,838
Natural Systems/Restoration	2,045	9,025	0	12,320	1,278	0	172	4,546	236	29,622
Surface Water Augmentation	0	0	0	0	0	0	0	0	0	0
Indirect Potable Resuse	0	0	0	0	0	0	0	0	0	0
Other	1,191	2,563	17	937	1,591	19	147	2,013	7,311	15,789
<b>Regional Water Board Total:</b>	<b>25,772</b>	<b>41,019</b>	<b>23,275</b>	<b>169,641</b>	<b>177,855</b>	<b>9,810</b>	<b>14,090</b>	<b>155,743</b>	<b>51,952</b>	<b>669,157</b>

<sup>a</sup>The total number of systems is greater than 210, because the California State Prisons were split to include the total of each facility within the appropriate county and Regional Water Board.

<sup>b</sup>This number considers the City of Los Angeles and the County Sanitation Districts of Los Angeles County recycled water systems each as one system.

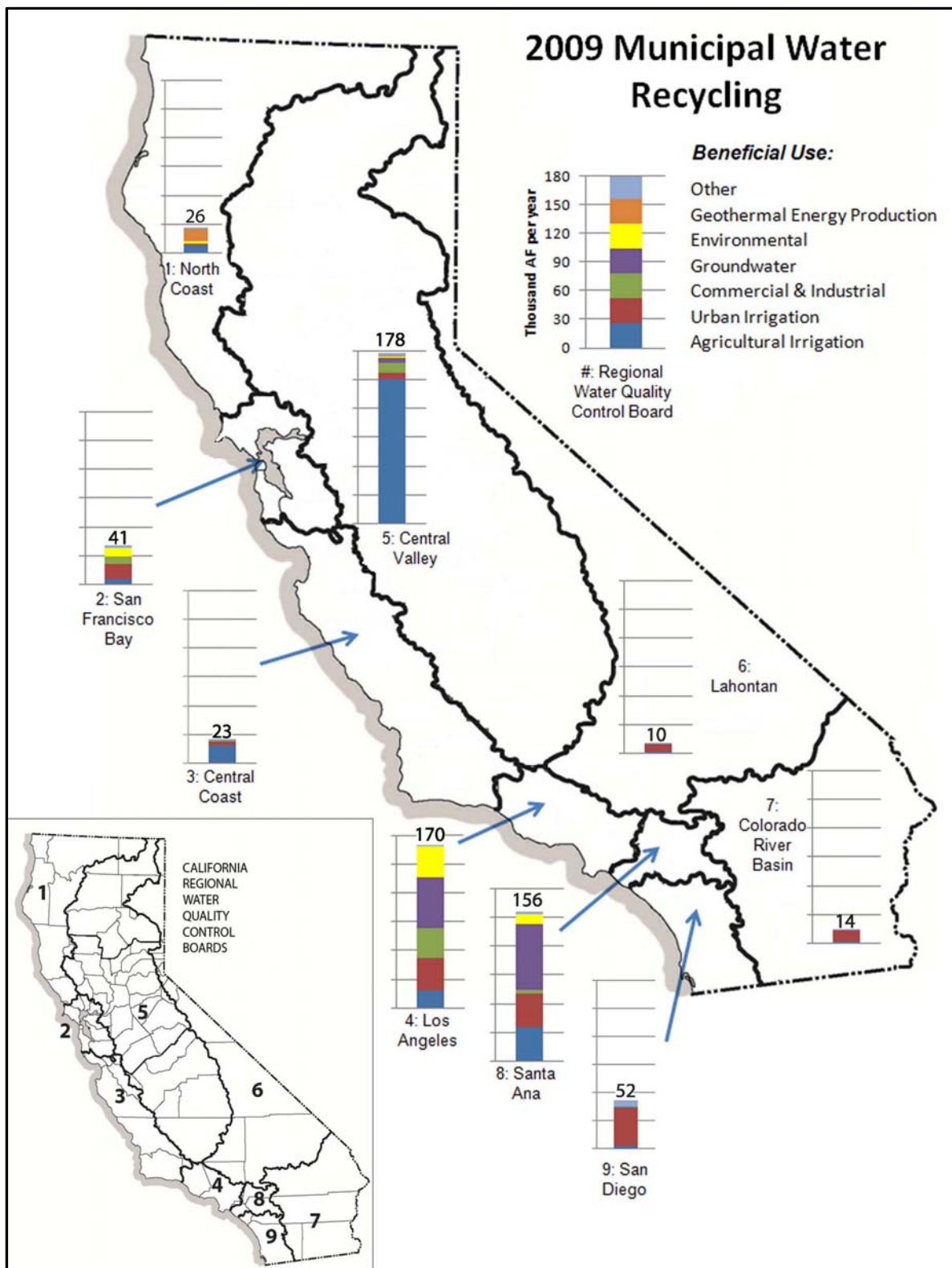
*Units are in acre-feet*

**Table 2. 2009 Recycled Water by Region as a Percentage of Urban Water Use**

Regional Water Board	Total Urban Water Use <sup>a</sup> <i>1,000 acre-feet</i>	2009 Total Recycled Water <i>1,000 acre-feet</i>	2009 Urban Recycled Water <sup>a,b</sup> <i>1,000 acre-feet</i>	Non-Agricultural Recycled Water to Total Urban Water <i>percent</i>
North Coast	161	26	4	3
San Francisco Bay	1,134	41	36	3
Central Coast	313	23	5	1
Los Angeles, Santa Ana, San Diego	4,532	377	320	7
Central Valley	2,469	178	25	1
Lahontan	358	10	8	2
Colorado River	795	14	12	2

<sup>a</sup> Urban water use based on GEI Consultants/Navigant Consulting, Inc. (2010), projected from historic California Water Plan estimates.

<sup>b</sup> Total 2009 recycled water use, less agricultural irrigation and geothermal use.



**Figure 4. Regional Variation of Recycled Water Volume and Beneficial Uses in 2009.**

Breakdown of recycled water within the area of each regional water board. The groundwater category includes groundwater recharge and seawater intrusion, the urban irrigation category includes landscape and golf course irrigation, and the environmental category includes natural systems and restoration plus recreational impoundments. Units are thousands of acre-feet per year.

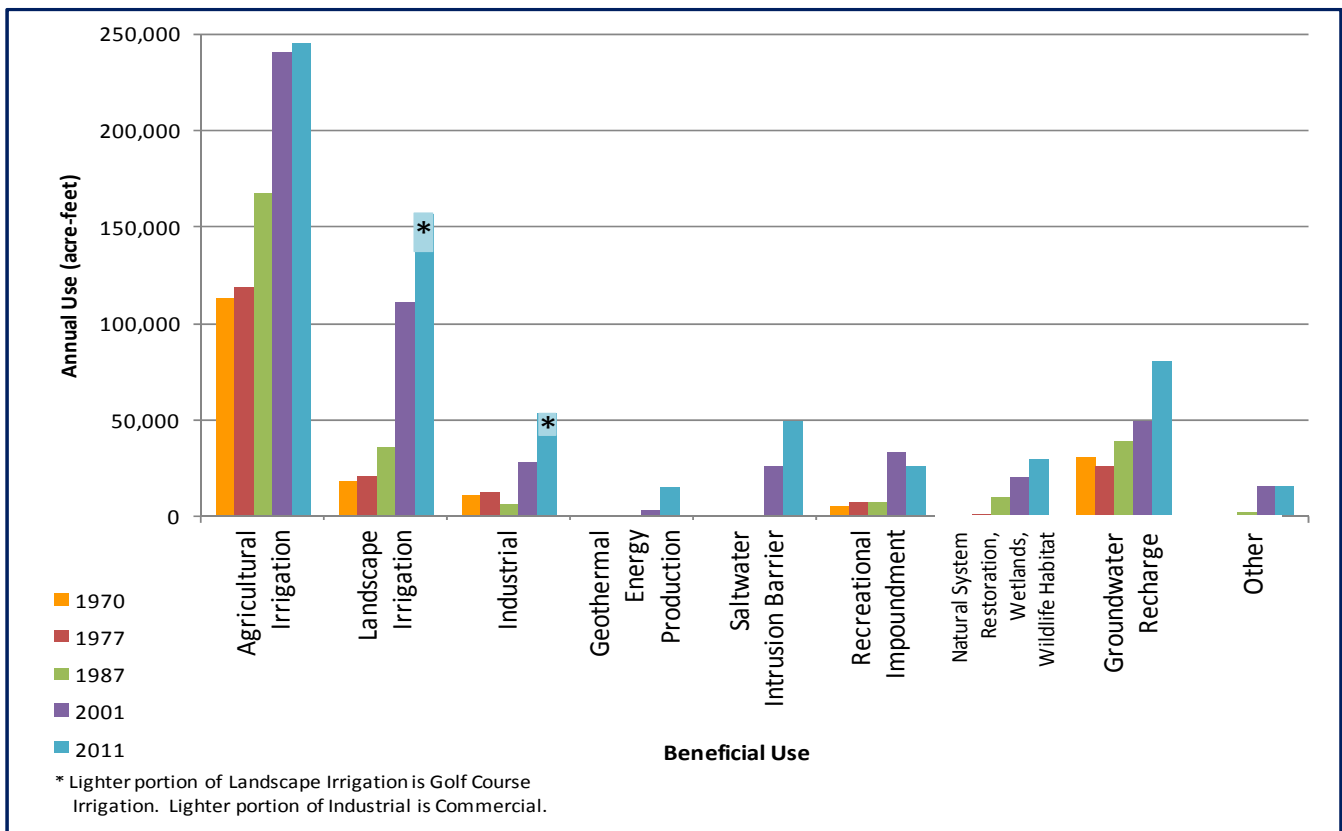


In urban parts of Southern California and the San Francisco Bay area, recycled water uses are more diverse and more commonly replace non-potable demands that had formerly used potable water, when compared with agricultural areas. Primary urban uses are urban irrigation and environmental enhancement, as well as groundwater recharge to supplement local groundwater resources and to reduce seawater intrusion. In urbanized areas, infrastructure costs are higher than for agricultural applications because of conveyance constraints, and recycled water is usually treated to higher levels because of Title 22 requirements for planned uses, the potential for human contact, and other water quality concerns. The inland regions of Southern California are also investing in regional conveyance for disposal of the non-recoverable, high-salinity wastes, which include brine byproducts from recycling and brackish groundwater treatment facilities.

As indicated earlier, the diversity of beneficial uses of recycled water has increased since the first quantitative survey of recycled water uses was conducted in 1970. Figure 5 shows these beneficial use changes. Over time, all types of beneficial uses have increased, and new uses have been identified — most prominently geothermal reuse and natural systems restoration/wetlands/wildlife habitat.

**Discontinued Recyclers**

Overall, more agencies were involved in recycling municipal wastewater in the 2009 Survey than in the previous survey conducted in 2001. However, 22 agencies have discontinued recycling during the same period. These agencies had recycled a total of about 7,000 acre-feet in 2001. The 2009 Survey did not attempt to identify why agencies had discontinued the practice, but this is planned to be evaluated further in 2012.



**Figure 5. Recycled Water Statewide Beneficial Use Changes Since 1970.**  
Units in acre-feet.

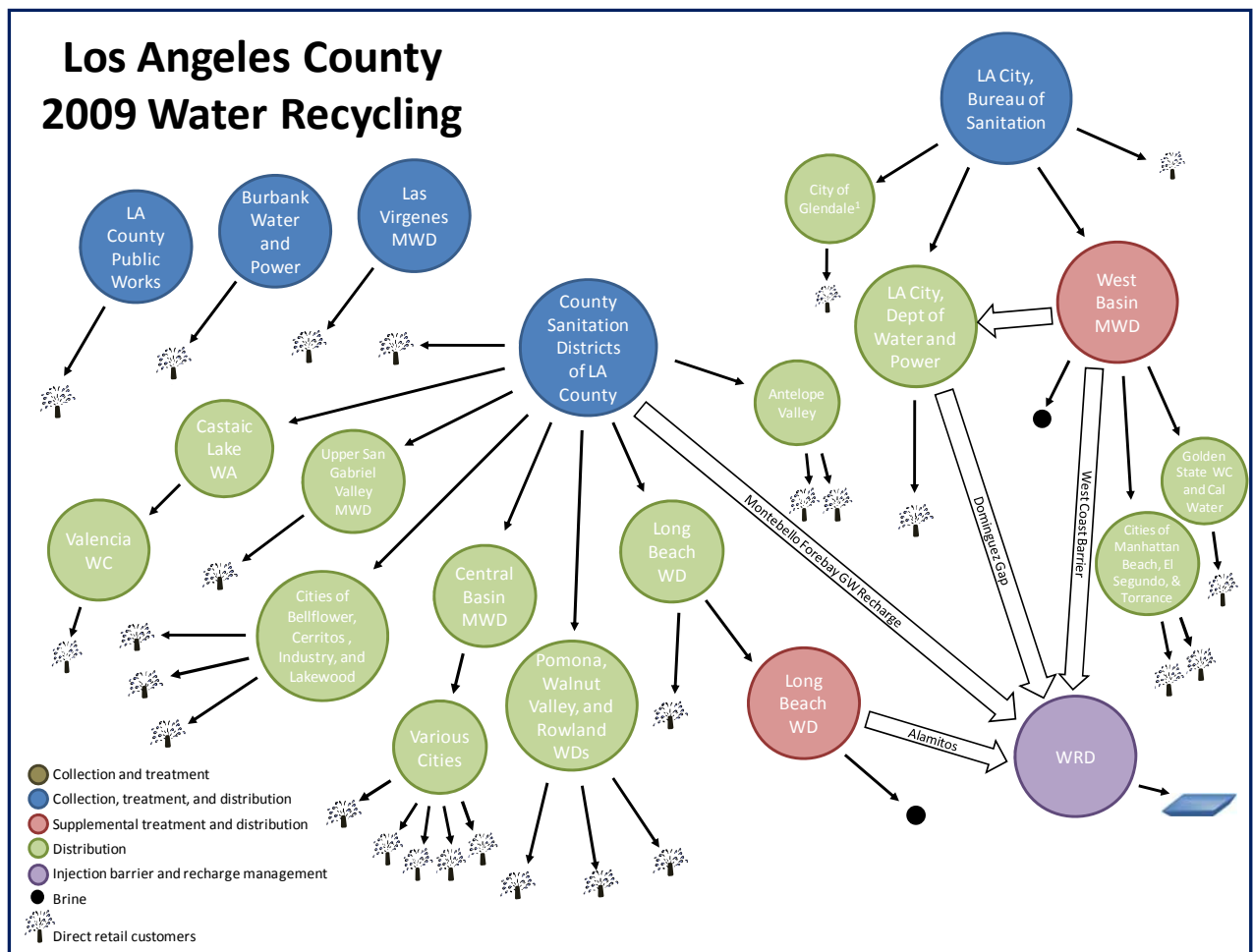
## Survey Challenges

Challenges identified during the 2009 Municipal Wastewater Recycling Survey included obtaining information from the involved agencies, not duplicating data, and assigning the water to an appropriate agency. The first challenge is common to most surveys and will not be addressed further in this paper. The second two issues stem from the increasing complexity in how recycled water is generated, conveyed, and managed in California. As more urban and cooperative projects have been implemented, particularly since the 1987 survey, this issue has become more challenging. Because more projects being implemented now are cooperative, this will continue to be an issue and will be reassessed before the next survey is completed to determine the best way to collect and report data.

Further complicating data collection for periodic water recycling surveys are the current permitting and reporting requirements of wastewater agencies. Several different types of permits are used by wastewater agencies and recyclers, depending upon the specific needs of the agency. Required reporting by most permit holders is not done electronically, and uniform formatting or parameters reported are not required. Therefore, data compilation under the current structure is labor-intensive and challenging.

The complexity of how interagency recycled water systems were implemented (see “System Definition,” above) resulted in challenges sorting through the reports from multiple agencies and often resulted in multiple agencies reporting the same water. In one case, three agencies were identified as reporting the same volume of water. Additionally, when multiple agencies were involved, the numbers reported were not always consistent.

Because of the potential for duplication, both the State Water Board and DWR were careful to sort out the relationships to provide greater confidence in the value reported for the 2009 Survey. An example of the complexity and challenges associated with tracking and accurately reporting recycled water is shown in the schematic representation of Los Angeles County recycled water management (Figure 6). In Los Angeles County, there are five agencies treating municipal wastewater for reuse. Three agencies, Las Virgenes Municipal Water District, Burbank Water and Power, and the Los Angeles County Department of Public Works, independently treat and deliver recycled water to their users. The majority of the recycled water in the county is generated by two agencies with multiple treatment facilities, County Sanitation Districts of Los Angeles County (10 facilities plus Long Beach Water Department) and the City of Los Angeles (four facilities plus West Basin Municipal Water District). Recycled water from these two large generators is provided directly to retail customers, as well as cities and wholesalers, as shown in Figure 6. In addition, there are two supplemental treatment facilities (operated by West Basin Municipal Water District and Long Beach Water Department) that operate within the overarching organization. Because of the complexity of recycled water treatment and distribution, recycled water was reported in the 2009 Survey by the top tier agencies (shown in blue in Figure 6).



**Figure 6. Generation and Distribution of Recycled Water in 2009 within Los Angeles County.**

### Potential Future Survey Approaches

The State Water Board currently has existing authority to require a uniform reporting system for recycled water in California. It would like to identify an existing reporting structure to use to minimize disruption to the state’s water and wastewater purveyors.

Several options are being considered for the next statewide survey. These include:

- Aligning the next comprehensive survey with the 2015 Urban Water Management Plan update to coordinate data collection and reporting functions
- Conducting future interim survey updates in a phased approach to help maintain institutional knowledge with reduced staff resources
- Continuing to collaborate with WateReuse Association, DWR, and the wastewater community to refine a process on survey development and implementation
- Targeting producers for recycled water data for future surveys
- Utilizing a Web-accessible database
- Prescribing the standardized reporting that regional water boards should require permittees to provide

## References

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The State Water Resources Control Board and the California Department of Water Resources would like to express sincere appreciation to each of the water agencies that voluntarily provided their 2009 recycled water information for this survey.