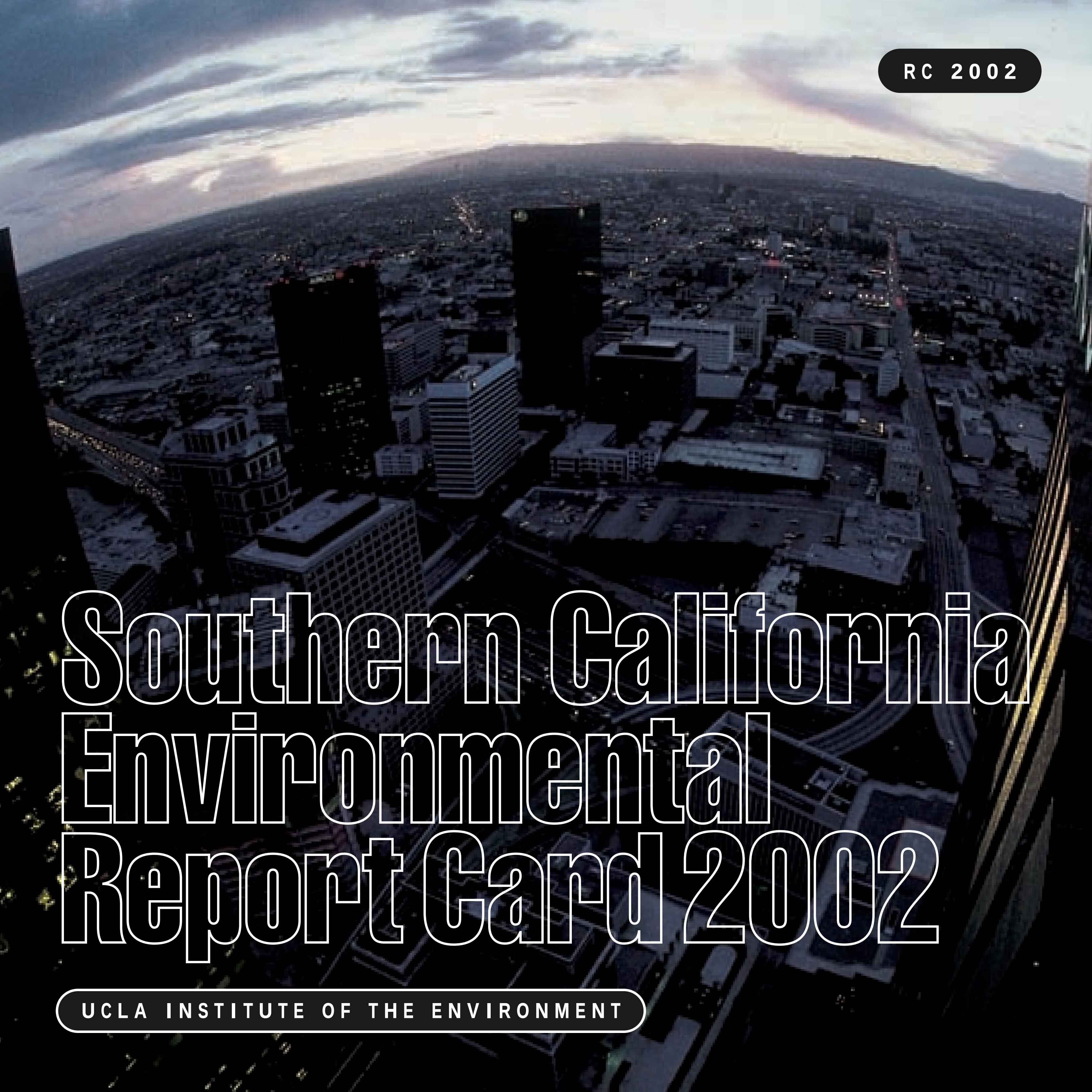

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Southern California Environmental Report Card 2002

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GRADES A to D

Water Reclamation

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INTRODUCTION

Previous editions of the Southern California Environmental Report Card discussed various aspects of Southern California's water. RC 1998 and RC 1999 discussed wastewater treatment and stormwater management. RC 2000 described our drinking water supply. We reported generally favorable grades for these activities, although there were some negative findings with respect to the time it has taken to comply with the 1972 amendments to the Clean Water Act. The present report discusses water reclamation, which completes the cycle between wastewater or stormwater and water supply. This article relies on information presented in the earlier Report Cards.

Southern California receives its water from several sources. We are lucky that visionary pioneers developed the systems to transport water from the Colorado River, the Sierras and northern California. The presence of these water supplies enabled growth and created the California we live in. All major California cities except Sacramento depend on imported water. The sparse 15 inch yearly average rainfall is insufficient to meet Los Angeles' needs, and water must be brought to the region from far away places. You may have heard that Los Angeles would be a desert without these water supplies. This is true not only for Los Angeles but also for Fresno, San Diego, San Francisco, and San Jose; we would not have large coastal cities in California without imported water. This situation is not unique to California, and many other American cities rely upon imported water. What is different about California is the extensive reliance on imported water to support the majority of the population, which prefers to live along the coast.

Unfortunately, Southern California is gradually losing its imported water supplies. The demand for water in other locations, along with environmental needs, are reducing our imported water supplies. The most significant example is the loss of a large portion of the Colorado River. California lost its case in the US Supreme Court, and Arizona was awarded its share of the Colorado River—water we have previously used. More recently the City of Los Angeles lost additional supplies to preserve Mono Lake and other areas in the Sierras. California cities can expect continued decline of imported water supplies.

In order to meet the challenges, new sources must be found. Unfortunately there are no rivers left to dam and even if there were, our enlightened environmental polices would allow us to do so only in rare instances. Agriculture still uses 85% of the fresh water in California. Water transfers from agricultural users to municipal users are possible and a good source of water, but transfers take planning and a long time to affect. Agricultural lands must be purchased and taken out of service, which many farmers and corporations are loath to do.

Technologies such as saline water conversion are possible, but only at great expense and extensive energy consumption. Conservation should be viewed as a new water source, but has only limited potential. Water reclamation—reusing wastewaters—is an important source, and can potentially provide new supplies equal to approximately 50% of our water consumption.

Water reclamation is already happening in California and several of our agencies have made important progress. However much more can be done. This article describes current reclamation practice, some of the technologies that exist, and how we must better utilize these technologies to meet our future water needs.

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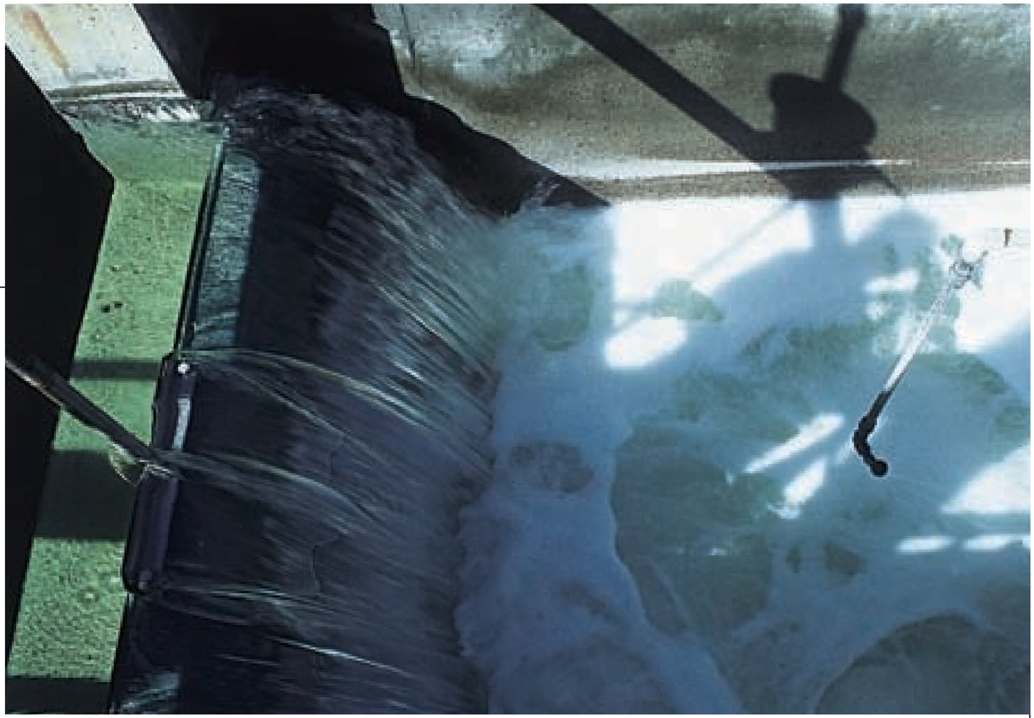

Reclaimed water flowing over a weir in a treatment plant.

TOILET-TO-TAP

"Flush twice, LA needs the water." This was a statement made by a Department of Water Resources Director in a keynote address in California in 1979. Our water supplies originate in many places and some of those places are wastewater treatment plants, whether we like it or not. State project and Colorado River waters receive the treated wastewaters from hundreds of treatment plants. Just where do the treated wastewaters from Denver and Sacramento go? They are discharged into rivers that make up our drinking water supplies.

We occasionally read a headline "Toilet-to-Tap" and are amazed that such a concept would even be proposed. Even in the recent Los Angeles mayoral race, one candidate solicited votes by opposing one of Los Angeles' planned reclamation programs. An informed view of water reclamation programs shows that nothing is farther from the truth than "Toilet-to-Tap."

Figure 1 shows our existing situation, where a wastewater treatment plant discharges treated wastewaters into a river or lake that supplies drinking water for downstream users. A good example is the Sacramento Regional Wastewater Treatment Plant. This plant is about 1/3 the size of the City of Los Angeles' Hyperion treatment plant, and uses similar technology. Fortunately there is lots of dilution as it flows south, but some of the Sacramento discharge makes it to our drinking water treatment plants. Drinking water treatment plants provide treatment, including disinfection, before the water is supplied to users (see RC 1998 and 2000 for a description of the plants). Whether we like it or not, we are already using reclaimed waters as part of our drinking supply.

RECLAMATION TECHNOLOGIES

Water reclamation takes many forms, but all use wastewaters for another purpose. A common example is "gray water." Gray waters are wastewaters from clothes washing and showers, which can be reused to flush toilets or to water lawns. In this way, high quality potable water is reserved for applications requiring high quality; low quality water is used for other applications, and a net reduction in water use is obtained.

Another example is using treated wastewaters for irrigation or industry. In many areas of California, freeways and golf courses are watered with treated wastewaters. Oil refineries and other industries can often use treated wastewaters within their processes (some industries, such as semi-conductor manufacturing, require water purity far greater than drinking water). The Los

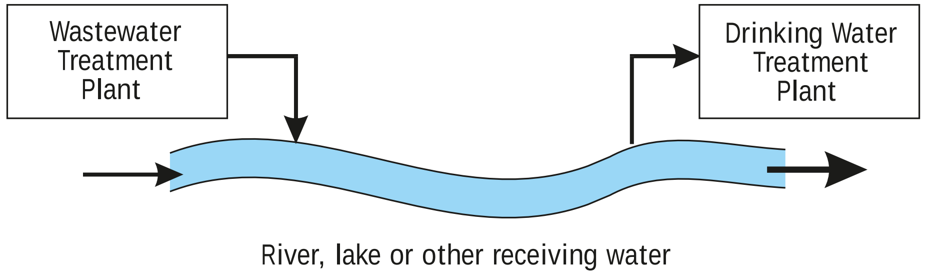

Figure 1. Relationship between water and wastewater treatment plants.

"Flush twice, LA needs the water."

Angeles County Sanitation Districts and its predecessors began reclaiming wastewaters in this way in 1927. California developed rules to govern this type of reclamation in 1978, generally called "Title 22" waters, in reference to the rule number in the administrative code. Title 22 waters can be easily produced by modern wastewater treatment plants, such as the "inland plants" described in RC 1998. A well-designed secondary treatment plant with final filtration and disinfection can produce Title 22 waters

More advanced reclamation techniques produce higher quality water and in some cases these waters are potable. Figure 2 shows technologies called "indirect potable" reclamation. Treated wastewaters are further purified by advanced treatment and are discharged to a reservoir (top) or aquifer (bottom). The reclaimed water has a residence time of one or more years. During this time any remaining bacteria or viruses decay. Indirect potable reclamation has been practiced in California for almost 40 years. Epidemiological studies have found no evidence of any harmful effects.

Indirect potable reclamation is one method for meeting part of our future water needs. Orange County Water District's Water Factory 21 has practiced indirect potable reclamation for more than 20 years, using the direct injection method of Figure 2. Advanced reclamation treatment plants provide treatment far in excess of the treatment provided by water treatment plants.

The heart of indirect potable reclamation is a process called reverse osmosis (RO). Reverse osmosis uses semi-permeable membranes that pass water molecules but reject most other elements and compounds, generally in relation to their size. Large molecules, such as pesticides, are rejected more efficiently. Bacteria, viruses, and protozoan pathogens such as Giardia are 100% rejected based upon their size differences. A size analogy is useful; if a water molecule were represented by a golf ball, a virus diameter would be as large as the combined length of the two longest golf clubs, and a bacteria would be larger in diameter than the length of Tiger Woods' best tee shot.

Figure 3 shows an example of a water reclamation pilot plant. This plant was used to demonstrate the technical feasibility of indirect potable reclamation at Lake Arrowhead (Arrowhead bottled waters are unrelated to Lake Arrowhead). The small

Pressure tubes that hold reverse osmosis membranes at a water reclamation plant.

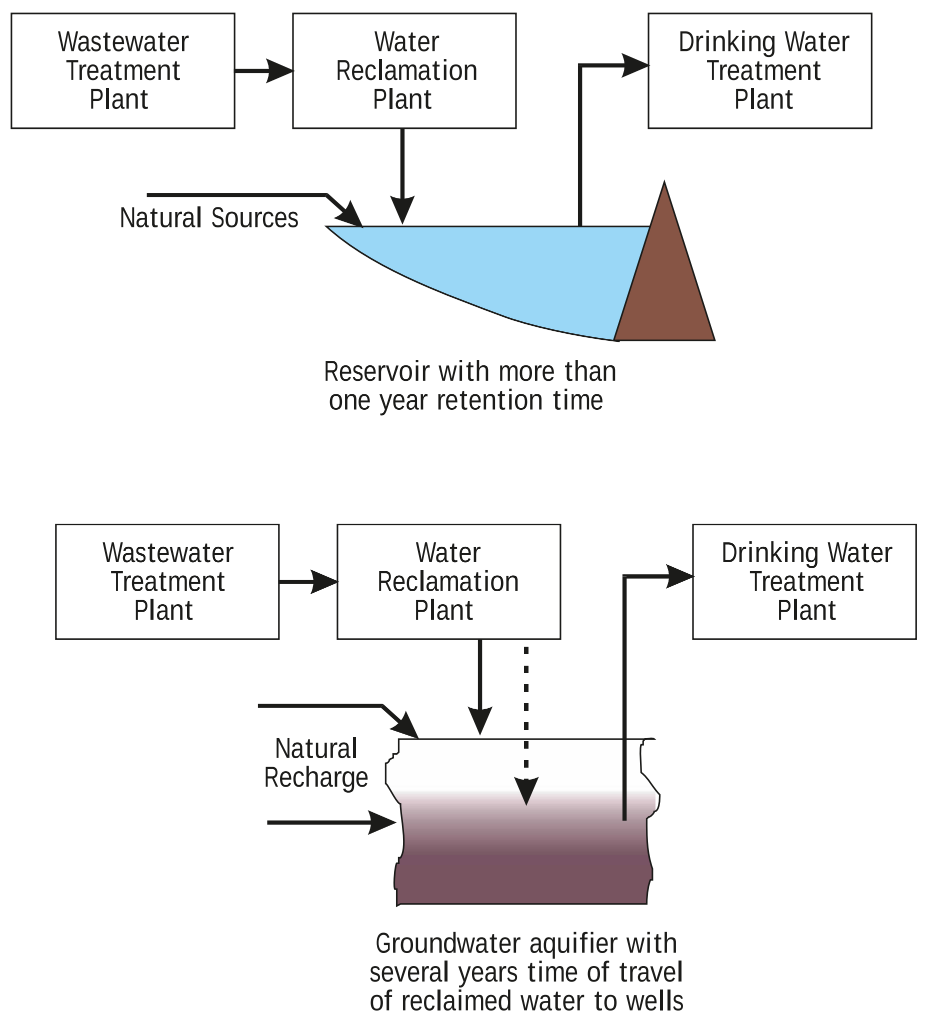

Figure 2. Two examples of indirect potable water reclamation using a drinking water reservoir (top figure) or groundwater aquifer (bottom figure). When using a ground water aquifer, reclaimed water can percolate through the soil, or be can be directly injected (dashed line).

mountain community has no water supply other than the Lake, which is inadequate to meet water needs in drought years. Lake water quality is exceptional, and the treatment goals were much more ambitious than drinking water standards. In many cases the water quality needed to protect the Lake is 10 to 100 times more stringent than drinking water standards. Figure 3 shows the concept of multiple barriers. If one process fails, either due to technology failure or human error, a second process provides the needed treatment. The most redundancy is provided for pathogen control. Pathogens are inactivated by the first and second stage ozonation, and both membrane processes also remove them. Similar multiple barriers exist for other contaminants. Lake Arrowhead has not constructed any reclamation facilities and the end of the 1985-91 drought reduced their incentive.

BARRIERS

There are barriers to water reclamation. Technology barriers are less formidable than before, but still exist. Often the cost of reclaimed water is greater than fresh water. This occurs because reclamation facilities need to be constructed, while existing water supplies and treatment systems have been amortized over the past 30 years. Fresh water prices are sometimes controlled, and in some cases, much of the cost is paid in indirect ways, such as tax incentives. A simple concept such as parallel pipe lines to transport fresh and reclaimed waters seems to be an obvious alternative but in practice has limited application. It is more expensive than the other alternatives, and finds application only

Table 1: Percentage of Respondents Who Would Use Reclaimed Water (N=501)

Type of Water Use	Percentage Who Would Find Reclaimed Water Acceptable
Median Strips	91%
Watering Lawn	89%
Washing Your Car	85%
Washing Clothes	57%
Washing Dishes	40%
Showering and Bathing	38%
Cooking	25%
Drinking	18%

Southern California is gradually losing its imported water supplies.

for high volume users, such as industries. There is also an inherit danger; it is easy to inadvertently connect the two systems together, so that reclaimed water flows into the potable system. These accidents already occur with existing sewer pipes, and are known as cross connections. They are one of the leading causes in the United States of water born diseases. Parallel distribution systems have some important applications, and our local agencies have built several. Freeway medians and shoulders are good candidates for a dedicated reclaimed water distribution system.

PUBLIC ACCEPTANCE

The greatest barrier to water reclamation is public perception and acceptance. In a recent survey of Los Angeles Area home owners (See Berk, RC2000), a question was asked about the potential acceptance of reclaimed water: "*Technology now exists to make reclaimed water at least a pure as regular water from the tap. If reclaimed water this pure were available at the same price as water from the tap, would you use it for...*". As can be seen in Table 1, the percentage that say they would use reclaimed water varies from a high of 91% (for watering median strips) to a low of 18% (for drinking). Clearly, acceptance depends on use. There is widespread acceptance of reclaimed water for outdoor use. For use in the home, a majority would find reclaimed water acceptable for washing clothes, but that majority disappears for use in washing dishes, showering and bathing, and as drinking water.

One might infer that there are health-related concerns despite the wording of the question, which stated that the reclaimed water would be as pure as tap water. Of course, some of the respondents might not choose to use tap water for cooking or drinking either (See RC 2000 for information on the quality of tap water). Still in absolute terms, the level of acceptance for these uses is quite low. Perhaps many respondents did not interpret the word "pure" as free of health risks, or perhaps they would in general not believe such claims.

The survey also explored whether acceptance of reclaimed water varied by a respondent's education, income, or occupation. No importance differences were found. For example, respondents with a college degree were no more or less willing to use reclaimed water than respondents who had only graduated from high school.

PROGRESS

Despite the previously cited difficulties, we have made important progress in water reclamation. The Los Angeles County Sanitation Districts publishes a yearly update on their reclamation activities and they report increasing reclamation. In 2000 they produced more than 520 million gallons per day (MGD) of treated wastewater, and 190 MGD was suitable for Title 22 reclamation. Approximately 60 MGD were used in reclamation projects that used special distribution systems or watering trucks. Another 25 MGD was used for groundwater recharge (Figure 2, bottom). The Districts

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In 1977 he joined UCLA and since that time has performed research and teaching in environmental engineering with an emphasis on biological treatment systems, computer methodologies, aeration systems and waster reclamation. He is the author of over 200 technical publications. He has held several administrative positions, including Chair of Civil and Environmental Engineering, Director of the Institute of the Environment, and Associate Dean of the School of Engineering and Applied Science. He is a board member of Heal-the-Bay and co-chaired their Scientific Advisory Board.

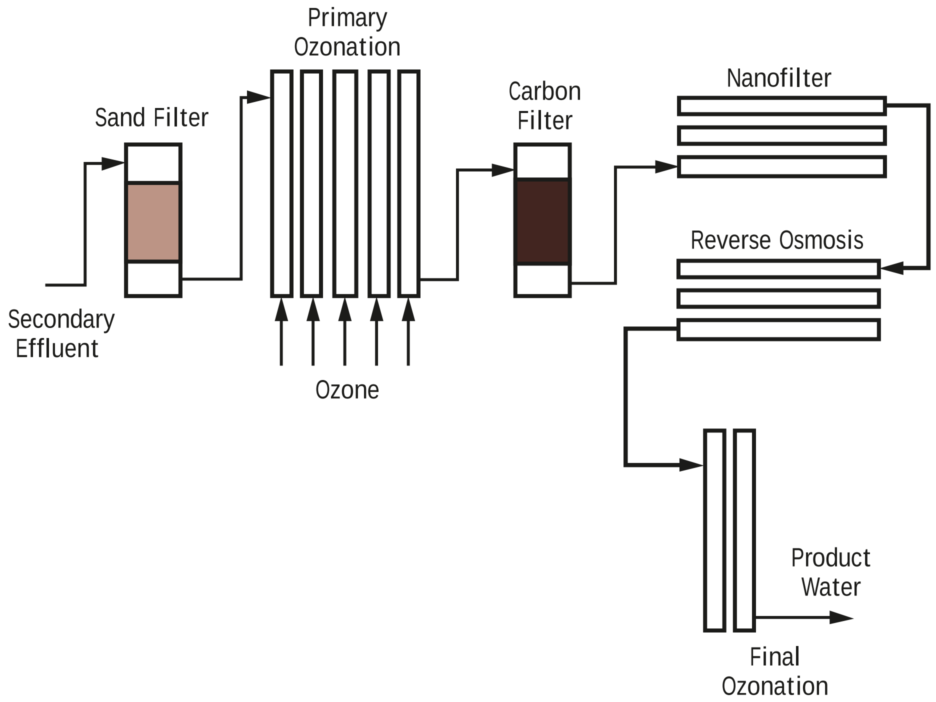

Figure 3. Example of an advanced reclamation plant (this plant was used in a UCLA demonstration study at Lake Arrowhead).

reports increasing trends depending upon rainfall; less reclamation occurs in wet years, like 1998. The number of reclamation sites increased from 100 in 1990 to 418 in 2000.

The Orange County Water District has also made good progress. They are recognized as the leader in reclamation and especially in indirect potable reclamation. The City of San Diego has an aggressive non-potable reclamation program.

OUTLOOK

As with many other topics examined by the Southern California Environmental Report Card, the outlook is mixed. We have agencies such as the Los Angeles County Sanitation Districts and the Orange County Water District who are showing leadership and wisely directing public investment.

There is a lesson to be learned from the recent energy crisis in California. We did not

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construct the needed electricity generating infrastructure or implement the necessary conservation to provide for the future. The same thing is occurring with water supply. Water reclamation plants take just as long to construct as electricity generating plants, and water is much less transportable than electricity.

Global warming is an acknowledged fact according to reputable scientists (see Report Card 2001). We do not know all the potential impacts, but extremes in weather are expected to increase, which means longer droughts and greater floods. Tree ring records suggest the droughts in the past century have been fewer and shorter than the long-term average. The next drought could be more severe and longer than any we can remember, and the problems it creates could make our electricity shortage seem trivial by comparison.

Our real problem is a lack of public interest and incorrect perceptions of water reclamation. We read newspaper headlines of "Toilet-to-tap." No agency has ever proposed or will propose a toilet-to-tap reclamation program. The proposed projects use advanced treatment technologies that provide treatment well in excess of that provided for normal drinking water. When you read such a headline, know that the writer is making an appeal to your emotions, rather than relying on facts or good science.

GRADES

Agencies: **A**. The rest of us: **D**.

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He is an elected fellow of the American Association for the Advancement of Science and the American Statistical Association, and a former member of the National Research Council's Committee on Applied and Theoretical Statistics.

Professor Berk has published a dozen books and over 150 journal articles and book chapters, many on environmental issues. His current work addresses the links between climate change, water resources, and water quality in large urban areas. In addition to his research on Southern California, he is undertaking related work in several large Asia Pacific Cities. He also collaborates with statisticians and scientists at UCLA and the Los Alamos National laboratories on statistical tools for evaluating large-scale computer simulation models, such as those used in climate research, and on new statistical tools to permit sound generalizations from environmental case studies. His recent work is funded by the National Science Foundation and the Environmental Protection Agency.