



Using Recycled Water on Agriculture: Sea Mist Farms and Sonoma County

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Introduction

Growers in California are increasingly looking to recycled water as a way to consistently meet their irrigation demands in the face of growing water scarcity and pollution concerns. Water recycling (also known as water reuse or water reclamation) is the application of water that has already been used for human purposes and discharged as wastewater, and it typically involves the treatment of wastewater in order to make it safe for reuse. At first, water recycling was used largely to reduce the pollution associated with wastewater discharge. However, in the last decade it has been used primarily as a supplement to dwindling water supplies. Recycled water in California is most commonly used for agricultural irrigation, but it also goes to groundwater recharge, environmental uses, industrial uses, landscape irrigation, and, increasingly, as a way to mitigate the intrusion of seawater into coastal aquifers.

In the United States, recycled water is typically used only for non-potable or indirect-potable uses. It is rarely used directly as drinking water. Non-potable uses (e.g. irrigation and cooling) are those in which recycled water is not intended to come in contact with drinking water. Indirect-potable reuse refers to situations where recycled water is blended with potable water supplies, such as in groundwater basins, storage reservoirs, or streams. While recycled water helps mitigate water pollution and supplement water supplies, it also carries with it a stigma and some important human and environmental health concerns. In response, standards have been developed (Title 22 of the California Code of Regulations) that proscribe particular treatment technologies for different uses of recycled water, and require frequent testing and monitoring of recycled water quality at the treatment plant and at the point of application. Today, recycled water is increasingly recognized as a useful technology that will help growers, and other water users, in California meet their water demands well into the future.

Background

In the last twenty years, the number of water recycling projects and the volume of recycled water produced have grown dramatically. A comparison of recent surveys shows that the total volume of recycled water consumed in California has more than doubled since 1987 (Figure 1). In the 1990s, agricultural irrigation and groundwater recharge were the largest volume uses for recycled water; however in the last decade, recycled water use has shifted from groundwater recharge to landscape irrigation, while agricultural irrigation remains by far the most common use. Recycled water use has grown in nearly all of the categories of use (with the notable

exception of groundwater recharge). By 2000, there were already 234 wastewater treatment plants that provided recycled water in California (Sonoma County Water Agency 2007).

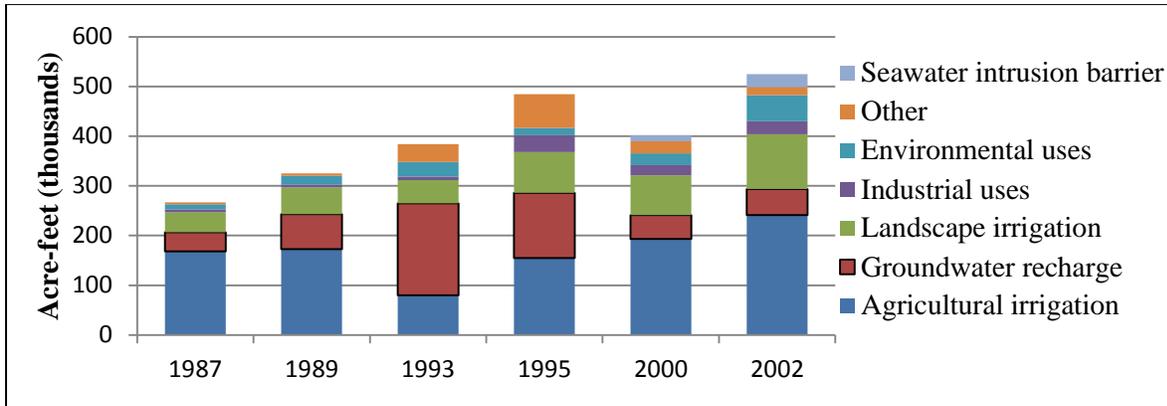


Figure 1. Uses of recycled water in California, 1987, 1989, 1993, 1995, 2000, and 2005

Sources: 1987 and 1989 data: State Water Conservation Coalition Reclamation/Reuse Task Force (1991). 1993 data: WaterReuse (1993). 1995 data: DWR (1998). 2000 data: DWR (2003). 2002 data: DWR (2004).

Note: These surveys use different methodologies and received different response rates.

Many agricultural water recycling projects grew out of the necessity to find alternatives for wastewater disposal due to the restrictions set by the Clean Water Act (CWA). The CWA, passed by the U.S. Congress in 1972 to limit pollution of the nation’s waters, requires the Environmental Protection Agency (EPA) to set minimum standards for treatment plant discharges. It also authorized major federal grant assistance for municipal sewage treatment plant construction and improvement. Thus, the CWA not only provided for new regulations related to water quality, but also funded the infrastructure for centralized wastewater treatment facilities which can be used to recycle water.

Reclaimed water can be treated to three different levels of increasing cleanliness/safety:

- *Primary:* A physical process removes some of the suspended solids and organic matter from the wastewater. The remaining effluent from primary treatment will ordinarily contain considerable organic material and will have a relatively high biochemical oxygen demand.
- *Secondary:* Biological processes involving microorganisms remove organic matter and suspended material. The effluent from secondary treatment usually has little biochemical oxygen demand and few suspended solids.
- *Tertiary:* This process further removes suspended and dissolved materials remaining after secondary treatment and often involves chemical disinfection and often involves chemical disinfection and filtration of the wastewater.

Figure 2. Descriptions of primary, secondary, and tertiary wastewater treatment

Source: Tchobanoglous, G. and E. Schroeder 1987

The biggest concern regarding the use of recycled water on farms is the impact on human and environmental health. In response, California has put in place clear policies to regulate the type of treatment required for particular uses. Title 22 of the California Code of Regulations established by the California Department of Public Health governs the allowed uses for recycled water, the conditions of the use, and the physical and operational requirements to protect the health of workers and the public. Each application of recycled water is given a required degree of treatment (see Table 1), depending on its potential for harm to humans or the environment. For instance, if recycled water contacts the edible portion of the crop, e.g., all root crops, tertiary treatment and disinfection are required. Title 22 also requires frequent monitoring of recycled water quality at the treatment plant and the point of application. In addition, the California State Water Resources Control Board is responsible for regulating the production, conveyance, and use of recycled water through its nine Regional Water Quality Control Boards.

Table 1. Title 22 Wastewater reclamation regulations

Source: originally published on the EBMUD website

USE	TREATMENT REQUIRED			
	<i>Disinfected Tertiary Recycled Water</i>	<i>Disinfected Secondary-2.2 Recycled Water</i>	<i>Disinfected Secondary-23 Recycled Water</i>	<i>Undisinfected Secondary Recycled Water</i>
Irrigation for:	Allowed	Not Allowed		
Food crops where recycled water contacts the edible portion of the crop, including all root crops	X			
Parks and playgrounds	X			
Schoolyards	X			
Residential landscaping	X			
Unrestricted access golf courses	X			
Any other irrigation uses not prohibited by other provisions of the California Code of Regulations	X			
Food crops where edible portion is produced above ground and not contacted by recycled water	X	X		
Cemeteries	X	X	X	
Freeway landscaping	X	X	X	
Restricted access golf courses	X	X	X	
Ornamental nursery stock and sod farms	X			
Pasture for milk animals	X	X	X	
Non-edible vegetation with access control to prevent use as a park, playground, or schoolyard	X	X	X	
Orchards with no contact between edible portion and recycled water	X	X	X	X
Vineyards with no contact between edible portion and recycled water	X	X	X	X
Non-food-bearing trees, including Christmas trees not irrigated less than 14 days before harvest	X	X	X	X
Fodder crops (e.g. alfalfa) and fiber crops (e.g. cotton)	X	X	X	X
Seed crops not eaten by humans	X	X	X	X
Food crops that undergo commercial pathogen-destroying processing before consumption by humans (e.g. sugar beets)	X	X	X	X
Ornamental nursery stock, sod farms not irrigated less than 14 days before harvest	X	X	X	X

In addition to these regulations that identify safe uses of recycled water for agriculture, there is growing scientific data that supports the safety of recycled water for these purposes. Perhaps most notably, the Monterey Wastewater Reclamation Study for Agriculture, an 11-year analysis of the safety of recycled water for the irrigation of crops, studied artichokes, broccoli, cauliflower, lettuce, and celery grown on two five-hectare plots in Castroville under two different types of recycled water (MRWPCA 1987). Among its key findings were:

- There were no viruses on samples of crops grown with the two types of recycled water used in the study;
- Levels of naturally occurring bacteria on samples of crops irrigated with recycled water were equivalent to those found on the control samples;
- There was no tendency for metals to accumulate in soils or plant tissues after irrigation with recycled water;
- Medical examinations and the serum banking program routinely conducted for the project personnel revealed no project-related health issues;
- The marketability, quality, and yield of crops were comparable with the control samples.

Benefits and Applications of Recycled Water

The use of recycled water on agriculture has grown significantly in California over the last decade due to its many benefits. These benefits are divided into four broad categories:

Reducing water pollution

Recycled water was originally and for over a century used primarily as a way to reduce the pollution associated with wastewater discharge. By treating wastewater and applying it for other uses, it no longer needed to be discharged to rivers, lakes, and streams and therefore significantly reduced pollution and the subsequent ecosystem damage and human health concerns.

Redistributing this wastewater to agricultural land incentivizes better treatment (as it will be used for economically valuable purposes) and prevents accumulation of pollution in any one water body. Water pollution reduction continues to be one of the primary benefits of water recycled programs.

Augmenting water supply

As freshwater becomes scarcer, recycled water has increasingly been used as an alternative source of water for agriculture and industrial uses. Municipalities often treat their wastewater and send it to growers as irrigation waters. Industrial facilities also often treat their own water and reuse it immediately. In this way, recycling relieves pressure on surface waters and slows the depletion of groundwater. Recycled water not only provides more water, but is also often more reliable than surface supplies. Because municipal sources must use water by necessity (and therefore create wastewater), wastewater production—and thus the potential for water recycled supply—is relatively stable. Recycled water supplies are often used to mitigate water shortages caused by drought for this very reason.

Supporting healthy ecosystems

Water use and wastewater discharge often cause great damage to ecosystems by drastically reducing environmental flows or causing excessive pollution. Increased use of recycled water

offers environmental benefits in the form of reduced effluent discharge, decreased pressure on existing water sources, increased in-stream flows, and avoiding the need for new water supply/infrastructure that may destroy local habitat (such as dams). Recycled water is also an option for supporting restoration projects, such as wetlands construction.

Reducing energy requirements and costs

Recycled water is also often preferable as a source of water due to its relatively low energy requirements compared to other water supply technologies. This is particularly true in Southern California where imported water must be transported long distances and pumped over mountains (requiring large amounts of energy) in order to reach growers. A recent study by the Inland Empire Utilities Agency shows that recycled water requires 400 kilowatt hours per acre-foot (kWh/AF) compared to 550 kWh/AF for groundwater pumping; 2,000 kWh/AF for the Colorado River Aqueduct Water; and 4,400 kWh/AF for desalination (Figure 3). Lower energy use not only reduces the environmental impacts associated with energy production, but also reduces energy costs to water districts, and so, the cost of providing the water itself.

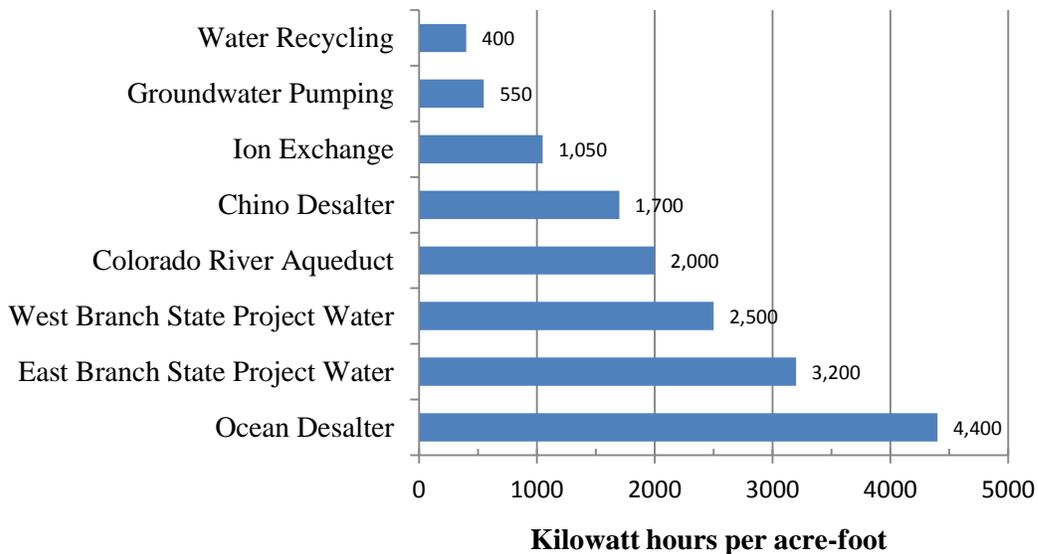


Figure 3. Energy requirements for Inland Empire Utilities Agency water supply

Source: http://www.aceee.org/conf/05ee/05eer_ewhitman.pdf

Sea Mist Farms

Sea Mist Farms, located in the Salinas Valley along the Central Coast of California, has successfully used recycled water since 1998. Sea Mist grows artichokes, spinach, lettuce, and variety of other crops on its nearly 11,000 acres of land. Recycled water comprises roughly two-thirds of the farm's total water use and is applied to roughly 80% of its acreage. Sea Mist uses well water only when its water demand exceeds the supply of recycled water.

Sea Mist receives its recycled water from the Monterey County Water Recycling Projects which consists of the Salinas Valley Reclamation Plant and the Castroville Seawater Intrusion Project (CSIP). CSIP is the 45 mile recycled water pipeline delivery system that was constructed in 1998 by the Monterey Regional Water Pollution Control Agency in order to minimize seawater intrusion in the aquifers on which the farms in the area rely by providing access to recycled water. Seawater intrusion occurs when coastal aquifers are drawn down and/or sea levels rise, so as to allow seawater to filter into freshwater aquifers. Seawater contamination is both a water-quality concern (excessive salinity is damaging to crops) and a water-scarcity issue (as it effectively makes these supplies unusable). Sea-level rise caused by climate change threatens to increase the number of aquifers subject to this intrusion. Recycled water is sometimes injected in these aquifers in order to stop this intrusion. However, as in the case in Castroville, recycled water is more often used as a source of irrigation water that reduces the need for groundwater pumping and therefore reduces intrusion. In 2008, CSIP delivered over 15,000 acre-feet of tertiary-treated recycled water to farmlands in the Salinas Valley. Sea Mist uses roughly two-thirds of all water produced by CSIP every year, making it by far the single biggest user of CSIP recycled water.

Dale Huss, General Manger of Sea Mist Farms for over two decades, is an advocate of recycled water for agriculture, saying that Sea Mist Farms is “proud of the fact that we are the biggest user of recycled water in the world.” While acknowledging that this has been a concern among consumer and buyers, when asked about any food safety concerns due to the use of recycled water Huss explains, “Our water, from a food safety standpoint ... is one of the safest water sources in the world... It is actually better, from an agronomic standpoint, than what the well water was.” Finally, Huss notes that “in over eleven years of using recycled water to irrigate vegetable crops we have never had a food safety or human safety issue” (D. Huss, General Manager of Sea Mist Farms, personal communication, October 27, 2009).

Sea Mist has established a thorough monitoring system to ensure the quality of its soil and its products. These tests are more stringent than required by law and are checked by the County of Monterey's Department of Environmental Heath. Sea Mist has monitored its soil quality concerns twice a year since 2000 and compares those samples to soils from a nearby control site that uses well water instead of recycled water. These comparisons have shown the soils receiving recycled water to be consistently parallel to the control soils in respect to salinity and the soil absorption rate (SAR), and in many cases better. Moreover, the recycled water is disinfected and therefore has lower concentrations of microbial contaminants. There is an economic cost for this treatment, and Sea Mist Farms pays \$180 per acre-foot of delivered water, compared to the \$130-\$150 per acre-foot they would pay to pump groundwater. However, Huss is comfortable with paying slightly more, citing the improved quality and reliability of recycled water.

Sonoma County

Sonoma County has used recycled water for decades and has seen a surge in demand from a variety of different users over the past ten years. The Laguna Wastewater Treatment Plant (WTP) treats wastewater collected from the cities of Santa Rosa, Rohnert Park, Cotati, and Sebastopol, from the South Park County Sanitation District, and from septic systems from most of Sonoma County. The Laguna plant opened in 1968, producing 2 million gallons of treated wastewater per day. Today, it produces over 21 million gallons of tertiary-treated wastewater every day (City of Santa Rosa 2009a).

While originally planned primarily as a wastewater disposal strategy, this recycled water is now largely used as a supplement to water supplies. Initially this water was primarily used for landscape irrigation, but Laguna WTP's conversion from secondary to tertiary-treated water in 1989 greatly increased the range of uses for its recycled water. The treatment plant now provides water to roughly 6,000 acres of farmland (City of Santa Rosa 2009b). Most of this acreage is used for pasture and fodder for dairy (about 4000 acres) and vineyards (about 1500 acres), although it is also used for turf, vegetables, and other crops. The treatment plant provides an average of 3.6 billion gallons per year for irrigation. A portion of the recycled water is also used for various created wetlands projects and the irrigation of parks, schoolyards, and other landscape areas. The treatment plant is only allowed to discharge to local water bodies (usually the Russian River) during the rainy season, October through May. Even then, recycled water can comprise only five percent of the river flow. The amount of water discharged to the river has decreased since 2003, when The Geysers—the largest geothermal power plant system in the world, located along the Sonoma and Lake County border—began operations using recycled water to produce steam. The Geysers now uses approximately 11 million gallons of recycled water every day.

Growers in Sonoma County currently receive recycled water for no charge; however, as soon as their contracts expire (around 2014), they will begin to be charged an as-yet undefined fee per acre-foot. Urban irrigators are provided recycled water at a rate set at 95% the potable rate, up from 75% ten years ago. These rate increases are largely due to growing demand for water in general and increased comfort with recycled water among growers and urban users. Similarly, though growers in Sonoma County were initially allowed to take as much recycled water as they could use, they are now being given allocations due to high demand.

The Sonoma County Water Agency (SCWA) recently proposed the *North Sonoma County Agricultural Reuse Project* to provide recycled water for an additional 21,100 acres of existing agricultural lands—nearly three times the current for Laguna WTP (SCWA 2007). This project would include the design and construction of storage reservoirs, pipelines, and pump stations. SCWA conducted a feasibility study on this project estimating costs at over \$375 million in 2006 and released a final Environmental Impact Report in 2009 (SCWA 2007). However, despite this progress and support from many growers in the area, the project lacks funding and firmer commitments from both recycled water suppliers and users (SCWA 2009).

In sum, the application of recycled water for agriculture in Sonoma County has been quite successful, and in fact, demand for this water now well exceeds supply. However, the spread of recycled water use for agriculture is being tempered by a number of different factors. Growing water scarcity has created higher demand for water supplies among other users and more and more recycled water is being diverted for higher-value urban uses. The Geysers Project is now using much of the recycled water supply in the area. Efforts to expand recycled water production have been blocked mostly by inadequate funding.

Conclusions

Though the volume of recycled water used in California has more than doubled in the last two decades, there are still a number of barriers hindering it from more widespread use. Water recycling can be significantly cheaper than alternative sources of new water supply, though the initial investment costs can be high. Construction costs for these facilities are often borne by a single entity (e.g., water agency, municipality) even if benefits are provided to many water users through reduced pollution and increased water supply. Moreover, many of the environmental benefits from water recycling programs are difficult to quantify monetarily and therefore, are often excluded from cost-benefit analyses. Better valuing and quantifying of these benefits can play a large role in garnering support and securing funding for recycling programs. Existing funding sources, including the Clean Water State Revolving Funds and the American Recovery and Reinvestment Act 2009, should be targeted at expanding the availability of recycled water to agricultural consumers.

The variety of agencies and authorities necessary for successful implementation of water recycling projects (e.g. wastewater managers, water retailers and wholesalers, cities and counties, regulatory agencies, planning agencies, and the public) poses a number of institutional issues that slow the uptake of water recycling. A mechanism for cooperation among these agencies could promote water recycling in order to provide wastewater treatment, meet regulations and permit requirements, identify and market to customers, and operate and maintain service. We know that in California water demand exceeds supply in many water years, and that this gap is likely to grow in the future due to a growing population and new pressures, e.g., climate change. Nevertheless, the majority of farmers in California still do not have access to recycled water. There is still much untapped potential to conserve water and protect ecosystems.

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