

# Executive Summary: Draft PA No. 4 – Graywater and Rainwater Projects

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## Description

Graywater and/or rainwater projects would allow SCWD or SqCWD to reduce potable water used for landscape irrigation. This would save energy associated with potable water and therefore reduce indirect GHG emissions.

## Amount of GHG Reduction

The estimated GHG reductions rely on customers participating in the program and may be less than estimated if actual participation is less than assumed by this project assessment.

SCWD – Accelerated Residential Graywater/Rainwater Reuse Project: In non-drought years, the water supply offset would be for surface water; in drought years, the offset would be for a blend of desalinated and surface water. GHG emissions could be reduced by an average of 1.3 metric tons annually.

SCWD – UCSC Graywater/Rainwater Reuse Project: In non-drought years, the water supply offset would be for surface water; in drought years, the offset would be for a blend of desalinated and surface water. GHG emissions could be reduced by 5 metric tons annually.

SqCWD – Accelerated Graywater/Rainwater Reuse Program: The water supply offset would be for a blend of desalinated and groundwater. GHG emissions could be reduced by an average of 3.2 metric tons annually.

This project is estimated to reduce less than 1% of the potential GHG reduction goals for SCWD and SqCWD.

## Project Life and Sustainability

Graywater and/or rainwater reuse programs would provide non-potable water for irrigation for the life of their systems. For SCWD and SqCWD, the additional GHG reduction credit from these accelerated programs is estimated to have a 15 year lifetime, since it is assumed that in 15 years, customers would have signed up through the existing graywater/rainwater programs offered by SCWD and SqCWD. The UCSC project, since it is not existing or planned, is assumed to provide GHG reduction for 30 years and beyond with normal maintenance.

## Project Cost

**Table ES-1: Graywater/Rainwater Reuse Project Summary**

Project	Life (yrs)	Avg Annual GHG Reduction (MT/yr)	Capital Cost (\$)	Average Annual Net Cost (\$/yr)	Lifecycle Energy Cost (\$/kWh)	Lifecycle GHG Reduction Cost (\$/MT)
SCWD – Residential Graywater/Rainwater	15	1.3	\$872,000	\$120,000	\$12	\$75,000
SCWD – UCSC Graywater/Rainwater	30	5	\$1,100,000	\$85,000	\$4	\$11,000
SqCWD –	15	3.2	\$591,000	\$91,000	\$4	\$23,000

Accelerated Graywater/Rainwater						
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# Draft Project Assessment No. 4 – Graywater and Rainwater Programs

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## Description

This assessment estimates the energy savings and GHG reduction potential from the development of a graywater program and rainwater harvesting/storage program for SCWD and SqCWD.

## Background

Graywater: Graywater is untreated water that drains from a bathtub, shower, clothes washing machine, or bathroom sink. Graywater reuse provides a year-round non-potable water supply.

Regulations finalized in January 2010 allow homeowners in California to install clothes washing machine graywater systems, also called "laundry to landscape" systems, in their homes without a permit by following the guidelines outlined by Chapter 16A of the California Plumbing Code. The reuse of graywater from any source other than a clothes washing machine requires a construction permit issued from the local enforcing agency. The total number of California households diverting graywater for onsite use is estimated to range from approximately 600,000 to 1.8 million (Sheikh).

Landscape irrigation is the most common reuse of graywater. However, it cannot be used to irrigate root crops or edible parts of food crops that touch the soil and cannot be used in spray irrigation systems. Graywater used for indoor uses, such as toilet flushing, must be treated to standards for disinfected tertiary recycled water (California Code of Regulations, Title 22), but is not common in the United States.

Rainwater Harvesting: Rainwater harvesting is defined as precipitation collected from rooftops and other above-ground impervious surfaces that is stored in catchment tanks for later use. In California, rainwater harvesting provides a seasonal, wet-weather, non-potable water supply. Rainwater harvesting systems can range from a simple barrel at the bottom of a downspout to multiple cisterns with pumps and filtration.

The most common reuse of rainwater is landscape irrigation. Untreated rainwater can be used for sub-surface outside irrigation, including edible plants and gardens. For indoor uses, such as toilet flushing, laundry, and bathing, additional treatment is required (US EPA).

Figure 1 shows a large rainwater catchment system at the SqCWD Headquarters Office that can store approximately 2,000 gallons of rainwater for irrigation.

**Figure 1: Rainwater Storage Tank at SqCWD Headquarters Office ( ~2,000 gallons)**



Table 1 provides a summary of the availability, sources, and potential uses of treated and untreated graywater and rainwater.

**Table 1: Summary of Availability, Sources, and Potential Uses of Graywater & Rainwater**

	<b>Graywater</b>	<b>Rainwater</b>
<b>Availability</b>	Year-round	Seasonal (wet weather)
<b>Sources</b>	Laundry, shower/bathtubs, sinks	Rooftops, other impermeable surfaces
<b>Uses (Untreated)</b>	Irrigation – no root crops or edible parts of food crops that touch the soil	Irrigation – includes all food crops
<b>Uses (Treated)</b>	Outdoor – sprinklers, carwash, HVAC; Indoor – toilet flushing, laundry	Outdoor – sprinklers, carwash, HVAC; Indoor – toilet flushing, laundry
<b>Required Treatment</b>	Disinfected tertiary treatment (CCR, Title 22, Section 4, Chapter 3)	Pre-filtration – first flush diverter, Cartridge filtration – 5 micron sediment filter, Disinfection – chlorination with household bleach or UV disinfection
<b>Treatment Goals for Indoor Use</b>	Disinfected tertiary treatment (CCR, Title 22, Section 4, Chapter 3)	Total coliform < 500 cfu per 100 mL; Fecal coliform < 100 cfu per 100 mL

## Existing Programs

Graywater: Existing SCWD and SqCWD graywater reuse programs are as follows:

- SCWD provides guidelines for residential graywater on its website but currently does not offer a formal graywater program.
- SqCWD has implemented a graywater rebate program that offers a \$75 rebate for each qualified graywater system, up to three connections per household. Eligible connections include clothes washing machines, bathtubs/showers, and bathroom sinks. SqCWD provides guidelines and resources for graywater reuse on its website. To date the program has provided 2 rebates for graywater systems.

Rainwater Harvesting: Existing SCWD and SqCWD rainwater harvesting programs are as follows:

- SCWD has implemented a rain barrel distribution program, which provides 65-gallon rain barrels to its customers at a reduced price of \$50. SCWD estimates that a rain barrel would conserve a maximum of 260 gallons per year, or 0.7 gallons per day averaged over the course of a year. To date, the program has provided 168 rain barrel systems to customers.
- SqCWD has implemented a rainwater catchment rebate program that offers \$25 to \$750 in rebates for the capital costs associated with installing rain barrels (up to 200 gallons) or large catchment systems (over 200 gallons). SqCWD provides guidelines and resources for rainwater reuse on its website. To date, the program has provided 25 rebates for rainwater catchment systems.

## Potential New or Accelerated Graywater and/or Rainwater Reuse Programs

Programs are evaluated separately for SCWD and SqCWD. For SCWD, a new residential graywater/rainwater program and a new graywater/rainwater project for the University of California, Santa Cruz (UCSC) were evaluated. For SqCWD, an accelerated graywater/rainwater program was evaluated. This analysis assumes that a rainwater system would include a large, approximately 2,000 gallon catchment tank to provide similar offsets of irrigation water as a graywater system (2,600 gallons per year).

SCWD New Residential Graywater/Rainwater Reuse Program: SCWD could implement a residential graywater/rainwater reuse program that would reduce potable water demands during irrigation months. It is assumed that residential reuse would be limited to landscape irrigation because of the complex treatment requirements for indoor reuse. The program would consist of customer rebates, as well as customer outreach and education.

The following assumptions were used to estimate the benefit of a SCWD residential graywater/rainwater reuse program:

- \$300 rebate per residence to provide incentive to install a graywater system or \$1,000 per rebate per residence to install a large approximately 2,000 gallon rainwater catchment system.
- \$150,000 budget for marketing materials and public outreach and education campaign over the 15 years of the program.

- One quarter-time FTE staff position for 15 years
- 10% of single-family households apply for the rebate (1,835 households) (SCWD UWMP Table 4-1) over the program. This was assumed to be 120 households per year participating in the program. Approximately 3/4 of the rebates would be for graywater.
- Graywater supplies 2,600 gallons per year per household for landscape irrigation (scwd<sup>2</sup> Graywater Fact Sheet, 2010). For this analysis a large, approximately 2,000 gallon rainwater catchment system is assumed to provide a similar volume.
- During non-drought years, graywater/rainwater reuse would offset only surface water. During drought years, graywater/rainwater reuse would offset a combination of surface water and desalination water. It is assumed that, during drought years, SCWD will implement a 15% curtailment of irrigation water supply.
- The program could initially offset approximately 300,000 gallons per year and increase up to 4.8 million gallons per year (MGY) of irrigation demand over the 15-year program duration.

UC Santa Cruz Graywater/Rainwater Reuse Program: A graywater/rainwater reuse program at UC Santa Cruz (UCSC) could provide a larger-scale benefit than a residential program because of the size of the campus. The graywater supply is assumed to be from showers and laundry facilities. Although UCSC could potentially implement a treatment facility to supply treated graywater/rainwater for indoor uses, this option is not considered feasible because of the high cost for retrofitting buildings for a dual-plumbed supply. Therefore, graywater/rainwater is assumed to be used only for landscape irrigation.

The following assumptions are used to estimate the benefit of a UCSC graywater/rainwater reuse program:

- A conceptual cost of \$1,100,000 is allocated to retrofit dorms and laundry facilities to divert graywater, install rainwater catchment tanks, and retrofit the campus irrigation system.
- 25% of campus irrigation demands would be supplied through the graywater/rainwater reuse project (SCWD Water Shortage Contingency Plan, Table 3-4)
- During non-drought years, graywater/rainwater reuse would offset only surface water. During drought years, graywater/rainwater reuse would offset a combination of surface water and desalination water. It is assumed that, during drought years, SCWD will implement a 15% curtailment of irrigation water supply.
- The program could offset approximately 10.3 MGY of irrigation demand during non-drought years and 8.7 MGY during drought years over the 30-year project duration.

SqCWD Accelerated Graywater/Rainwater Program: The following assumptions are used to estimate the benefit of an accelerated graywater/rainwater reuse program in SqCWD:

- \$300 rebate per residence (instead of \$75) to provide enhanced incentive to install a Laundry-to-Landscape system and \$1,000 per rebate per residence (instead of \$750) to install a large, 2,00 gallon rainwater catchment system.
- \$150,000 budget for marketing materials and public outreach and education campaign over the 15 years of the program.
- One quarter-time FTE staff position for 15 years

- 10% of single-family households apply for the rebate (1,245 households) (SqCWD Draft UWMP, 2010). This was assumed to be 83 households per year participating in the program. Approximately 3/4 of the rebates would be for graywater.
- Graywater supplies 2,600 gallons per year per household for landscape irrigation (scwd<sup>2</sup> Graywater Fact Sheet, 2010). For this analysis a large, approximately 2,000 gallon rainwater catchment system is assumed to provide a similar volume.
- Graywater/rainwater reuse would offset a combination of groundwater and desalination water, the proportions of which vary depending on whether it is a drought or non-drought year. It is assumed that, during drought years, SqCWD will implement a 15% curtailment of irrigation water supply.
- The program could initially offset approximately 200,000 gallons per year and increase up to 3 MGY of irrigation demand over the 15-year program duration.

## Vendors

Graywater and rainwater catchment systems can be installed by homeowners or contractors. Permits are required for any graywater systems other than laundry-to-landscape systems. The SqCWD website provides a partial list of local companies and contractors that sell and/or install water catchment systems (<http://www.soquelcreekwater.org/content/rain-catchment>).

## History and Technical Maturity

The use of graywater and rainwater to offset potable water use for irrigation is a technically mature concept that has been implemented throughout California. The number of residential graywater and rainwater catchment systems is relatively small, but growing.

A potential risk with graywater/rainwater systems is the potential for poor site management, which could result in ponding or runoff of the graywater, which is not permitted by state and county regulations and ordinances. Another risk is the possibility of “bootlegged” graywater systems that have not undergone appropriate permitting that increases the risk of cross-connection to the onsite potable water supply. However, these risks can be mitigated through appropriate education, permitting, and monitoring.

## Reliability and Operational Complexity

The reliability of this and other rebate programs to provide GHG reductions will depend on the participation rate in the program. Participation can be increased through public education and advertising campaigns, however, participation is not guaranteed. The actual program participation rates would need to be confirmed on an annual basis and additional efforts made to promote the program if participation is below target. Also, over time it may be more and more difficult to maintain participation rates, especially with more complex systems such as graywater systems.

The technical reliability of graywater and rainwater reuse projects will depend on each individual customer to optimize the potential for reuse and to continue to use graywater or rainwater to offset landscape irrigation demands. The complexity of the graywater and/or rainwater catchment system will vary for individual households depending on the piping arrangements, space and irrigation systems of the residence. The more complex the system, the greater chance that a homeowner may not properly maintain and use the system. However,

households that do install these systems are more likely to be aware of the water and energy saving benefits of the systems and therefore maintain the systems.

A graywater/rainwater reuse programs would have little impact on SCWD or SqCWD operations. A 25% FTE staff person would help to implement and market the program and to respond to residential inquiries/problems.

## Project Lifetime and Sustainability

Graywater and rainwater reuse projects would provide an additional water resource for the life of respective systems. The residential projects would be sustained over the 15-year period by outreach to water customers and providing assistance to those customers who wish to install graywater or rainwater systems. At the end of the 15-year project life, an assessment could be made to determine if continuing the program would provide additional GHG reduction credits that met the Kyoto Protocol additionality criteria.

Due to the criteria of additionality, only new or accelerated programs, beyond the existing programs described above, can be counted as a GHG reduction project for the **scwd<sup>2</sup>** Desalination Program. The concept of additionality was introduced in the Kyoto Protocol in Article 12.5, which states that “emission reductions resulting from each project activity shall be certified by DOEs (Designated Operational Entities) on the basis of ... reductions in emissions that are additional to any that would occur in the absence of the certified project activity.” Because of the relatively low participation rate of the existing graywater and rainwater programs, this analysis assumes that all systems that would be installed through an accelerated program would be considered additional.

However, because plumbing code regulations have recently changed to permit easier installation of graywater and rainwater systems, and these programs are starting to become more widespread, the project life time for the GHG reduction credits has been assumed to be only 15 years. It is assumed that in 15 years, customers would have signed up through the existing graywater/rainwater programs offered by SCWD and SqCWD. The UCSC project, since it is not existing or planned, is assumed to provide GHG reduction for 30 years and beyond with normal maintenance.

## Local Considerations

### **Economy**

Graywater reuse and rainwater harvesting programs would provide a local benefit. The primary economic benefit would be an increase in business to local contractors. The programs also would reduce local energy consumption and associated GHG emissions from potable water production and take advantage of untapped local water resources. This also could provide cost savings for homeowners from water and energy use reduction.

### **Environment**

Air. These projects do not create air pollution, but the reduction in electricity use will reduce GHG emissions.

Land. The use of untreated graywater from laundry may impact soil quality and/or sensitive plant species. This could be mitigated or managed through the use of environmentally-friendly laundry detergents that do not include chlorine or bleach, peroxygen, sodium perborate, sodium

trypochlorite, boron, borax, petroleum distillate, alkylbenzene, “whiteners”, “softeners” and “enzymatic” components. The use of rainwater is not anticipated to impact soil quality or plants.

Water: Ultimately, graywater reuse could reduce the amount of wastewater in the sanitary sewers, thereby reducing the volume of secondary effluent discharged at the ocean outfall and potentially improving water quality. Rainwater harvesting could divert stormwater from storm drains and waterways, potentially improving water quality of receiving waters. However, the relatively small amount of water reduction through this program may not provide a significant difference.

Noise: This project is not anticipated to have any noise impacts.

Aesthetic/Visual: Graywater and rainwater systems should be constructed in such a way as to not be visually disruptive.

Waste by-product: There are no waste by-products of graywater or rainwater programs.

### Energy Savings and GHG Reductions

The SCWD Residential Graywater/Rainwater Reuse, the UCSC Graywater/Rainwater Reuse, and the SqCWD Accelerated Graywater/Rainwater Reuse projects potentially would allow SCWD and SqCWD to substitute graywater water for potable water (either surface water, groundwater, desalinated water, or a combination, depending on the drought conditions), for landscape irrigation. Desalination requires about 14.5 kWh of energy to produce 1 kgal of water, surface water requires about 1.3 kWh of energy to produce 1 kgal of water, and groundwater requires about 2.14 kWh of energy to produce 1 kgal of water. Graywater and rainwater use little energy since generally the water is collected and distributed by gravity, although the systems may require small pumps to supply irrigation systems.

Table 2 provides a summary of the estimated potential energy saved and GHG emission reductions from the proposed graywater/rainwater reuse programs. Actual GHG emission reductions will depend of public participation rates throughout the life of the program.

**Table 2: Estimated Energy Savings and GHG Reductions for Graywater/Rainwater Reuse Programs<sup>1</sup>**

Project Title	Life (yrs)	Average Annualized Energy Savings (kWh/yr)	Average Annual GHG Reduction (MT CO <sub>2</sub> e/yr)	Lifetime Energy Savings (kWh)	Lifetime GHG Reduction (MT CO <sub>2</sub> e)
SCWD – Residential Graywater/Rainwater	15	4,300	1.3	65,000	19
SCWD – UCSC Graywater/Rainwater	30	17,000	5	521,000	151
SqCWD – Accelerated Graywater/Rainwater	15	11,000	3.2	162,000	47

<sup>1</sup>Assuming 2 drought years every 7 years.

This project is estimated to reduce less than 1% of the potential GHG reduction goals for SCWD and SqCWD.

## Cost

Table 3 summarizes the estimated costs and cost effectiveness for the graywater/rainwater reuse programs. The supporting cost information is included in Attachments 1 and 2. The average annual cost is the annual operating costs plus the debt service on the capital cost over the life of the project minus energy savings.

**Table 3: Estimated Costs for Graywater Reuse Programs**

Project Title	Life (yrs)	Capital Cost (\$)	Average Annual Net Cost (\$/yr)	Lifecycle Energy Cost (\$/kWh)	Lifecycle GHG Reduction Cost (\$/MT)
SCWD – Residential Graywater/Rainwater	15	\$872,000	\$120,000	\$12	\$75,000
SCWD – UCSC Graywater/Rainwater	30	\$1,100,000	\$85,000	\$4	\$11,000
SqCWD – Accelerated Graywater/Rainwater	15	\$591,000	\$91,000	\$4	\$23,000

## Summary of Advantages and Disadvantages

### Advantages:

- Utilization of a water resource that currently is under-utilized
- Energy saving and GHG emission reduction opportunities (energy/water nexus projects)
- Potentially provides drought-proof irrigation water supply for customers who want to continue watering their landscapes without disruption and/or mandates that may be enforced during drought-time curtailments.

### Disadvantages:

- Limited and costly GHG reduction opportunities for SCWD and SqCWD
- Projects may have limited program life for additional GHG reduction credits
- Reliability depends on individual customers maintaining their systems

## References

City of Santa Cruz Water Department. 2005 Urban Water Management Plan. February 2006.

City of Santa Cruz Water Department. Water Shortage Contingency Plan. March 2009.

Sheikh, Bahman, PhD, PE. "White Paper on Graywater," 2010.

Soquel Creek Water District. Draft 2010 Urban Water Management Plan. 2011.

scwd<sup>2</sup>. Graywater. Fall 2010.

US Environmental Protection Agency. Municipal Handbook EPA 833-F-08-010, Rainwater Harvesting Policies, provides recommendations for treatment of rainwater for indoor non-potable reuse.