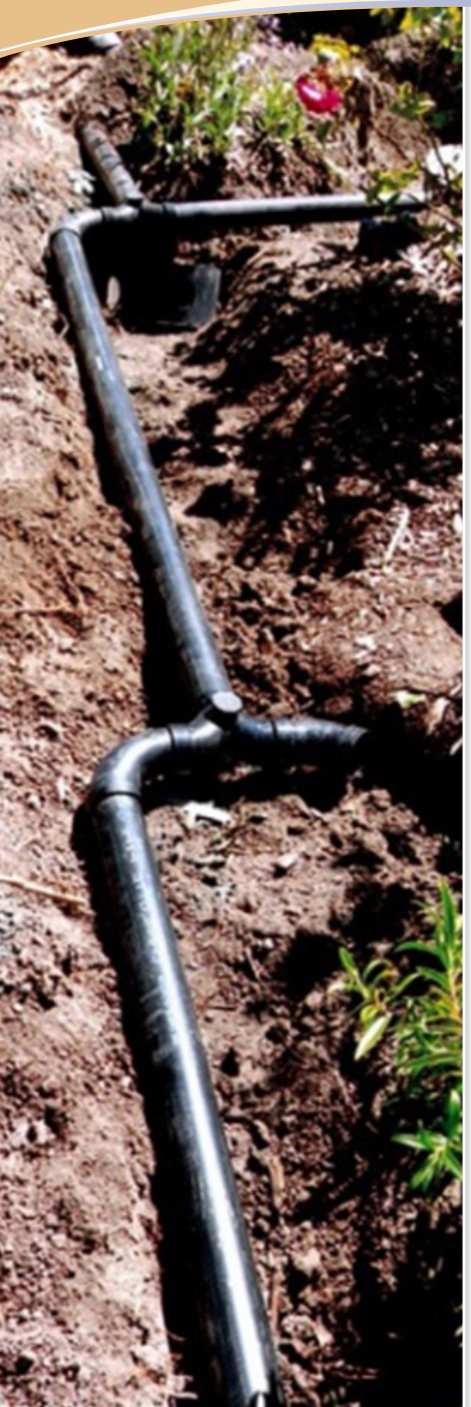
University of California
Agriculture and Natural Resources

ANR Publication 8536 | August 2015
http://anrcatalog.ucanr.edu
UC PEER REVIEWED



DROUGHT TIP

Use of Graywater in Urban Landscapes in California

JANET HARTIN, University of California Cooperative Extension Environmental Horticulture Advisor, San Bernardino, Los Angeles, and Riverside Counties; BEN FABER, University of California Cooperative Extension Soils/Water/Subtropicals Advisor, Ventura and Santa Barbara Counties

Definition and Overview

The use of graywater (also spelled greywater, grey water and gray water) to irrigate landscape plants is increasing throughout the United States, particularly in California and other arid states. Municipalities are rapidly amending their codes to encourage the use of home graywater systems. This publication describes what graywater is, the basics of laundry to landscape systems, and the associated benefits and risks of graywater systems to humans and other animals as well as to plants.

In California, under Health and Safety Code § 17922.12, graywater is defined as "untreated wastewater that has not been contaminated by any toilet discharge, has not been affected by infectious, contaminated, or unhealthy bodily wastes, and does not present a threat from contamination by unhealthful processing, manufacturing, or operating wastes. Graywater includes, but is not limited to, wastewater from bathtubs, showers, bathroom washbasins, clothes washing machines, and laundry tubs, but does not include wastewater from kitchen sinks or dishwashers."

A construction permit is no longer required for the installation of a single-family or two-family residential graywater irrigation system from a washing machine to an outdoor irrigation or disposal field as long as it does not alter the household plumbing (graywater is accessed from the hose of the washing machine, not by cutting into plumbing) and complies with the following (Health and Safety Code § 17922.12):

1. If required, notification has been provided to the enforcing agency regarding the proposed location and installation of a graywater irrigation or disposal system.
2. The design shall allow the user to direct the flow to the irrigation or disposal field or the building sewer. The directional control valve of the graywater shall be clearly labeled and readily accessible to the user.
3. The installation, change, alteration or repair of the system does not include a potable water connection or a pump and does not affect other building, plumbing, electrical or mechanical components, including structural features, egress,

fire-life safety, sanitation, potable water supply piping, or accessibility.(Note: The pump in a clothes washer shall not be considered part of the graywater system.)

4. The graywater shall be contained on the site where it is generated.
5. Graywater shall be directed to and contained within an irrigation or disposal field.
6. Ponding or runoff is prohibited and shall be considered a nuisance.
7. Graywater may be released above the ground surface provided at least two (2) inches (51 mm) of mulch, rock, or soil, or a solid shield covers the release point. Other methods which provide equivalent separation are also acceptable.
8. Graywater systems shall be designed to minimize contact with humans and domestic pets.
9. Water used to wash diapers or similarly soiled or infectious garments shall not be used and shall be diverted to the building sewer.
10. Graywater shall not contain hazardous chemicals derived from activities such as cleaning car parts, washing greasy or oily rags, or disposing of waste solutions from home photo labs or similar hobbyist or home occupational activities.
11. Exemption from construction permit requirements of this code shall not be deemed to grant authorization for any graywater system to be installed in a manner that violates other provisions of this code or any other laws or ordinances of the Enforcing Agency.
12. An operation and maintenance manual shall be provided. Directions shall indicate the manual is to remain with the building throughout the life of the system and indicate that upon change of ownership or occupancy, the new owner or tenant shall be notified the structure contains a graywater system.

All other graywater systems, aside from "laundry to landscape" types described above, require a construction permit prior to erection, retrofitting, construction, and installation as stated in the California Plumbing Code (California Code of Regulations Title 24, Part 5). Examples include:

- Simple system. A graywater system serving a one- or two-family dwelling, with a discharge of 250 gallons (947 L) per day or less.
- Complex system. A graywater system that discharges over 250 gallons (947 L) per day.

The updated code and its provisions for use of graywater to irrigate landscapes can be found in its entirety at the website www.hcd.ca.gov/codes/shl/2007CPC_Graywater_Complete_2-2-10.pdf.

It is important to note that cities, counties, and other local jurisdictions can impose stricter guidelines than the state. Homeowners interested in installing graywater systems should contact their local jurisdiction for specific regulations concerning graywater handling and use.

Important Definitions included in the California Graywater Code

Irrigation field. An intended destination for graywater in the receiving landscape including but not limited to a drip irrigation system, mulch basin, or other approved method of dispersal for irrigation purposes.

Disposal field. An intended destination for graywater including but not limited to a mulch basin or receiving landscape feature, graywater leach field, or other approved method of disposal.

Mulch basin. A type of irrigation or disposal field filled with mulch or other approved permeable material of sufficient depth, length, and width to prevent ponding or runoff. A mulch basin may include a basin around a tree, a trough along a row of plants, or other shapes necessary for irrigation or disposal.

The Basics of Laundry to Landscape Graywater Systems

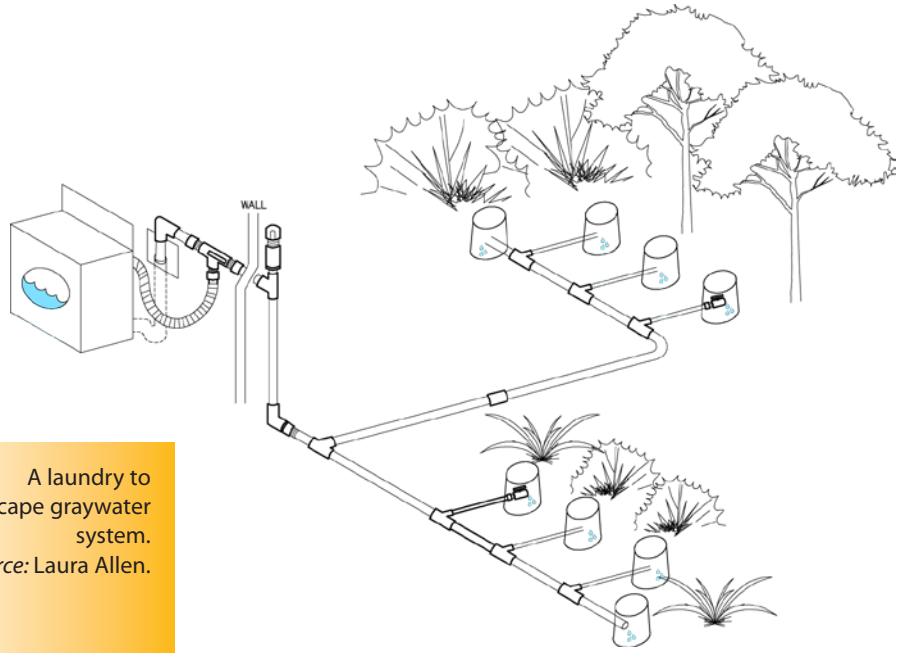
Laundry to landscape graywater systems are relatively inexpensive and simple to install. The number of cities and counties approving the use of these graywater systems without requiring permits is rapidly increasing. Metropolitan areas including Berkeley, Los Angeles, San Francisco, Santa Barbara, San Diego, and Santa Rosa no longer require permits for these systems. Some even offer rebates to install graywater systems, and many offer regular workshops on system design and installation. Specific details regarding system requirements,

rebates, and workshops can be found below.

- Berkeley: www.ci.berkeley.ca.us/Planning_and_Development/Energy_and_Sustainable_Development/Graywater_Clothes_Washer_System__Laundry_to_Landscape.aspx
- Los Angeles (City): ladbs.org/LADBSWeb/LADBS_Forms/InformationBulletins/IB-P-PC2014-012Graywater.pdf.
- San Francisco: sfwater.org/modules/showdocument.aspx?documentid=55
- Santa Barbara (County): www.waterwisesb.org/documents/greywater.pdf
- San Diego (City): www.sandiego.gov/water/recycled/graywater.shtml
- Santa Rosa: ci.santa-rosa.ca.us/departments/utilities/conserve/Pages/Graywater.aspx

How Do Laundry to Landscape Graywater Systems Work?

The hose exiting the clothes washing machine is attached to a valve that separates graywater from water destined for the sewer.



A laundry to landscape graywater system. *Source:* Laura Allen.

Laundry to landscape graywater system 3-way valve separates water destined for the sewer from water used to irrigate landscape plants. *Photo:* Central Coast Greywater Alliance

All water can be channeled directly into the sewer when bleach or powder-based detergents are used, when a graywater use quota is exceeded (a detailed explanation with examples is found on page 9 of the San Francisco design manual for outdoor use, sfwater.org/modules/showdocument.aspx?documentid=55), or when a rain event raises the groundwater level. Graywater is directed to and contained within an irrigation or disposal field. A vacuum break or backflow prevention device may also be needed. When using laundry to landscape systems it is important to select appropriate detergents and related cleaning products to reduce the chance of adverse effects on irrigated plants and the environment. Refer to the section "Benefits and Risks of Using Groundwater Systems," below, for help in selecting appropriate detergents and other products that are recommended for these systems.

An example of a mulch shield.
Photo: Greywater Action

Mulch Basins

The simplest laundry to landscape graywater systems often discharge water directly into mulch basins via mulch shields. Leaving an air space between the pipe and the ground helps prevent plant roots from growing into and clogging the graywater pipe.

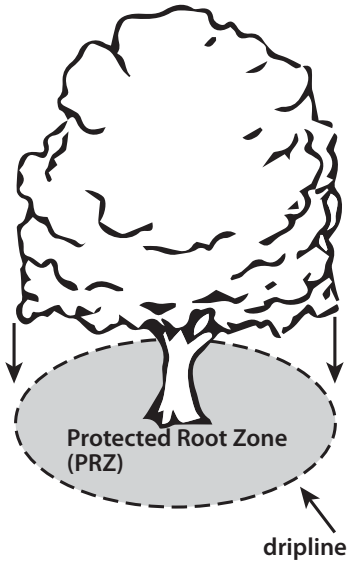
Mulch basins constructed by replacing several inches of soil with coarse organic mulch to irrigate flower beds and small ornamentals are common and are generally not problematic to plant growth. However, basins constructed within the drip line (see photo) of mature trees are not recommended and can result in injury to established roots and unstable and unsafe trees. How can this happen? Small, restrictive mulch basins may cause roots to grow in circular patterns and never grow outward beyond the mulch basin into native soil, potentially leading to tree failure.

If mulch basins are used, they must be sized correctly to prevent surface pooling and must be in accordance with Table 16A-2 from the plumbing code, shown below. Remember that graywater may not be allowed to sit unused for more than 24 hours and that the discharge point (disposal field) must have a two-inch or greater layer of mulch, rock, or soil or a solid shield to minimize human contact.

The size of the mulch basin depends mainly on soil texture (sandy loam, clay loam, etc.). Graywater percolates quickly through sandy soil, requiring minimal mulch. In slower-percolating clay loam soil, a larger mulch basin is required to prevent graywater pooling. Large wood chip mulch is more durable and longer lasting than smaller wood chip mulches or shredded fiber and is therefore preferred. A series of holes or valves that are between 3/8 inch and 1 inch in diameter should be added to reduce back pressure on the pump. Mature trees may require ten or more mulch basins to avoid overloading the pump and to achieve even distribution. For instance, if each basin is 4 inches in diameter (12.6 square feet) ten basins will irrigate 126 square feet of rooting area. Remember that mulch decomposes over time, requiring regular augmentation to maintain the required 2-inch depth.

Table 16A-2. **Design Criteria of Six Typical Soils**

Type of soil	**Square feet**	**Gallons**	**Square meters**	**Liters**
	Minimum square feet of irrigation or leaching area per 100 gal of estimated graywater discharge per day	Maximum absorption capacity in gallons per square foot of irrigation or leaching area for a 24-hour period	Minimum square meters of irrigation or leaching area per liter of estimated graywater discharge per day	Maximum absorption capacity in liters per square meter of irrigation or leaching area for a 24-hr period
coarse sand or gravel	20	5.0	0.005	203.7
fine sand	25	4.0	0.006	162.9
sandy loam	40	2.5	0.010	101.8
sandy clay	60	1.7	0.015	69.2
clay with considerable sand or gravel	90	1.1	0.022	44.8
clay with small amounts of sand or gravel	120	0.8	0.030	32.6



Tree roots should not be cut into or severed within the dripline. Irrigation water should be applied within the dripline and not on or near the main trunk. *Illustration:* University of Minnesota Cooperative Extension

Branched Drain Systems

Branched drain types (shown below) of graywater systems rely on gravity to distribute graywater to mulch basins. While often capturing graywater from showers, they can also be used in conjunction with washing machines as laundry to landscape systems. They work only when plantings are located below the water source since they do not contain an external pump. Branched drain systems are excellent methods of watering trees and shrubs. The final exit point of each branch is trees and shrubs in mulch basins. While these systems are relatively maintenance-free and efficient once installed, the installation process may be difficult, and homeowners may want to hire an expert to install them. Like other laundry to landscape systems, no filters need to be changed, no additional wiring or pumps are required, and cleanouts can be incorporated for regular, easy flushing.

Laundry Drum Graywater Systems

Laundry drum graywater systems pump household water into a surge tank, which is a large barrel or watertight storage container. Simple systems take advantage of gravity to move water downhill but are not suitable for upward elevations. The water drains out of the bottom of the drum into a hose that the homeowner can move around the yard as needed. Laundry drum systems are inexpensive and efficient methods of irrigating landscape plants. They are well suited to residential landscapes as well as small plantings maintained by apartment renters. When uphill pumping is required, drums (watertight temporary storage containers) connected to effluent pumps that move graywater uphill are needed. Since no filters are used in these systems, they are not compatible with drip irrigation due to clogging.

Common Questions about Graywater Systems

How much graywater can be harvested by a household washing machine?

On average, between 10 and 25 gallons of water is generated per washing machine load from a horizontal drum machine (side loader), and about 40 gallons per washer load is generated from a vertical drum machine that loads from the top. Since the maximum flow rate from newer, high-efficiency washers may be as low as 1.5 gallon per minute (far less than that of many top-loading machines), when using water from these washers it is important to limit the number of outlets per irrigation zone in the drain system to achieve the desired water distribution. The average amount of graywater

A branched drain graywater system, which relies on gravity. *Photo:* Central Coast Greywater Alliance

generated by one person per day recycled via a laundry to landscape system is estimated at 15 gallons. In comparison, per capita daily graywater production from showers, bathtubs, and lavatories is estimated at 25 gallons.

How many trees and shrubs can be irrigated using graywater from a laundry to landscape graywater system?

The number of plants irrigated depends on the amount of graywater generated, the climate zone, and the water requirements of the plants. For example, 200 gallons of graywater generated each week can keep four mature trees with high water requirements and canopies of 50 square feet well irrigated and healthy in Sacramento and Riverside/San Bernardino (inland climate zones). However, it would take 300 gallons of water to keep four similar trees healthy in hotter desert climates. Conversely, trees that require high amounts of water growing in coastal climates perform well on much less water. Drought-resistant plants that require only low amounts of water growing in coastal areas require the least amount of water under all circumstances.

Table 1 illustrates how many gallons of water per week well-established trees and shrubs of various canopy sizes require in July, the highest water-demanding month of the year. Keep in mind that under drought and water restrictions, most plants can be kept alive on less than half of these rates.

Can homeowners install their own laundry to landscape graywater systems?

Yes, but installing a system correctly requires time to acquire the necessary knowledge as well as knowing what components to purchase and where to locate them. Before starting, it is wise to consider enrolling in a "how to" class offered by local government jurisdictions. Greywater Action is a non-profit consortium that provides training on the design and installation of graywater systems to interested individuals, companies, and agencies. The Greywater Action website, greywateraction.org/business-directory/, contains a list of upcoming workshops as well as a list of trained personnel who have completed their training course. Other useful websites that detail design and installation are oasisdesign.net and the San Francisco Design Manual, sfwater.org/modules/showdocument.aspx?documentid=55

Larger-Scale, Complex Graywater Systems

Complex, multifaceted graywater systems using pumps, filters, and even smart controllers linked to weather stations to target irrigations based on real-time plant water needs are now being used to irrigate expansive plantings at apartments, condominiums, and other facilities. Installing these systems requires permits. Due to the required plumbing, pumping, filtering, energy requirement, and overall cost, their use is generally not justified in single-family

Table 1. Amount of water (gallons) required per week required in July for optimum growth in selected climates

Climate	Relative water requirement of tree or shrub	Gallons required for 50 square-foot canopy	Gallons required for 100 square-foot canopy	Gallons required for 200 square-foot canopy
Coastal (historical evapotranspiration = 1 inch/week)	low	10	19	38
	medium	16	31	62
	high	25	50	100
Inland (historical evapotranspiration = 2 inches/week)	low	19	38	76
	medium	31	62	124
	high	50	100	200
Desert (historical evapotranspiration = 3 inches/week)	low	28	57	114
	medium	47	93	186
	high	75	150	300

Source: Adapted from DWR 1995.

A residential landscape irrigated by a graywater system. *Photo: Sunset.com*

households with fewer than four or five residents. However, while the cost to design and install these systems can be high, their flexibility and efficiency often outweigh these disadvantages on large-scale sites.

Sand-filtered drip systems are excellent examples of these high-tech systems that fill a distinct and important void in the area of graywater reuse and water conservation. In these systems, graywater is temporarily stored in a tank with an effluent pump until it is needed for irrigation. Hair, lint, and other debris are filtered out before the graywater can be run through tubing and emitters to prevent clogging the system. An obvious advantage of these systems over simple mulch basins that require digging trenches in root zones of trees is that root damage is prevented and tree roots are not prone to circling and girdling in the mulch area over time. Other advantages are that these systems can irrigate uphill, downhill, and at level elevations, are fully automated, can be used in conjunction with smart controllers, and in most cases, use all graywater generated. If too little graywater is available potable water can be temporarily piped through the system.

For specific information on planning, design, construction, and management of complex graywater irrigation systems, contact the American Society of Irrigation Consultants (ASIC), www.asic.org/ or the Irrigation Association, www.irrigation.org.

Benefits and Risks of Using Graywater Systems

Specific benefits of using graywater to irrigate California landscapes include

- reduced reliance on potable water sources to irrigate landscapes
- reduced energy load otherwise required for pumping and treating potable water
- a sustainable, steady, and reliable water harvesting source in areas of the state with low rainfall where the potential for rain harvesting is negligible

Along with many potential benefits come potential risks, which should be carefully evaluated before deciding whether to install a graywater system. Graywater varies substantially in quality and potential risks from site to site. Without adequate natural rainfall, any system (including graywater) that discharges wastewater into garden soil can potentially add damaging concentrations of salts to the soil that can negatively impact plant health. Many household cleaning products, as well as many shampoos, soaps, and detergents, contain compounds that can pose significant human and environmental health concerns and can injure and even kill plants at high dosages over a short period of time; others can cause significant damage from smaller dosages over a longer period. Products containing high levels of sodium should not be used in laundry to landscape systems, and accumulated salts may need to be leached regularly through the soil. Products high in sodium include some detergents, whiteners, and water filtered through softener systems. In general, liquid detergents are lower in sodium and are therefore preferred over powdered products. Chlorine-based bleach should be avoided; oxygenated bleaches containing hydrogen peroxide are an excellent alternative.

Casa Dominguez, an affordable housing development in Los Angeles, uses washing-machine-generated graywater for landscape irrigation.
Photo: Benchmark Contractors, a Morley Builders Company.

Impact of Graywater on Human Health

Because of the recent changes regarding graywater reuse under California and other state statutes, research pertaining to the long-term impacts and risks of graywater reuse on human health, plant health, soil chemistry, and ground and surface water quality is very limited. An overview of current research-based information follows.

Research examining the microbial constituency of graywater indicates that direct contact with graywater can pose a health risk to humans (Maimon et al. 2010; WHO 2006). Pathogens can enter graywater through food sources in the kitchen, which is why use of graywater generated from kitchen sinks and dishwashers is not recommended. Also, because pathogens can enter graywater through fecal matter, water contaminated by dirty diapers should be avoided.

Pathogens posing the greatest concern in graywater include bacteria such as enterotoxigenic *Escherichia coli, Salmonella* spp., *Shigella* spp., *Vibrio cholera, Campylobacter* spp., *Clostridium perfringens*, and *Legionella* spp.; protozoans such as *Giardia* spp. and *Cryptosporidium* spp.; and viruses such as enteroviruses, hepatitis A, rotavirus, and Norwalk virus.

Some contaminants and pathogens active in sewage and sewage effluent can be translocated to fruits and vegetables grown in proximity. Results from study to study vary widely. Several studies (Gorbatsevich et al. 2013; Lopez et al. 2010; Morocco et al. 2007) found that microbiological contamination in municipal wastewater used to irrigate agricultural crops can pose significant risks from viruses, bacteria, and pathogenic protozoan/helminthes under certain conditions. A wide variety of growing conditions and maintenance practices, as well as climate and microclimate, influence adverse outcomes. Since graywater can contain some of the same contaminants as raw sewage (although in lower concentrations) such as fecal coliforms, they can register above international drinking, bathing, and irrigation water standards. Graywater can also contain pathogens derived from food handling and opportunistic pathogens found on skin. While to date there have not been any documented cases of graywater resulting in public health impacts, caution should be exercised, since it is difficult to trace illness back to its source in many cases.

In any case, graywater should not be applied directly to edible plant parts or root crops. To be safe, it should be applied only to nonedible ornamental plants. Splashing graywater on neighboring edible plants should be avoided. Graywater should not be applied through sprinkler systems, since droplets containing harmful microbes can become suspended in the air and inhaled.

Impact of Graywater on Soil Chemistry and Water Quality

Limited research has addressed the fate of microorganisms found in graywater and their resulting impact on indigenous soil microorganisms, soil chemistry, and water quality (Roesner et al. 2006; WHO 2006). Infiltration through soil, rock, and other materials that serve as filters can significantly diminish the threat of water pollution from graywater use. Unfiltered graywater accumulating in surface water and graywater seepage into nearby wells can diminish water quality, resulting in w pollution of waterways. Graywater, by California statute, cannot come in close contact with groundwater. The California plumbing code states that "no irrigation or disposal field shall extend within three (3) vertical feet (915 mm) of the highest known seasonal groundwater, or to a depth where graywater contaminates the groundwater, ocean water

or surface water" (California Building Commission Standards 2013). When graywater is applied per these provisions, risks are greatly reduced and/or prevented.

Impact of Graywater on Plant Health

Because graywater is often rich in nutrients required for plant growth, ornamental plants may benefit from its use. However, graywater may include high levels of sodium, potassium, and calcium, which can increase pH (alkalinity). Since many California soils are alkaline (pH above 7.0) to begin with, soil tests should be conducted to determine whether sulfur should be added to reduce the pH to optimize growth of alkaline-sensitive plants. Ornamental plants vary dramatically in their sensitivity to the wide array of potentially harmful salts found in graywater, particularly over a long-term basis. In general, evergreen trees are more salt sensitive than deciduous trees. Very little is known regarding the impact of graywater use on annual bedding plants. More research is needed on the impact of graywater on plant health, since the chemical composition of graywater is different than that of treated wastewater and surfactants are widely used in household cleaning products.

Regardless of what graywater system is chosen, the following precautions should always be taken.

- Carefully label all valves and pipes associated with your graywater system and prevent backflow.
- Do not store graywater more than 24 hours.
- Wear gloves and do not come into direct contact with graywater.
- Do not let graywater pool or run off of the soil surface or come into contact with well water.
- Do not irrigate edibles with graywater or allow it to splash on neighboring edible plants.
- Do not irrigate turfgrass or ground cover areas with graywater, since potentially harmful microorganisms can remain on the surface.
- Do not use graywater contaminated with human waste, infectious disease organisms, grease, paint residue, gasoline, solvents, or other chemicals found in household and industrial products.
- Keep the graywater system simple and avoid systems requiring heavy upkeep and maintenance.
- Contact a professional with experience designing and installing graywater systems if you lack the specific skills required for design and installation.

References

California Building Standards Commission Standards. 2013. Part 5: California Plumbing Code. www.iapmo.org/Pages/2013CaliforniaPlumbingCode.aspx.

California Department of Housing and Community Development. 2015. State of California Graywater Code. Cal HCD website, www.hcd.ca.gov/codes/shl/Preface_ET_Emergency_Graywater.pdf.

DWR (California Department of Water Resources). 1995a. Using greywater in your home landscape. Sacramento: DWR.

———. 1995b. Using greywater in your home landscape. California Department of Housing and Community Development website, www.hcd.ca.gov/codes/state-housing-law/preface_et_emergency_graywater.pdf

Gorbatsevich, E., S. Sela, R. Pinto, and N. Bernstein. 2013. Root internalization, transport and in-planta survival of *Salmonella enterica* serovar Newport in sweet basil. Environmental Microbiology Reports 5(1): 151–159.

Lopez, A., A. Pollice, G. Laera, A. Lonigro, and P. Rubino. 2010. Membrane filtration of municipal wastewater effluents for implementing agricultural reuse in southern Italy. Water Science & Technology 625:1121–1128.

Maimon, A., A. Tal, E. Friedler, and A. Gross. 2010. Safe on-site reuse of greywater for irrigation—A critical review of current guidelines. Environmental Science and Technology 44:3213–3220.

Morocco, Y., L. Karamoko, et al. 2007. Bacterial pathogens recovered from vegetables irrigated by wastewater in morocco. Journal of Environmental Health 69:10 (June): 47–51.

Roesner, L, Y., M. Qian, M. Criswell, and S. Klein. 2006. Final report: Long-term effects of landscape irrigation using graywater. Literature review and synthesis. Alexandria, VA: Water Environment Research Foundation. PubMedwebsite, www.urbanwater.colostate.edu/A1_Published_Report_03CTS18CO.pdf.

San Francisco Graywater design manual for outdoor use. 2012. San Francisco Water Power Sewer website, sfwater.org/modules/showdocument.aspx?documentid=55.

WHO (World Health Organization). 2006. Guidelines for the safe use of wastewater, excreta and greywater. WHO website, www.who.int/water_sanitation_health/wastewater/gsuww/en/index.

Wu, L., and L. Dodge. 2005. Landscape plant salt tolerance guide for recycled water irrigation. Special report to the Elveina J. Slosson Research Endowment Fund. Davis: University of California, Davis, Department of Plant Sciences. DWR website, www.water.ca.gov/wateruseefficiency/landscapeordinance/Model-Water-Efficient-Landscape-Ordinance/Documents-Relied-Upon/PlantSelection_RecycledWater_UCANR.pdf.

To order or obtain ANR publications and other products, visit the ANR Communication Services online catalog at anrcatalog.ucanr.edu/ or phone 1-800-994-8849. You can also place orders by mail or FAX, or request a printed catalog of our products from

University of California
Agriculture and Natural Resources
Communication Services
1301 S. 46th Street
Building 478 – MC 3580
Richmond, CA 94804-4600

Telephone 1-800-994-8849
510-665-2195
FAX 510-665-3427
E-mail: anrcatalog@ucanr.edu

©2015 The Regents of the University of California. This work is licensed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License. To view a copy of this license, visit creativecommons.org/licenses/by-nc-nd/4.0/ or send a letter to Creative Commons, PO Box 1866, Mountain View, CA 94042, USA.

Publication 8536

ISBN-13: 978-1-60107-932-9

The University of California Division of Agriculture & Natural Resources (ANR) prohibits discrimination against or harassment of any person participating in any of ANR's programs or activities on the basis of race, color, national origin, religion, sex, gender identity, pregnancy (which includes pregnancy, childbirth, and medical conditions related to pregnancy or childbirth), physical or mental disability, medical condition (cancer-related or genetic characteristics), genetic information (including family medical history), ancestry, marital status, age, sexual orientation, citizenship, or service in the uniformed services (as defined by the Uniformed Services Employment and Reemployment Rights Act of 1994: service in the uniformed services includes membership, application for membership, performance of service, application for service, or obligation for service in the uniformed services) or any person in any of its programs or activities.

University policy also prohibits retaliation against any employee or person participating in any of ANR's programs or activities for bringing a complaint of discrimination or harassment pursuant to this policy. This policy is intended to be consistent with the provisions of applicable State and Federal laws.

Inquiries regarding the University's equal employment opportunity policies may be directed to Linda Marie Manton, Affirmative Action Contact, University of California, Davis, Agriculture and Natural Resources, 2801 Second Street, Davis, CA 95618-7779, 530-750-1318. For information about ordering this publication, telephone 1-800-994-8849.

For assistance in downloading this publication, telephone 530-750-1225.

An electronic copy of this publication can be found at the ANR Communication Services catalog website, anrcatalog.ucanr.edu/.

UC PEER REVIEWED

This publication has been anonymously peer reviewed for technical accuracy by University of California scientists and other qualified professionals. This review process was managed by ANR Associate Editor for Land, Air, and Water Sciences Anthony O'Geen.

pr-08/15-SB/CR